

Compendium of Postgraduate Research

Sriyani Ileperuma



National Library and
Documentation Services Board of Sri Lanka

Compendium of Postgraduate Research

Theses and Dissertations Submitted to the University of Peradeniya
Sri Lanka
1997-2013

Sriyani Ileperuma
Compiler



National Library and Documentation Services Board of
Sri Lanka
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Compendium of postgraduate research

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I owe special thanks to Prof. Piyadasa Ranasinghe, Senior Professor, Department of Library and Information Science, University of Kelaniya, a doyen in the field of Librarianship for recognising the value of producing this compendium. His encouraging words inspired me in producing this publication. I deeply appreciate Prof. Ranasinghe's contribution in writing the foreword for this compendium in spite of his numerous commitments.

I am deeply indebted to Mr. Sunil Walimuni, the Director General, National Library and Documentation Services Board (NLDSB) for his generous gesture in undertaking the task of publishing this compendium. Publishing a compendium comprising of bibliographic information on theses and dissertations, the NLDSB could provide a valuable service in disseminating information on original research findings, which are mostly unpublished, among local and foreign scholars.

This work would never have come to life without the encouragement, commitment and tireless support of Dr. Premila Gamage, Librarian, Institute of Policy Studies. She has been very patient and generous in sharing her knowledge and experience with me. Her enthusiasm about this project guided me throughout the process of its completion. Without her assistance and dedicated encouragement in all stages throughout the process, this compilation would have never been accomplished. I would like to record my heartfelt gratitude for her constant support and bearing with me over these past four years.

I would also like to acknowledge the contributions of the staff of the Science Library, University of Peradeniya who have helped me in numerous ways in collecting bibliographic information of the theses collection.

I am both humbled and tremendously grateful for all those voices who assisted me in the compilation of this compendium.

Sriyani Ileperuma

Table of Contents

Message from Director - PGIS	i
Message from Director General - NLDSB	ii
Foreword.....	iv
Preface	vi
Acknowledgement	vii
1 Biochemistry and Molecular Biology	1
Ph.D. Dissertations	1-3
M.Phil Theses	3-19
M.Sc. Research Project Reports	19
Clinical Biochemistry.....	19-23
Experimental Biotechnology.....	23-28
2 Chemical Sciences	29
Ph.D. Dissertations	29-61
M.Phil Theses	61-111
M.Sc. Research Project Reports.....	111
Analytical Chemistry	111-127
Chemical Ecology and Pesticide Chemistry	128
Industrial Chemistry.....	129-132
Nanoscience and Nanotechnology	132-135
3 Earth Sciences	136
Ph.D. Dissertations	136-137
M.Phil Theses	137-153
M.Sc. Research Project Reports.....	153
Disaster Management.....	153-160
Engineering Geology and Hydrogeology.....	160-163
Gemmology and Industrial Minerals	163-165
GIS and Remote Sensing	165-173
Oceanography.....	173-174
Water Resource Management.....	174-176
4 Environmental Sciences.....	177
Ph.D. Dissertations	177

M.Phil Theses.....	178-181
M.Sc. Research Project Reports	182
Biodiversity, Ecotourism and Environmental Management	182-183
Environmental Science	183-200
5 Mathematics	201
M.Phil Theses.....	201-203
M.Sc. Research Project Reports	203
Industrial Mathematics	203-205
6 Physics	206
Ph.D. Dissertations	206-218
M.Phil Theses.....	219-233
M.Sc. Research Project Reports	233
Medical Physics	233-237
Physics	238
Physics of Materials	238-244
7 Plant Sciences	245
Ph.D. Dissertations	245-260
M.Phil Theses.....	260-287
M.Sc. Research Project Reports	287
Biodiversity Conservation Management	287-288
Medical Microbiology	288-292
Plant Sciences	292-295
Postharvest Technology of Fruits and Vegetables	295-303
Wildlife Ecology and Management	303-304
8 Science Education	305
Ph.D. Dissertations	305-307
M.Sc. Research Project Reports	307-348
9 Statistics and Computer Science	349
M.Phil Theses	349-354
M.Sc. Research Project Reports	355
Applied Statistics	355-368
Computer Science	368-396
10 Zoological Sciences	397
Ph.D. Dissertations	397-404

M.Phil Theses	404-414
M.Sc. Research Project Reports	414
Fish and Wildlife Management	414-415
Parasitology	415-416
Title Index	417-455
Author Index	456-470
Supervisor Index	471-480

Message from Director - PGIS

The Postgraduate Institute of Science (PGIS) is a national institute attached to the University of Peradeniya. The PGIS, under its ten Boards of Study covering all aspects of science, has produced several hundred postgraduate degrees in various disciplines since its inception in 1996. Most of the research projects conducted by students of the PGIS are of national significance which would lead to significant discoveries. The end product of these research projects are Theses/Project Reports, and information provided in these documents would thus be beneficial to researchers in many aspects such as,

- Identification of areas of scientific research that have been undertaken,
- Findings of critical scientific issues in the nation,
- Identification of areas of scientific research that are difficult to be performed,
- Design of new projects.

Nevertheless, there is no single document to track down the information on postgraduate research projects that have been completed under the PGIS, although access to available literature is an integral part in designing and completing research, and carrying out innovations.

Having identified the necessity of providing information on these documents, Mrs. Sriyani Ileperuma, the Librarian of the Faculty of Science, University of Peradeniya, has compiled the information of the Ph.D. Theses, M.Phil. Theses and M.Sc. Project Reports of students who have completed the postgraduate degrees at the PGIS within the period from 1997 to 2013.

The author has included abstracts and titles of Ph.D. and M.Phil. theses, and titles of M.Sc. Project Reports, together with the names of the authors (graduands), under each Board of study: Biochemistry & Molecular Biology, Chemical Sciences, Earth Sciences, Environmental Science, Mathematics, Physics, Science Education, Statistics & Computer Science, Plant Sciences and Zoological Sciences. In addition, supervisor index is attached as a supplement which provides a ready guide for the supervisors to trace their work and for the students to familiarize with the work of scientists.

I have no doubt that this book on "Compendium of Postgraduate Research" will be of immense benefit to both local and international researchers, in particular those who conduct research as students of the PGIS and their research supervisors. I congratulate Mrs. Ileperuma for her efforts in producing this valuable book.

Prof. Namal Priyantha
Director
Postgraduate Institute of Science
Peradeniya
Sri Lanka

Message from Director General - NLDSB

Postgraduate theses and dissertations in Sri Lanka represent a wealth of information because of their national relevance and also as they are often unpublished. Even when they are published, these works may not be readily accessible. In this context, comprehensive bibliographic details of theses/dissertations of Sri Lankan scholars will be of immense benefit to present and future researchers.

In the past, several institutes have made a number of efforts to record bibliographic details of postgraduate theses/dissertations of Sri Lankan scholars. The library of the University of Peradeniya initiated the endeavour in 1971 by publishing an index to theses covering the period of 1942-1971. Subsequently supplementary indexes were published in 1977, 1983. The coverage of these indexes limited to the theses deposited in the University of Peradeniya Library. The index published in 1992 (1942-1992) by them contains many of the theses given to the University of Peradeniya by its teachers who have carried out their postgraduate studies abroad and submitted to various universities worldwide.

In 1978, the National Library and Documentation Services Board (NLDSB) took the initiative to compile holdings of theses/dissertations with a broader coverage to include those submitted to libraries of universities, postgraduate institutes and research institutes. Of these, the Index to Postgraduate Theses 2007-2010 Volume I is the last publication in this series.

In addition, there are other indexes on theses/dissertations published by the state sector organisations such as the Materials and Manpower Division of the Ministry of Finance and Planning (1984) and the National Science Foundation then the Natural Resources, Energy and Sciences Authority (no date).

Apart from these institutional publications, there are a few theses/dissertations indexes compiled by individuals which are deposited at the National Library.

During the past three decades with the expansion of the higher education system increasing the number of universities, postgraduate institutes and research institutes, there has been enhanced research activity and a phenomenal increase in the number of theses and dissertations submitted. With the increase in the number of graduates, there is an increasing tendency for them to carry out postgraduate research locally.

The indexes so far compiled encompass all disciplines and the present bibliography by Sriyani Ileperuma covers only those theses/dissertations submitted to the Postgraduate Institute of Science from its inception in 1996 in the area of pure sciences. Therefore, this can be considered as a unique collection which is timely and is a significant contribution to bibliographic work in Sri Lanka.

The National Library under its mandate carries on activities such as national union catalogue, newspaper article index, periodical article index, current and retrospective national bibliographies. It is therefore, pertinent for the National Library to undertake the task of

publishing this index on Postgraduate theses/publications submitted to the PGIS dealing exclusively the discipline of Science. This work fulfils a void that is commendable and useful to those researchers and postgraduate students.

Sunil Walimuni
Director General
National Library and Documentation Services Board
14, Independence Avenue
Colombo 7
Sri Lanka

27 September 2014

Foreword

In the unfathomable ocean of information, the bibliographical databases such as indexes and bibliographies are the lighthouses which help navigators to reach their destinations safely. Without such tools it is unthinkable for any researcher to find information relevant to their fields of study. Information essential for researchers are contained in information carriers such as books, journal articles, electronic or digital publications as well as manuscripts such as theses and dissertations. However, this mass of information is not accessible if no bibliographical information on them is readily available. It is the bibliographical information tools, namely indexes and bibliographies that provide information on such information carriers or containers. Thus these bibliographical information tools play an important role in the provision of access to sources of information.

The present compendium of research theses and dissertations submitted to the Postgraduate Institute of Science, University of Peradeniya, a firsthand bibliographical tool compiled by Sriyani Ileperuma is to be evaluated within this context. The Postgraduate Institute of Science, an institute attached to the University of Peradeniya, since its inception in 1996 has produced a good number of postgraduate research theses submitted for the degrees of Ph.D., M.Phil. and M.Sc. These research theses cover a wide range of topics which address the scientific problems pertaining to the national context. Hence, the findings of these theses are directly related to the socio-economic development of the country in particular and the rest of the world in general. However, as these valuable sources of information have so far not been properly indexed with necessary bibliographic details, the interested researchers or users will find it difficult to access them. The present compendium provides the answer to this serious problem.

The compiler has arranged all Ph.D. Dissertations, M.Phil. Theses and M.Sc. Project Reports under ten broad subject areas namely Biochemistry & Molecular Biology, Chemical Sciences, Earth Sciences, Environmental Science, Mathematics, Physics, Science Education, Statistics & Computer Science, Plant Sciences and Zoological Sciences. Under each entry the following bibliographical information is given: title, author, physical description, degree and year, location number and any other information that would be useful to the searcher. Abstract of the dissertation or thesis is also given after each entry. Thus the compilation provides all necessary information on the cited work.

In addition, the compilation is augmented by an extensive title index, author index and a supervisor index. The supervisor index is a new addition to a compilation of this nature and it is a useful guide to academic supervisors as well as bibliometric researchers. The presence of abstracts compensates the absence of a subject index.

Printed bibliographical tools of different disciplines are widely used by the academics in information searching. An online version of this compendium would satisfy the interest of those who use internet regularly for information searching. However, compared to the digital format, this type of printed compendium provides complete information classifications such as Boards of Study and also under theses offered by various courses by each Board of study. Such information

is not offered by the present databases available on postgraduate research. The printed form also makes it easy to carry around to be used at the reader's convenience.

Sriyani Ileperuma's contribution is indeed a landmark in the field of bibliographical tools in Sri Lanka, especially in the discipline of science. It is my earnest opinion that this work, in addition to its intended value as a bibliographical tool, will spur librarians and information workers in the production of similar tools to ease the burden of information searching by scholars.

Piyadasa Ranasinghe
Senior Professor in Library and Information Science
University of Kelaniya
Kelaniya
Sri Lanka

07 September 2014

Preface

The Postgraduate Institute of Science (PGIS) is a national institute attached to the University of Peradeniya, Sri Lanka. The PGIS was established in 1996 by an ordinance from the Ministry of Higher Education in order to promote Postgraduate Science Education and promote Research and Development in the various scientific disciplines. The principal objective of the Postgraduate Institute of Science is to promote and provide postgraduate instruction, training and research in various scientific specialties, enhancing the academic experience of the graduates. The academic programmes of the PGIS are conducted through ten Boards of Study and these programmes are conducted in close collaboration with the Faculty of Science, University of Peradeniya. Being situated in the premises of the University of Peradeniya, it provides an ideal environment for intellectual activities particularly in interdisciplinary areas. The PGIS has the opportunity of obtaining services from academic staff members who have obtained their postgraduate qualifications from some of the best universities in the world. The members of the teaching panels are drawn from the eight faculties of the University of Peradeniya, as well as from other universities and institutes. The excellent research facilities available at the Faculty of Science and other science based faculties of the University of Peradeniya and research institutions in the country are used to provide research training to students.

Currently, the PGIS offers M.Sc., M.Phil. and Ph.D. programmes as well as other postgraduate diploma and certificate courses. It has become the leading degree awarding institute in Sri Lanka for postgraduate research and education in scientific disciplines. During the past 14 years the PGIS has awarded, through the University of Peradeniya, more than 1000 postgraduate degrees (Ph.D., M. Phil. and M. Sc.) in different disciplines of Science.

This compendium consists of bibliographic details pertaining to 1390 Ph.D, M.Phil and M.Sc. thesis coming under the different Boards of study in the PGIS from its inception to the end of 2013. Author abstracts of Ph.D. and M.Phil. theses are included along with the basic details of the M.Sc. theses. There were several grammatical and spelling mistakes in the abstracts and no attempt was made to correct any such errors. However, certain minor corrections have been made to increase uniformity, clarity and accuracy.

While some of this information is available over the University of Peradeniya Library web page, the printed format provides advantages such as cross referencing and location of thesis, according to the names of supervisors and authors. It is our belief that access to this compendium is valuable for supervisors in order to keep track of their contributions in their academic fields.

With the advent of internet based resources, there is the question whether the printed materials are appropriate and worthy of use. The answer is complex and this is because of the librarian's mission to meet the current and future needs of its clientele. Print materials still form the backbone of a library and the changing patterns in the web based technological developments have inherent risks for libraries. There is an increasing tendency to shift to web based information as providers of knowledge and librarians have an important role to harness its strengths while educating its patrons on their weaknesses.

One inherent problem is the false contention that all information is available in the web as free or paid services. Most of the world's published literature still exists in the print form and digitising such an enormous amount of print is a herculean task. Printed format is adept at providing information at a glance without having to scroll down hundreds of pages in a digitised document. Also, referring back to earlier pages through scrolling up is also time consuming compared to a printed book. Users should be skilled at retrieval mechanisms such as formulation of precise search strategies without which the final outcome would not be successful. A printed index helps to overcome this drawback as the total collection of information is in the hands of the user making it possible to analyse the contents without missing any item.

The general public with no access to an academic library increasingly use internet resources to obtain information on a multitude of issues ranging from politics, news and medicine. However, an academic library has a role to provide authoritative information to its readers to support research and scholarship. Information on internet is always not authoritative and data are liable to be changed or destructed. Many online publications are not subjected to thorough reviewing, editing or checking for accuracy. It has also been pointed out that even fee-based online resources suffer from the same fate and may report false information from titles to content. Print material cannot be changed in this manner and will remain for a long time without any alterations possible while the destruction or accidental erasing of an e-resource destroys the original document making verification and retrieval impossible for a future generation. Organisations dealing with databases can abruptly terminate the links in order to make way for new materials and also to weed out low-use resources. This is a tragedy since some valuable data may be lost for ever and information that is of no value today may suddenly become important in the future. Cyber-hacking and corruption of databases with no effective firewalls and back-ups suffer the same fate.

Printed books and journals have lifespans of centuries and the Science Library is in possession of journals dating back to 1786 still in readable form. E-documents, on the other hand are short lived owing to rapidly changing digital technologies. The printing industry has standards they adhere to such as the quality of the paper, binding methods and comprehensive editing. There are no such standards for electronic resources and many errors, both factual and grammatical inadvertently creep into these documents. Also, while the printed version of a book is available for inter-library loans serving a larger clientele, there is no provision to share databases with other libraries in the country due to the high cost of multi-user facility.

E-resources also have several advantages. When technology has permeated to every aspect of our lifestyles from mobile phones, information over internet, skype and rapid communication through electronic mail, the value of obtaining scholarly information through internet cannot be under-valued. Printed materials require gathering information, publishing them in printed form and physically delivering them to subscribers. Internet resources, on the other hand, provide easy and immediate access to the reader. Furthermore, updating information in e-resources is fast and efficient. This is important for researchers to keep up with the latest developments in a research area at the touch of a button. Online databases provide instant access through Boolean searching, nested queries and often with access to full text articles. They also do not occupy

physical space when compared to print sources. Also, cross referencing is much easier through internet when compared to searching printed material in a library by going from one stack to another.

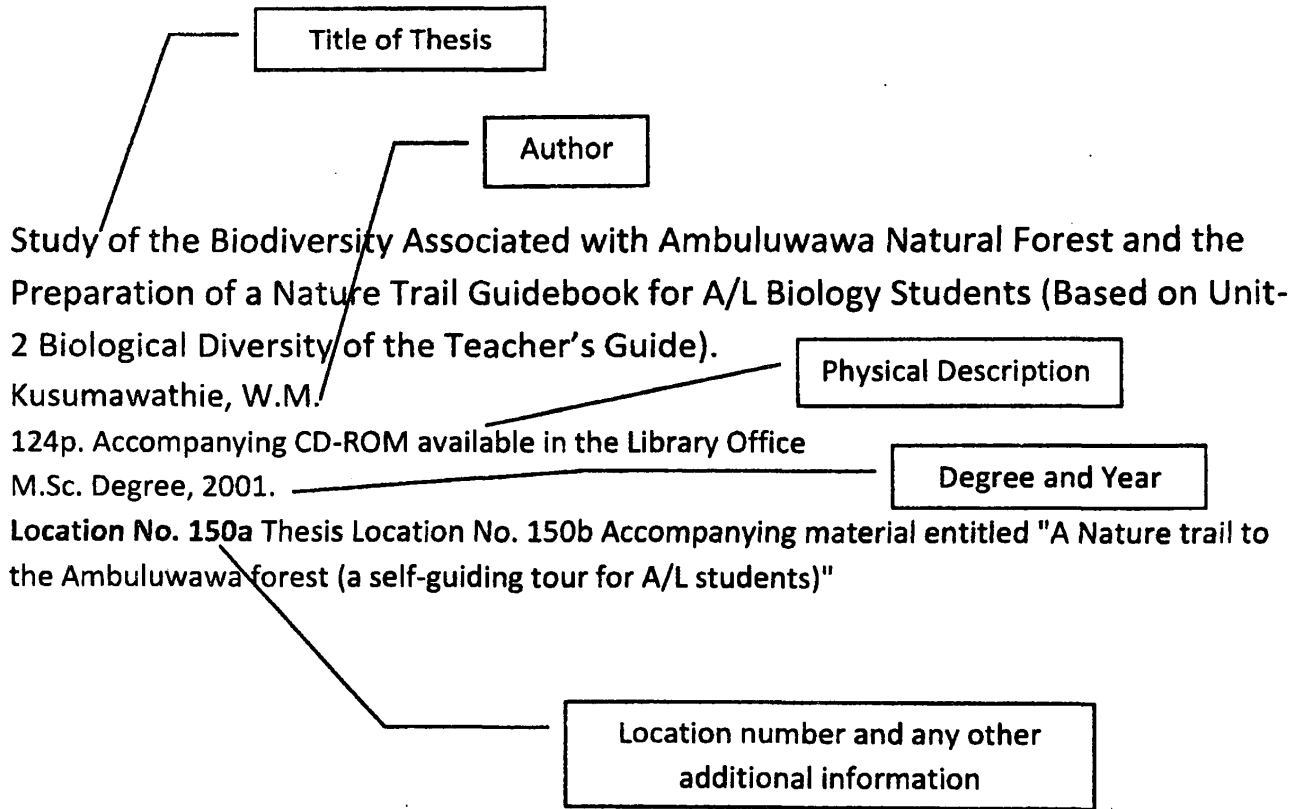
Print and electronic information have their own inherent advantages and disadvantages. Both types are important and should ideally complement each other. Librarians have a special role in providing the appropriate media for relevant information to its readers. Over dependence on one type of resource is not useful to obtain the maximum services and information for a researcher.

The online collection of the abstracts of M.Sc., M.Phil. and Ph.D. degrees of the PGIS is available in the Digital Library from the University of Peradeniya Library web site. There is a total of 1019 entries relating to all the eight Faculties providing titles along with their abstracts with respect of the dissertations, thesis and research reports submitted between 1999 and 2012. However, this collection is not arranged in any particular sequence by the subject area or the different Boards of study. Therefore, a reader has to scroll through the entire collection to find any relevant information. Unlike print media, electronic documents require access to internet and a computer and many postgraduate students still lack such basic amenities. Also, presently, the digital library containing the few abstracts of theses is accessible only through the University Wide Area Network. Often a supervisor or a student will have to be aware of the research already done before embarking on a new project. This type of information can be readily scanned merely by turning pages in a printed book and examine what has been done and by whom in order to formulate a new project. It is in this context that this index has been compiled which will be useful to both students and staff.

This compendium contains valuable information on the scientific research carried out in the sciences and allied fields in Sri Lanka particularly on problems relevant to Sri Lanka. It will serve as a sourcebook of research carried out on nationally relevant problems for organisations such as Universities, Research Institutes, Government Institutions and even private sector organisations. Some of this information is unpublished and a proper record of such unpublished data may have future use if the information is available in a printed format without which they will simply go into oblivion.

Sriyani Ileperuma
Deputy Librarian
Science Library, University of Peradeniya
Sri Lanka
20 September 2014

Sample Entry



1 - BIOCHEMISTRY AND MOLECULAR BIOLOGY

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Project Reports

Ph.D. Dissertations

1.1

Effect of Coconut Fat on Serum and Aortic Tissue Lipids, and Endothelial Dependent Relaxation of Blood Vessels: A Study in Guinea Pig.

Edirisinghe, E.M. Indika

177p.

Ph.D. Degree, 2005.

Location No. 546

Abstract

Atherogenicity of saturated fat is well documented. Coconut fat is a rich source of cholesterologenic-saturated fatty acids (CSF). Sri Lankans use coconut extensively to prepare their daily food and have a high dietary intake of coconut fat. Although coronary heart disease is one of the leading causes of death in Sri Lanka, the role of coconut consumption remains controversial.

The present study was undertaken in an animal model to test the hypothesis that a diet rich in coconut fat induces atherosclerosis. The experiments were done on guinea pigs, which lipid metabolism is similar to that of humans. The anti-atherogenic effect of grape seed extract (GSE) was also studied. This extract is abundant in polyphenolic antioxidants.

Study was done in two phases. The animals in each phase were age and weight matched. Groups of guinea pigs (n=6) were assigned to different isocaloric diets containing 5% (w/w) fat. Fat content was varied as follows: coconut oil (Co), coconut + corn oil (1:1)(Co+Cor) and corn oil (Cor). After 12 weeks of feeding, animals were sacrificed and blood and aortic tissue were collected to estimate total cholesterol, serum and aortic fatty acids in one study and lipid profiles and epithelium dependent relaxation (EDR) in the other. Same measurements were made in an animal group fed the Co diet with 1 mg GSE/g food.

The animals that consumed Co diet had the significantly high concentrations of plasma total cholesterol (77%), LDL cholesterol (97%), HDL cholesterol (53%), serum CSF (16%) and aortic cholesterol (51%) compared to the lowest values reported in animals fed Co+Cor diet. Bradykinin induced EDR was significantly lower in animals fed Co (24%) compared to animals fed Co+Cor diet.

Feeding the Co diet with GSE significantly reduced the aortic cholesterol (29%), but did not prove plasma lipid profiles and EDR. GSE caused EDR even when the vessels were not responsive to acetylcholine.

It is concluded that coconut fat is atherogenic in the guinea pig. This conclusion is based on the high cholesterol content of the aorta and impaired bradykinin induced EDR in animals fed the Co diet. Partial replacement of dietary saturated coconut fat with unsaturated corn fat improved serum lipids.

1.2

Molecular Detection, Quantification and Characterisation of Hepatitis C Virus Strains in Sri Lanka.

Senevirathna, D.B.

203p.

Ph.D. Degree, 2010.

Location No. 940

Abstract

The Hepatitis C Virus (HCV) was first identified in 1989 and since then HCV infection has become an increasing public health concern. The World Health Organization (WHO) estimated that in the year 2000, at least 160 million were infected and over 3 million new cases were reported each year. The global prevalence rates of HCV infection vary with geographic region and according to the WHO, 2.15% of the Asian population is infected. Sri Lanka was one of the few countries in the world which did not have data relating to the occurrence and molecular characterization of HCV. Therefore, the main objective of this study were to develop and apply molecular methods for the detection, quantification and characterization of HCV strains found in Sri Lanka.

Low-cost in-house RT-PCR based methods were developed for the qualitative and quantitative detection of HCV and determination of the prevalence of HCV Ribonucleic Acid (RNA) among liver disease patients in Sri Lanka. Genetic diversity among the HCV RNA positive cases was estimated in terms of genotypes by type-specific amplification and sequence analysis. Phylogenetic analyses were performed on HCV sequences to determine the relatedness of Sri Lankan strains to global strains.

Of a cohort of 1933 liver disease patients, 214 (11.07%) were positive for anti-HCV antibodies and 49 (2.5%) were positive for HCV RNA. The data suggests that the occurrence of HCV among the liver disease patients is relatively low in Sri Lanka. Of 49 positively tested patients, 11 (22.44%), 13 (26.53%), 6 (12.24%), 6 (12.24%), 8 (16.32%) and 1 (2.04%) were found to be genotype 1a, 1b, 2a, 2b, 3a mixed infection of genotypes 1b and 2b respectively. Four (8.16%) samples could not be typed with the type-specific PCR assay which was used in this study. The most prevalent genotype among the liver disease patients in Sri Lanka is genotype 1. The type-specific PCR done in this study was found to have concordance 95% in specificity and 96% in sensitivity against the nucleotide sequencing which is the gold standard method for HCV genotyping. According to the phylogenetic analysis of studied sample population it is possible to say that HCV genotypes 1 and 2 found in Sri Lanka are most closely related to HCV strains from western countries such as USA, UK and France and there was a clear segregation of genotype 3 strains which showed a close affinity to strains from Thailand.

1.3

Protein, Energy, Zinc, Iron and Vitamin A Nutriture in Children (3 - 5 Years) of Low Socio-economic Status in Kandy, Sri Lanka.

Karunaratne, Anjani M.

238p.

Ph. D. Degree, 2007

Location No. 699

Abstract

This study was undertaken to assess the micronutrient adequacy, with special reference to zinc (Zn) in rural children (3-5 y, n=160), whose diets were primarily cereal based. The dietary

intakes of children were assessed qualitatively (24 hour recall, n=68; Food frequency questionnaire, n=50) and quantitatively (n=21). Micronutrient levels in blood and hair were assessed and followed by a Zn supplementation study to see whether undernutrition could be corrected.

Anthropometric assessment at baseline (n=137) showed that the z scores of boys for stunting and underweight indices were significantly ($p=0.01$) lower than that of girls. Compared to the recommended daily intake, the mean energy intake was 89%, where as protein intake was two fold higher. Micronutrients and calcium intakes were inadequate.

The mean biochemical indices measured (plasma Zn, hair Zn, Ferritin, hemoglobin, and retinal binding protein) were above the cut off levels but the percentage of children below the cutoff levels for the two Zn indices were 25% and 38% respectively. Similarly, 40% of the children were anaemic.

The main sources of Zn and iron (Fe) nutrition were rice (0.54 to 1.46 mg/100 g; 0.54 to 1.46 mg/100 g), wheat flour (0.21 to 0.96 mg/100 g and 0.12 to 6.25 mg/100 g). Green leaves contributed to the rest. Phytic acid (antinutrient) level was high in the diet and may have contributed to micronutrients being less bioavailable.

Zn supplementation did not benefit the children of this study. One of the major constraints was that children dropped out resulting in a small sample size (n=106) for analysis. In general, the nutrient supplementation that was given to both Zn and placebo groups appeared to have corrected the clinical signs and symptoms and reduced specific deficiencies at an individual level. For example, in both Zn and placebo groups, the Zn status of children at below cut off improved after nutrient supplementation. It appears that Zn deficiency is not a major problem in this sample. However, a larger sample should be assessed before making a final conclusion. The existence of multimicronutrient deficiencies is suggestive. Although nutrient supplementation did correct some biochemical indices, it was not reflected in the status of anthropometry. It is prudent to assume multimicronutrient deficiencies and attempt dietary interventions rather than artificial supplementation.

M.Phil. Theses

1.4

Bioactivities of *Alpinia calcarata* Rosc. Rhizome.

Arawwawala, L.D.A.M.

190p.

M.Phil. Degree, 2006

Location No. 531

Abstract

Rhizomes of *Alpinia calcarata* Rosc. (Zingiberaceae) are recommended as an aphrodisiac and used in traditional medicine of Sri Lanka to treat bronchitis, cough, respiratory ailments, diabetics, asthma and arthritis. However, validity of these claims has not been scientifically proved so far except the anti-inflammatory activity (using a single dose of the decoction). Further, it is reported to have antibacterial, antifungal, anthelmintic and insecticidal activities. The toxic effects of the rhizomes are not known and it may possess new bioactivities. Therefore, the objectives of this study were to (1) investigate the antioxidant, antinociceptive and gastroprotective activities and mode of actions which are not reported yet (2) scientifically validate the antidiabetic and anti-inflammatory activities which are claimed by Aryurvedic physicians and investigate their mode of actions (3) standardization of *A. calcarata* extracts

and (4) toxicological studies. These objectives were carried out using hot water extract (HWE) and hot ethanol extract (HEE) of *A. calcarata* rhizomes.

The results revealed that both HWE and HEE possess antioxidant, antinociceptive, gastroprotective, antiinflammatory and, hypoglycemic and antihyperglycemic activities in a dose dependent manner. In addition, there were no serious toxic effects within the doses that tested for bioactivities of the plant up to 42 days. *A. calcarata* extracts possess moderate antioxidant activities *in vitro* assays. Delaying the lipid peroxidation was more prominent by HWE and HEE than their ability to scavenge the free radicals. To investigate the antinociceptive activity, different concentrations (100, 250, 500, 750, 1000 mg/kg) of *A. calcarata* extracts were orally administered to rats and the reaction times were determined using three nociception models (hot plate, tail flick and formalin tests). The antinociceptive activities of 500 mg/kg dose of both extracts were comparable with the effect of the reference drug, pethidine. The anti nociceptive activity was supraspinally mediated via opioid receptors.

Three doses (500, 750, 1000 mg/kg) of HWE and HEE were evaluated for gastroprotective activity against ethanol induced gastric ulcers in rats. Oral administration of *A. calcarata* extracts provided dose dependent and significant protection against gastric damage caused by ethanol. The gastroprotective effect of HWE and HEE were superior to that of cimetidine, the reference drug. The HWE significantly inhibited gastric volume, acidity (total and free) and significantly increased the gastric pH. On the other hand, gastric mucosal secretion remained unaltered. Further, *A. calcarata* extracts had strong antihistamine and antioxidant activities, which could have played an active role in inducing gastroprotection.

The antidiabetic activity was tested in normoglycemic and streptozotocin (STZ) -induced diabetic rats by oral administration of three doses (250, 500, 750 mg/kg) of HWE and HEE. In normoglycemic rats both extracts significantly lowered the blood glucose level in a dose dependent manner. Hypoglycemic activity of tolbutamide, the reference drug, was comparable to that of HWE. However, hypoglycemia induced by 500 mg/kg and 750 mg/kg of HEE was superior to that of tolbutamide. Moreover, both extracts markedly improved the oral glucose tolerance test. Tolbutamide also improved the glucose tolerance test up to 3 h. This impairment was comparable to that of HWE but was inferior to HEE. Further, HEE significantly inhibited the glucose absorption from the small intestine and increased the glycogen accumulation in both liver and skeletal muscle.

The antiinflammatory activity of *A. calcarata* extracts was determined using four doses (250, 500, 750, 1000 mg/kg) in rats. All the tested doses of both extracts showed significant and dose dependent antiinflammatory activity compared to the respective controls. Among the tested doses, 500 mg/kg of HEE showed the best antiinflammatory activity during the early phase (1 - 2 h) by 54.9 - 68.3% and late phase (3 - 4 h) by 51.5-77.6%. Further, inhibitory activity elicited by 500 mg/kg dose of HEE during the late phase was comparable to that of the reference drug, Indomethacin. Furthermore, the results revealed that the antiinflammatory activity of *A. calcarata* possibly mediated via prostaglandin synthesis inhibition and antihistamine activity.

Physico-chemical parameters, phytochemical screening studies, TLC and densitometer fingerprints were used to standardize the rhizomes and their extracts of *A. calcarata* grown in Sri Lanka. Phytochemical screening revealed the presence of alkaloids, steroids, tannins, phenolic and flavonoids in both HWE and HEE. Although the classes of phytochemicals present are common to both extracts, chemical constituents belonging to HWE differ from that of HEE. *A. calcarata* extracts were devoid of unacceptable side effects even following sub chronic administration: The results showed that both extracts were well tolerated in terms of % weight gain, food and water intake, adverse behaviors, mortality, hepatotoxicity (in terms of AST, AL T), renotoxicity (as judged by serum urea and creatinine), haematotoxicity (in terms of WBC,

RBC counts and Hb concentration) or organ weights except the weight of the spleen. Both extracts increased the weight of the spleen, which possibly suggest lymphoproliferative activity.

In conclusion, this study scientifically revealed the multifaceted bioactivities of *A. calcarata* rhizomes and its potential to be developed as drugs in future.

1.5

Development of an Animal Model to Study Oral Submucous Fibrosis Using Aqueous Arecanut (*Areca catechu*) Extract.

Perera, M.W.S.

149p.

M.Phil. Degree, 2005

Location No. 530

Abstract

Oral Submucous Fibrosis (OSF), a potentially malignant condition of the mouth, has an insidious onset inducing progressive fibrotic changes of the oral sub-mucosa resulting restricted mouth opening. Its aetiology and pathogenesis remain obscure to date. However, areca nut (*Areca catechu*) has been implicated for the development and progression of the disease as evidenced by numerous epidemiological and experimental studies.

Non-availability of a reproducible animal model of OSF may have hindered uncovering the pathogenic mechanisms involved in this disease process. In addition, it may also account for the paucity of research related to the development of specific therapeutic agents to treat this disease. Therefore, the present study was undertaken to develop an animal model of OSF which would be confirmed by qualitative and as well as quantitative histopathological analysis.

BALB/c mouse was selected as the experimental animal. The corresponding test ($n=20$) and control ($n=20$) animals were allotted to four different treatment intervals i.e. 300, 350, 450 and 600 days, maintaining 5 animals in each group. A drop ($\sim 35 \mu\text{l}$) of areca extract in normal saline (265g dry weight/L) was administered to the oral mucosa of each of the test group mice using a transfer pipette and a similar amount of normal saline was used for the control. The buccal and tongue mucosae of the animals were harvested at the allotted time intervals, fixed in para formaldehyde and processed for routine histology. Tissue sections of 4-5 μm were stained with haematoxylin and eosin. Selected tissue sections were stained with van Gieson and Masson's trichrome to confirm the fibrotic changes in the connective tissues. Histopathological criteria described by Pindborg and Sirsat (1996) were employed to confirm the diagnosis of OSF in the animal model. Quantitative histomorphometric measurements were taken for both buccal and tongue mucosae to confirm excessive deposition of collagen in the lamina propria and atrophy of the epithelium in the corresponding tissue.

Histopathological examination of tissues obtained from animals of every treatment interval clearly demonstrated cellular changes which were pathognomonic of OSF. Buccal mucosa of the test group showed excessive fibrotic changes both at qualitative and quantitative levels. Epithelial atrophy was increased throughout the treatment intervals except in the papillary epithelial compartment at 300-day interval. Polynomial regression plots showed that atrophy of the inter-papillary epithelial compartment occurred prior to the atrophy of the papillary epithelial compartment. Similar patterns of fibrosis and atrophy were observed in the tongue mucosae of the treated animals. Connective tissue changes preceded atrophic changes of the epithelium and a similar sequence of events has been observed in human subjects affected by this conditions.

The results obtained in the series of experiments with BALB/c mice clearly demonstrated the classical histological features seen in OSF in human subjects. Concerning the site-specificity for the development of OSF, the buccal mucosa ranked above the lingual mucosa. Scanning the literature, it appeared that this is the first successful attempt in inducing oral submucous fibrosis in an animal model substantiating the causative role of areca nut in the pathogenesis of this disease.

1.6

Effect of Dietary Fat on Blood Lipids.

Edirisinghe, E.M. Indika

121p.

M.Phil. Degree, 2001

Location No. 223

Abstract

A diet rich in saturated fat is considered atherogenic and therefore, nutritionists have recommended limiting the proportion of calories derived from saturated fat, as a means of reducing the incidence of coronary atherosclerosis. According to the health statistics of 1998, coronary heart disease is a leading cause of mortality and morbidity in the middle-aged population of Sri Lanka. Among the possible factors, high intake of coconut oil is believed to play a central role in developing coronary atherosclerosis. This resulted in shift in the use of dietary coconut oil towards other vegetable oil in the market.

Metabolism of lipids in the guinea pigs, especially that of cholesterol, closely resemble that in man, carrying the majority of cholesterol in the low-density lipoprotein (LDL) fraction and responds to change in the dietary fat quality, especially in the absence of dietary cholesterol.

Guinea pig diets were formulated with defatted coconut poonac, textured soya protein, wheat flour, paddy husk, mineral and vitamin supplements, and 5% or 15% w/w fat in the form of coconut oil, soya oil or 1:1 mixtures of coconut and soya oil. The test diet was fed for periods of four weeks and a two week adaptation period was allowed in-between dietary changes. Following feeding of test diets, animals were fasted 14 h and bled by cardiac puncture. Serum was analyzed for total cholesterol, HDL cholesterol, triglycerides and separate plasma was used to determine the prothrombin time. Results were analyzed using two-way anova and least significance test.

At 5% dietary fat level, coconut oil gave a high serum total cholesterol value of 58.8 ± 7.3 mg/dl, whilst soya oil gave a low serum total cholesterol value of 38.3 ± 7.3 mg/dl. The serum cholesterol level at 5% coconut – soya mixture (1:1) dietary fat level was 52.8 ± 8.5 mg/dl. The serum cholesterol concentration of animals fed the diets containing coconut oil, soya oil or coconut – soya mixture (1:1) at 15% level was significantly higher than those on oils at 5% level. Higher serum cholesterol level of 107.6 ± 6.6 mg/dl, at the 15% dietary fat level was observed in the coconut oil diet. The lowest serum cholesterol level of 58.2 ± 6.5 mg/dl, at the 15% (w/w) dietary fat level was observed in the soya oil diet. Both serum total and HDL cholesterol levels were significantly increased when a diet containing 5% (w/w) coconut oil was replaced with a diet containing 15% (w/w) of the same oil, serum total cholesterol increased by 83% and HDL cholesterol increased by 27%. However, when the diet containing 15% (w/w) coconut oil was replaced with 15% (w/w) coconut – soya oil mixture (1:1), their serum total cholesterol level was decreased significantly from 107.6 ± 6.6 mg/dl to 63.2 ± 6.8 mg/dl, while HDL cholesterol level did not change significantly.

Serum triglycerides significantly increased, when the total fat content of the diet was increased from 5% to 15% (w/w), with both soya and coconut oils. There was no significant difference in the mean serum triglyceride levels in the groups that were fed soya oil and coconut oil, at the same dietary fat level.

Prothrombin time was 30.2 ± 4.1 sec. at the 5% coconut oil containing diet and 31.0 ± 3.5 at the 5% soya oil containing diet. No significant changes were observed when both coconut and soya oil increased from 5% to 15% (w/w).

The higher serum cholesterol concentration due to the ingestion of coconut oil and a lower serum cholesterol concentration due to similar quantities of soya oil are in agreement with what is known. These results reiterate the cholesterogenic properties of coconut oil. However, as opposed to soya oil coconut oil was able to increase the serum HDL cholesterol as well. It is interesting to note a lowering of serum total cholesterol, when high fat diet containing coconut oil was replaced with coconut – soya oil mixture (1:1), while HDL cholesterol level remained the same without significant change.

This could be a safe way of dealing with those with an elevated blood cholesterol level, whereby introduction of an equal amount of soya oil to coconut oil could create a lowering of cholesterol, whilst maintain a high HDL cholesterol level and thereby lowering total cholesterol: HDL cholesterol ration to a reasonable safe level.

1.7

Effect of Inclusion of *Setaria italica* (L.) P. Beauv Seeds on the Level of *cis-9, trans-11* Isomer of Conjugated Linoleic Acid Content in Goat Milk.

Priyanwada, N.H.N.

116p.

M.Phil. Degree, 2012

Location No. 1257

Abstract

Conjugated linoleic acid (CLA), a constituent in dairy fat has experimentally proven a number of health beneficial activities such as anticancer effect, decreasing the severity of atherosclerosis, reducing adverse effects of immune stimulation, reducing body fat and increasing lean body mass. A number of researches have shown the ability to enhance CLA content in ruminant milk through modulation of ruminant diet. Increasing the linoleic acid (LA) content in ruminant diet has shown raised CLA content in milk fat. Peanuts, palm, canola, and sunflower are reported to be rich source of LA but they are uneconomical to be used as ruminant feed in Sri Lanka due to their cost. Therefore, it is important to experimentally evaluate home-grown cheap plant sources which are rich in LA to be used as ruminant feed. Hence, the objective of this study is to formulate a concentrate ration with a newly identified local feed ingredient/s LA acid, which are affordable to Sri Lankan farmers.

Nineteen (19) seed species available in Sri Lanka were analyzed in triplicates for their LA content and fat content. Total oil content of seeds were determined by hexane extraction, and fatty acid compositions were determined by direct trans-esterification and capillary column gas-liquid chromatography. The percentage of oil found in the tested seed species is as follows: *Vigna unguiculata* (L.) Walp. ($0.93 \pm .17$), *Dolichos biflorus* L. ($1.2 \pm .14$), *Tithonia diversifolia* (Hemsl.) A. Gray ($1.43 \pm .08$), *Panicum milliaceum* L. ($2.93 \pm .17$), *Mucuna pruriens* (L.) DC ($4.2 \pm .46$), *Setaria italica* (L.) Beauv. ($4.96 \pm .15$), *Leucaena leucocephala* (Lam.) deWit. ($6.28 \pm .69$), *Cicer arietinum* L. ($6.90 \pm .14$), *Sesbania grandiflora* (L.) Poiret (7.12 ± 1.36), *Limonia acidissima* L. (12.50 ± 1.12), *Psidium guajava* L. ($14.72 \pm .57$), *Psophocarpus tetragonolobus* (L.)

DC ($16.30 \pm .87$), *Glycine max(L.) Merr.* ($17.78 \pm .87$), *Manihot glaziovii* (Mull.) Arg. (18.60 ± 1.52), *Momordica charantia* (22.1 ± 1.27), *Arachis hypogaea* L. (48.34 ± 1.63), *Anacardium occidentale* L. (49.05 ± 3.96), *Canarium zeylanicum* (Retz.) Bl. (52.22 ± 2.08) and *Sesamum indicum* L. ($55.71 \pm .80$).

Among all examined species, *Setaria italica* has shown a promising percentage of linoleic acid content which is 75.88 ± 1.97 % of total fatty acids. Nutritional studies of *Setaria italica* have shown 4.96% of ether extract, 15.23% crude fiber, 8.3% of crude protein, 0.2% sand, 3.33% ash and 10.7% moisture content. Thus *Setaria italica* seeds were used to formulate a concentrate feed by including at the levels of 0%, 20%, 30 % and 50%. Consequently, the LA percentages of the new feed rations have increased up to; 0%, 14.13%, 19.94% and 29.68% respectively. Thirty two Jumnapari dairy goats around 30.6 ± 6.5 kg were randomly assigned into four experimental groups and four levels of formulated concentrate (200g per day per animal) was fed them respectively. Feed trials were conducted for twenty-one day time period. Linoleic acid content in four levels of feed were measured as 11.51 %, 14.13%, 19.94% and 29.68% (mg in 100 mg of total fatty acid methyl esters) and total fat contents were 4.33 g, 6.03 g, 6.43 g and 7.37 g in 100 g of feed.

Fatty acid composition (through direct trans-esterification and capillary column gas- liquid chromatography), total protein content (Bradford method) and total fat (REIL Electronic milk tester) of goat milk at day 0, 7, 14 and 21 were investigated. There was no significant influence observed by feeding *Setaria* seeds on the total milk fat and total milk protein content throughout the experimental period. However, palmitic acid, . oleic acid and conjugated linoleic acid content in milk were increased ($p < 0.001$) with increasing *Setaria italica* content in feed concentrate. It is observed that the stearic acid in milk was decreased at day 14 of feeding 50% *Setaria* seeds.

The present investigation showed a considerable increase of percentage CLA (*cis-9, trans-11*) in goat milk (up to 30%) after feeding *Setaria* seeds. Hence, Sri Lankan farmers will be able to produce CLA (*cis-9, trans-11*) rich goat milk by feeding *Setaria italica* ('Tanaha') seeds, which can be grown in Sri Lanka even under very dry conditions. It is suggested that further studies should be conducted for other ruminants such as cows, with the hope of increasing CLA in dairy products in Sri Lanka.

1.8

Isolation, Purification and Characterization of Inhibitors for Aspartic Proteinases from *Spondias pinnata*.

Kumari, H.M.P.S.

91p.

M. Phil. Degree, 2010.

Location No. 1070

Abstract

Proteinases are involved in a wide variety of physiological and biological processes. Inhibitors of serine, cysteine and metallo proteinases have been isolated from animal, plant and bacterial organisms and have been well characterized. But relatively, few studies have been reported on inhibitors of aspartic proteinases, Aspartic proteinases participate in a variety of physiological processes and pathological conditions such as hypertension, gastric ulcers, gastric cancers and inflammation.

Recently aspartic proteinases were identified from human immunodeficiency virus, malaria and filarial parasites. Aspartic proteinases participate in the processing of viral precursor

protein to form mature structural and functional protein in AIDS, hemoglobin breakdown in malaria and as functional enzyme in filariasis and hence identified as therapeutic target points in the control of the above disease conditions. Therefore investigation of natural inhibitors of aspartic proteinases is very important and essential. The objective of this study was isolation, characterization and purification of inhibitors for aspartic proteinases. Fresh stem bark of *Spondias pinnata* was ground at 4°C and water extracts were prepared. Purification of the extract revealed presence of two types of DEAE cellulose bound aspartic proteinase inhibitors in crude extract of stem bark. The major inhibitor compound contributes 55% inhibitory activity and minor inhibitory compound contributes 45% inhibitory activity to the total inhibitory activity. Both inhibitor compounds were purified to near homogeneity using anion exchange chromatography with DEAE cellulose at pH 7 ammonium sulphate precipitation with 70 % saturation, gel filtration with Sephadex G- 75 at pH 7 and anion exchange with Q Sepharose at pH 7. Purification fold and yield obtained after the affinity chromatography step, were 1100 times and 10.5 % respectively for major inhibitor compound and 1505 times 8.5% respectively for minor inhibitory compounds.

Inhibitors obtained at each step of purification were analyzed using biomolecular identification tests such as Molisch's test, Sudan III test, SDS PAGE with coomassie blue staining and silver staining, trypsin digestion, HCl digestion and UV spectrum. Major and minor inhibitory compounds were identified as short peptides according to trypsin and acid digestions, UV spectrum and SDS PAGE banding pattern. Molecular weights of major and minor inhibitors were found as 10 and 14 KD according to gel filtration chromatography. Study on pepstatin sepharose chromatography of major and minor inhibitors and incubation with pepsin at pH 4 revealed binding of inhibitor to the active site of pepsin. Increase in K_m with increasing inhibitor concentrations suggested competitive inhibition. K_i values of the major and minor inhibitors were 0.53 μ M and 0.6 μ M respectively.

Temperature dependency and pH dependency of inhibitor reactions and inhibitor stability were studied. The inhibitors were thermally stable between 0 °C – 97 °C in crude extract and for purified inhibitors stability was observed between 0 °C - 60°C. The inhibitors functioned optimally between pH 2 to 7.

1.9

Molecular Diagnosis of Specific Strains of Mycobacteria in Kandy and Matale Districts of Sri Lanka.

Vasanthakrishnan, R.B.

116p.

M. Phil. Degree, 2009

Location No. 861

Abstract

Tuberculosis (TB) caused by *Mycobacterium tuberculosis* Complex (MtbC), is the leading cause of death, due to a single infectious agent worldwide. Since TB is highly infectious for humans, it is important that the disease be diagnosed as early as possible to stop the spread of the disease. In Sri Lanka laboratory diagnosis of tuberculosis is done by direct microscopic examination of stained sputum specimens for tubercle bacilli. However, specificity and sensitivity of this technique is not sufficient to identify the disease at early stage. Further it is impossible to identify MtbC sub species and Mycobacteria other than tuberculosis (MOTT) by this and culture techniques.

Examination by bacteriological culture provides conclusive diagnosis of TB. The culture technique of egg based solid media used in our country has the disadvantage of long delay

(about 6 weeks) to obtain results, which is a significant delay in making a diagnosis. The polymerase chain reaction (PCR) based molecular diagnostic technique would overcome the deficiencies of the sputum direct microscopy and culture. It is possible to get rapid and accurate diagnosis of tuberculosis by using PCR.

This study focused on developing PCR based molecular diagnosis. The best method to extract DNA from three methods CTAB (Cetyltrimethyl ammonium bromide)/NaCl method, 2% SDS, 10% Triton X-100 method and tris-EDTA (TE)-boiling method of DNA extraction was identified. The methods were also evaluated with clinical samples. Sputum specimens were collected from patients suspected of TB from the chest clinics of districts of Kandy and Matale and from the Microbiology laboratory at the University of Peradeniya. A total of 278 sputum samples were collected from 238 patients, and DNA was extracted using the CTAB/NaCl method. Fragment of extracted DNA was amplified by PCR with the primers PT-8 and PT-9 flanking a 541 bp sequence within the repetitive sequence IS 986 of MtbC. A PCR based method was developed to differentiate MtbC species from MOTT species. H37Rv strain DNA was used initially as a reference strain. Clinical samples that were positive by acid fast bacilli (AFB) staining, but negative by PCR for MtbC were tested to differentiate the MtbC strains from the MOTT species. PCR results and AFB staining results were compared with the clinical picture of the patients.

The CTAB/NaCl method was found to be the best method to obtain high purity DNA with a significant yield. Of the 278 clinical samples, 193 were positive for AFB, of which 124 were positive for MtbC by PCR and 69 were negative by PCR. Of the 85 AFB negative samples 8 were positive for MtbC by PCR while remaining 77 were negative.

Sixty nine clinical samples which were positive by smear and negative by PCR and 6 AFB negative and PCR negative samples from Matale and Kandy clinics were further analyzed using 16S rRNA, Rv0577, IS1561, Rv1510, Rv1970, Rv3877/8, and Rv3120 gene loci. Of the 75 samples, 20 were identified as species from MOTT. Out of the 20 patients one has died and 7 of them are chronically ill, in spite of getting TB treatment for 6 months. Remaining 12 patients are considered as cured. These results strongly suggest the importance of use of sensitive molecular diagnostic techniques for early detection and identification of the subspecies of *Mycobacteria* in Sri Lanka. Identification of the specific strains of MtbC and differentiating the MtbC and MOTT will improve treatment of patients with tuberculosis. Use molecular diagnosis will help the clinicians to ensure cure of individual patients and would prevent transmission of tuberculosis in Sri Lanka.

1.10

Purification and Characterization of Acid Proteinases from *Nepenthes distillatoria* L.

Rajapakse, R.G.S.C.

116p.

M.Phil. Degree, 2002

Location No. 214

Abstract

Plant aspartic proteinases so far have received much less attention in contrast to well-characterized mammalian, fungal and viral aspartic proteinases. They are widely dispersed in the plant kingdom and have been detected in seeds, leaves and flowers of different plants as well as in the digestive fluid of some insectivorous species. Insectivorous plant *Nepenthes distillatoria* growing in the lowland wet zone of Sri Lanka is a good source of proteolytic enzymes. Proteolytic enzymes are interesting not only from the point of view of plant physiology but also from the point of view of structure-function relationship and molecular

evolution of aspartic proteinases. The objective of this study was to isolate, purify and characterize acid proteinases from the crude juice of the pitcher of *N. distillatoria* which could be useful for future studies on plant physiology, structure - function relationship and molecular evolution of aspartic proteinases.

In this study, two acid proteinases, *Nepenthes* major and minor proteinases present in the crude juice of pitchers of *N. distillatoria* were purified to near homogeneity. Purification steps used were DEAE cellulose chromatography, sephacryl S-200 chromatography, pepstatin-sepharose chromatography and mono Q chromatography. Enzymes after purification were analysed using SDS-PAGE to confirm the purity and to determine their molecular weights. Enzymatic properties of purified proteinases such as time dependency, enzyme concentration dependency, pH dependency, temperature dependency, stability at different temperature and pH, effect of proteinase inhibitors were studied. Partial amino terminal amino acid sequences of both proteinases were determined and compared with reported sequences of other known plant aspartic proteinases such as rice, barley and cardoon.

Antibodies to both enzymes were produced by immunizing rabbits with purified enzymes. Antibodies were purified by ammonium sulphate saturation and affinity chromatography on protein - A sepharose. Histochemical staining using both antibodies was performed using transverse sections of fresh *Nepenthes* pitchers obtained under freezing conditions. Proteolytic action of *Nepenthes* major proteinase at different pH levels was investigated on natural proteins.

Purification fold and yield obtained after mono Q chromatography step were 59 times and 26.1% with major proteinase and 44 times and 15.6% with minor proteinase. Based on the characteristics, it is suggested that both proteinases have similar properties. Purified enzymes are likely to be aspartic proteinases as reflected by the complete inhibition of proteolytic activity by 0.1mM pepstatin. Both proteinases were inhibited by diazoacetyl-DL norleucine methyl ester (DAN) and the pattern of inhibition is completely different with that of porcine pepsin suggesting that they are non-pepsin type aspartic proteinases. Molecular weights of major and minor enzymes are 43 kDa and 35 kDa as per SDS-PAGE separation. Purified enzymes have an optimum pH of 3.0 with 2% denatured hemoglobin as substrate. Optimum temperatures for activity of major and minor enzymes are 55°C and 45°C respectively. Both enzymes show a remarkable stability at higher temperatures (50°C) and at a wide pH range (pH 2-10) compared to porcine pepsin. Low homology of both major and minor proteinases with the amino acid sequences of known aspartic proteinases suggest the unique structural features of *Nepenthes* proteinases.

Immunohistochemical staining suggest that both enzymes are produced by the cells located in the inner wall of the lower 1/3 part of the pitcher. Proteolytic action of *Nepenthes* major acid proteinases on dhal and other proteins at acidic as well as neutral pH levels was remarkable.

Further studies on the three dimensional structure of the enzymes is recommended to precisely relate the unique properties of *Nepenthes* major and minor proteinases to their structure.

1.11

Purification and Characterization of Thermostable DNases from Bacteria in Hot Springs of Trincomalee, Sri Lanka.

Bandara, A.M.T.K.

83p.

M.Phil. Degree, 2013

Location No. 1283

Abstract

Thermophiles are defined as organisms capable of living at high temperatures (hot springs and water heaters). Thermophilic bacteria are an interesting source of stable enzymes including thermo stable DNases. Nucleases played crucial role in development and use of recombinant DNA technology and the field of molecular biology. Currently there are approximately 3000 identified nucleases and recognized 235 different sequences. Most of them are found in bacteria and an estimated 25% of bacteria examined contain at least one restriction endo nuclease and therefore the probability of encountering new enzymes is relatively high. Objectives of this study were to isolate, purify and characterize DNA digesting enzymes from bacteria living in hot springs of Trincomalee, Sri Lanka.

Five different bacterial strains were identified based on the basic biochemical characteristics. All five strains belonged to the newly introduced genus *Geobacillus*. Based on the high growth rate, one strain was selected for studies all DNases. In this study, two DNA digesting enzymes, the high molecular weight DNase and the low molecular weight DNase, from the selected bacterial strain were purified to near homogeneity. Purification steps used were ion exchange chromatography using CM-Cellulose, Q Sepharose and DEAE cellulose, gel filtration chromatography using Sephacryl S-200, and affinity chromatography using Heparin-Sepharose. After purification, enzymes were analyzed using SDS- PAGE to confirm their purity and to determine their molecular weights. Enzymatic properties of the purified DNases such as optimum pH, optimum temperature, thermal stability and metal ion requirement were studied.

The purified high molecular weight DNase and the low molecular weight DNase had an estimated molecular weight of 66 kDa and 28 kDa according to SDS-PAGE, respectively. Both enzymes had an optimum pH of 7.80. Optimum temperatures for the high molecular weight DNase and the low molecular weight DNase were 68°C and 55°C, respectively. Over 80% residual activity was observed for the low molecular weight DNase incubated at 65 °c for 15 days while the high molecular weight DNase retained over 80 % activity at 60°C for 15 days. The activity of the high molecular weight DNase was enhanced in the presence of Ca²⁺ ions while the activity of the low molecular weight DNase was enhanced in the presence of Mg²⁺ ions. There was no absolute need of metal ions by both enzymes.

Further studies of both DNases using known DNA sequences are recommended in order to precisely identify their cleavage specificities. Moreover, studies on the amino acid sequences and three dimensional structures of both enzymes are needed to relate their unique thermal stability to structure.

1.12**Purification and Molecular Characterization of Acid Proteinases from Filarial Parasite *Setaria digitata*.**

Jayarathne, Upeksha Priyantha

133p.

M.Phil. Degree, 2002

Location No. 213

Abstract

Acid proteinases are important as new targets for chemotherapy in the control of parasitic diseases. Proteinases of cattle filarial parasite *Setaria digitata* were characterized for this purpose.

Crude extract of the female cattle filarial parasites separated on PAGE showed three different

acid proteinase activities. When the body parts of the parasite were separated into uterus and oviducts, esophagus and intestine and body wall, three acid proteinases appeared differently. The uterus and oviducts representing the reproductive system, showed the highest levels of activity for all three enzymes. But in the esophagus and intestine, which represent the digestive system, there were only two enzyme activities and these two were at a lower level than those of the reproductive system. In the case of body wall there were only two enzyme activities, similar to the digestive system but at a much lower level of activities.

In developing methods for purification of the acid proteinases, crude extract of the whole parasite was used. The steps included DEAE cellulose chromatography, S-200 gel filtration, pepstatin sepharose affinity chromatography followed by mono-Q chromatography. DEAE cellulose chromatography resolves three distinct enzyme activities. Each of these was then separated by S-200 gel filtration, pepstatin sepharose affinity chromatography and mono-Q chromatography. In DEAE cellulose chromatography the enzyme activity detected in a fraction of single peak eluted during sample injection was referred to as DE-unbound (DEUB) proteinase, the second peak eluted at 0.4M NaCl was referred to as DE-bound major (DEBMJ) proteinase, it showed the highest activity and the third peak eluted at 0.8M NaCl was referred to as DE-bound minor (DEBMN) proteinase.

All these proteinase activities separated had a molecular weight of 42kDa as determined by SDS-PAGE. Since all these proteinase activities could not be resolved further using SDS-PAGE under reducing conditions. It suggested that three acid proteinases are made from a single polypeptide.

The optimum pH for enzyme activity was observed to be pH 2.0, 1.5 and 2.5 for DEUB, DEBMJ and DEBMN proteinases, respectively. Optimum temperature was observed at 45°C for all three proteinases. The DE-unbound proteinase was stable over a wider pH range than the DE-bound types. Even though DE-bound proteinases were stable in neutral and alkaline pH, they had a very little stability in acidic pH. They were not inhibited with soybean trypsin inhibitor, phenol methane sulphonyl fluoride (PMSF) and EDTA, but totally inhibited by pepstatin confirming that they belong to the family of aspartic proteinases.

Proteinases isolated from different tissues showed some similar as well as different characteristics. The results confirm the presence of three types of proteinases localized in different tissues of the parasite. The N-terminal amino acid sequencing is required to clarify whether they are isozymes of the same enzyme or different enzymes. Identification of cleavage specificity of the acid proteinases against susceptible biological peptides is necessary to clarify the physiological role of these proteinases. These investigations will clarify the physiological role of three acid proteinases and the possibility of identification as a therapeutic target point to control the filarial infections in the future.

1.13

Serological Detection and Identification of Rickettsial Species Infecting Humans.

Nanayakkara, D.M.

125p.

M.Phil. Degree, 2011

Location No. 1069

Abstract

Human rickettsiosis is a vector borne infection transmitted by a group of gram negative proteobacteria and is a common cause of febrile infections all around the world. A study was conducted to investigate the types of rickettsial agents prevalent in Sri Lanka as information on

the rickettsial species in the country is limited.

The study was conducted in patients with clinical rickettsioses (n=272) from Teaching Hospital Peradeniya (THP), patients visiting medical clinics at Mahiyanganaya (n=50) and Karapitiya (n=34) General Hospitals. Apparently healthy residents from AGA divisions of Udunuwara (n=57), Yatinuwara (n=68) and gramaniadhari divisions of Rajawatta (n=83) and Thambavita (n=118), dogs from Unawatuna (n=50), Rajawatta (n=32); Thambavita (n=18), Western Slopes of Central hilly country (n=24) which includes Manikdiwela, Hatharaliyadda, Kadugannawa, Wattapola, Hingula, Muruthalawa and Mawanella, cattle from Kandy slaughter house (n=32) and a farm in Anuradhapura (n=24). Immunofluorescence antibody assay (IFA) was used for serological analysis and molecular studies were done using Polymerase chain reaction (PCR).

The rickettsial agent causing clinical infection in majority of the patients attending the THP belonged to the spotted fever group. Forty-eight percent of the patients were from Udunuwara and Yatinuwara AGA divisions in the Kandy district and 19% of apparently healthy humans from these two divisions also had rickettsial antibodies. The local rickettsial species showed close homology to a strain identified as "*Candidatus Rickettsia kellyi*" from Tamil Nadu, South India. Considering the geographical proximity, it is possible that the species responsible for spotted fever group rickettsioses in Sri Lanka and India are related. Fifty-seven percent of patients visiting General hospitals at Mahiyanganaya and Karapitiya, 54% of healthy humans from Rajawatta and Tharnbavita had antibodies against rickettsiae indicating the existence of the pathogen in those areas and possibly subclinical infection among them. Areas of Central hilly country showed the existence of Spotted fever group (SFG) predominantly. Towards the south of the country both SFG and scrub typhus group co-existed equally whereas in areas of Uva province scrub typhus was predominant.

Rickettsial antibodies were also observed in dogs and cattle. Seropositivity in canines was always higher than humans in a given area.

The study indicates the importance of rickettsia as a zoonotic disease in Sri Lanka. Presence of antibodies among domestic animals will enable the identification of endemic zones. Whether these animals play a role as reservoirs in the natural rickettsial cycle, should be determined by molecular techniques and animal models.

1.14

Status of Insecticide Resistance Mechanisms in Some of the Insect Pests of Vegetables and Two Insect Predators.

Bambarandage, Thushari Damayanthi

138p.

M.Phil. Degree, 2001

Location No. 180

Abstract

Current status of insecticide resistance and underlying resistance mechanisms were studied in seven species of insect pests (five species of aphids ie. *Aphis gossypii*, *Myzus persicae*, *Aphis craccivora*, *Toxoptera citricidus* and *Lipaphis erysimi*; diamond-back moth *Plutella xylostella*; leafminer *Liriomyza huidobrensis*), and two species of natural predators of aphids (lady-bird beetle species *Coccinella sexmaculatus* and *Thea cincta*). All the insects except *L. huidobrensis* were collected from the fields at Horticultural Crop Research and Development Institute at Gannoruwa during 1997-1998. The leafminer, *L. huidobrensis* was collected from the Nuwara Eliya district in 1998. Insects were subjected to insecticide bioassays with malathion (an organophosphate), chlorpyrifos (an organophosphate), propoxur (a carbamate), permethrin (a

pyrethroid) and DDT (an organochlorine). Bioassays were carried out by insecticide impregnated paper method and by topical application method. Log-probit mortality lines and LD_{50} / LD_{90} values for each insecticide were obtained for all the pest species. For predatory species, fixed insecticide dosages were used.

Results of both bioassay methods were significantly correlated. *P. xylostella* and *M. persicae* showed highest organophosphate and pyrethroid resistance. *L. erysimi* had the highest resistance for carbamates. *A. gossypii*, *A. craccivora* and *T. citricidus* were susceptible to all the insecticides tested. *L. huidobrensis* had very high resistance to all the insecticides except DDT. Both predatory species showed high resistance to all insecticide groups.

Activity of insect carboxylesterases were measured using the substrates α/β naphthyl acetate and p-nitrophenyl acetate. Results obtained with both substrates were significantly correlated. Highest carboxylesterase activity with the substrate pNPA was present in *M. persicae* (1.006 ± 0.647 $\mu\text{mol}/\text{min}/\text{mg}$). Lowest activity was found in *L. huidobrensis* (0.143 ± 0.202 $\mu\text{mol}/\text{min}/\text{mg}$). Native polyacrylamide gel electrophoresis was used to resolve carboxylesterase isoenzymes. No elevated carboxylesterase bands were found in *T. citricidus* and in the predator *T. cincta*. The major mechanism of insecticide resistance of aphids and *P. xylostella* was elevated carboxylesterases. Malathion metabolism studies showed the presence of malathion carboxylesterases in *P. xylostella*, *M. persicae*, and *L. huidobrensis*. Glutathione transferase activities were high in *P. xylostella* and *L. erysimi* (1.43 ± 0.244 and 1.43 ± 0.933 $\mu\text{mol}/\text{min}/\text{mg}$ respectively) and very low in *L. huidobrensis* (0.338 ± 0.273 $\mu\text{mol}/\text{min}/\text{mg}$).

Presence of high amounts of oxidases was detected in *A. gossypii* (6.69 ± 77.33 OD/mg), in *M. persicae* (1.37 ± 1.61 OD/mg) and *T. citricidus* (2.63 ± 33.57 OD/mg). Lowest amounts were found in *L. huidobrensis* (0.107 ± 0.173 OD/mg). Inhibition of the organophosphate and carbamate targetsite acetylcholinesterase with propoxur showed that this targetsite of *L. huidobrensis* and the predator *T. cincta* is not sensitive to insecticides. High activity of carboxylesterases and altered acetylcholinesterases were correlated with high resistance to organophosphates and carbamates. Oxidases had contributed to high resistance to all the insecticide groups. High levels of glutathione S-transferase activity had provided high resistance to organochlorines.

1.15

Studies on Anthelmintic Efficacy of Medicinal Plants Against Gastrointestinal Nematodes of Goats.

Fernando. W.I.T.

114p.

M.Phil. Degree, 2010

Location No. 1151

Abstract

In Sri Lanka gastrointestinal nematodiasis is a major constraint in goat farming. Currently there is an increasing consumer-driven demand for organic food. Therefore, present study was focused on controlling nematode infections in goats using plant extracts. Medicinal plants used in ethno veterinary practice and folklore medicine in Sri Lanka, were selected, and 19 of them extracted with methanol. Then the plant extracts were evaluated for their anthelmintic activity by Larval migratory inhibitory (LMI) assay using gastrointestinal nematode larvae of goats. Of them methanol extracts of *Azadiractha indica* seeds (AS), *Areca catechu* immature fruit kernels (ANUFK), *Adhatoda vesica* leaves (PL), *Erythrina variegata* leaves (EL), *Cinnamomum verum* leaves (CL) and *Tamarindus indica* leaves (TL) showed significant ($p < 0.001$) inhibitory

activity at the concentrations tested, indicating potential use of them as natural anthelmintics. Toxicological properties of above active plant extracts were studied using Swiss mice to determine the safety margin, and thereby ensure the usage as natural anthelmintics. In the above experiment, histological sections of liver, kidney and lung revealed that there were no significant changes, when compared with the tissues from the control group, indicating the absence of toxicity in 5 active plant extracts.

Therefore, five of the above plant extracts were subjected to efficacy trials using goats. In the efficacy trial, the goats treated with methanol extracts of ANU FK, PL and CL showed significant anthelmintic efficacy. A second trial was conducted using a two-fold concentration and the anthelmintic efficacies were 80%, 75% and 66.6% respectively.

Therefore based on these results a long-term prophylactic trial was conducted using the crude extracts of ANU FK and PL for a period of six months. The mean monthly faecal egg count (FEC) difference remained high in the untreated group throughout the trial. whereas in the groups treated with extracts mean monthly FEC decreased significantly ($p < 0.05$), indicating that drenching with both extracts had decreased the FEC. The total worm burdens in the treated groups were significantly low when compared with the control. Live weight gain of the groups treated with ANU FK and the PL showed a significant increase ($p < 0.05$) when compared with the untreated group. Our findings of the present investigations indicate the potential use of the methanol extracts of ANU FK and PL as inexpensive and acceptable alternative to gastrointestinal nematode control in goats.

1.16

Study of Antigenic Salivary Gland Proteins of Mosquitoes and Detection of Antibodies against them in Human and Animals.

Niroshini, K.H.K. Tharanga

103p.

M.Phil. Degree, 2013.

Location No. 1394

Abstract

Mosquito salivary gland proteins modulate the host immune response leading to enhancement of arboviral infections. Identification of proteins in saliva responsible for immunomodulation should lead to new strategies to prevent and protect against arboviral infection. Mosquito salivary proteins are involved in several biological processes that facilitate their blood feeding and have also been reported to elicit an IgG response in vertebrates. A growing number of studies have focused on this immunological response for its potential use as a biological marker of exposure to arthropod bites. As mosquito saliva collection is extremely laborious and inefficient, most research groups prefer to work on mosquito salivary glands. Thus, salivary gland protein integrity is a critical factor in obtaining meaningful data from immunological and biochemical analysis.

In this study, the salivary gland morphology, antigenic and serological properties of *Armigeres subalbatus*, *Culex quinquefasciatus* and *Aedes albopictus* mosquitoes were investigated and compared. Salivary glands of both male and female mosquitoes consist of three lobes namely, two lateral and one median and each one was different in their sizes and shapes. Size of the male salivary gland was approximately one fifth of the female. Salivary protein concentration was higher in female than in male mosquitoes. Protein bands of salivary protein in SDS-PAGE revealed the molecular weights of proteins of *Ar. subalbatus* as 241, 79, 56, 35, 27, 22, 19, 15, 10, 8 kDa, *Cx. quinquefasciatus* as 249, 79, 60, 40, 36, 26, 20, 16 kDa and of *Ae. albopictus* as 250, 148, 120, 72, 62, 48, 39, 25, 15 kDa. Western blotting using both human and animal serum

samples revealed that 22 kDa is the major antigenic protein of *Ar. subalbatus* and 20 kDa protein of *Cx. quinquefasciatus* which developed IgG antibodies against human and rabbit. Proteolytic properties were shown in the salivary gland proteins of all the three mosquitoes namely *Ar. subalbatus*, *Ae. albopictus* and *Cx. quinquefasciatus* and their molecular weights were 27,100 kDa; 19, 120 kDa and 26, 36 kDa respectively. IFA results showed that antigenic proteins were present only in some regions of the female salivary glands and not in the male salivary glands of the mosquito *Ar. subalbatus*.

This study revealed some important facts on morphological, antigenic and serological differences between the salivary glands of mosquitoes *Ar. Subalbatus*, *Cx. Quinquefasciatus* and *Ae. albopictus* in the Yatinuwara area.

1.17

Toxicity and Biological Activity Studies of Green Leafy Vegetables Consumed in Sri Lanka.

Balasuriya, B.M.G.K.

112p.

M.Phil. Degree, 2007

Location No. 680

Abstract

Green leafy vegetables (greens) play a major role in the human diet, due to the low cost, easy accessibility and the influence of traditional herbal medicine. Due to their dietary importance, many scientific studies have been carried out on the nutritive values of greens. However, there is a lack of scientific literature on their toxic effects on consumers. Hence, there is a strongly felt need to conduct systematic scientific evaluation of their potential toxic effects, and screen them for possible biological activities to have a better understanding and educate the consumers on their choice of greens. Consequently, the present research project was initiated. The aim of the present investigation was to determine the toxicity and biological effects of thirty green leafy vegetables consumed in Sri Lanka.

Water extracts of 30 vegetable greens and culinary herbs consumed in Sri Lanka were tested for their cytotoxic properties using brine shrimp (*Artemia salina*) lethality bioassay. As anticipated most of the greens were found to have insignificant cytotoxicity. However, the water extracts of *Alternanthera sessilis*, *Passiflora edulis*, *Aerva lantana* and *Baccopa monierri* showed significantly higher ($p < 0.001$) cytotoxicity, when compared with the positive control. Of them *Alternanthera sessilis* (mukunuwenna/ Ponnakkani) is the most popular leafy vegetable among Sri Lankans. As large quantities of *A. sessilis* are often consumed in a single meal, there is an urgent need for more investigations on toxicological aspects. Therefore experiment was conducted using Swiss mice. Results indicated that oral administration of water extract of *A. sessilis* in high doses (0.96 g/kg and 1.92 g/kg of freeze dried extract) for 15 days leads to histopathological changes in the liver and kidney tissues of Swiss mice. Further, histopathological, serum biochemical and hematological changes caused after 21 days and 42 days of oral administration of water extract of *A. sessilis* to Male Wistar Rats in 3 different doses were examined. Concentrations of AST (Aspartate aminotransferase) and ALT (Alanine aminotransferase) were significantly elevated in rats that received the highest dose for 21 days. Significant changes were observed in AST, ALT, ALP (Alkaline phosphate), urea, creatinine, magnesium and albumin levels in all treatment groups, after 42 days. Mild histopathological changes were observed after 21 days in liver and kidneys of rats that received the higher doses. Mild to moderate histological lesions and/ or necrosis in liver and kidney tissues were found in all treatment groups after 42 days, while both control groups were devoid of significant histopathological changes. Present findings indicated that, the oral

administration of fresh *A. sessilis* extracts leads to mild to moderate hepatic and renal toxicities in male Wistar rats. Therefore, frequent consumption of larger quantities of *A. sessilis* should not be recommended, especially for patients with chronic hepatic and renal diseases. However, further investigations are necessary in order to understand the long-term effects of consuming of cooked *A. sessilis*.

The 30 green extracts were screened for antioxidant capacities using DOOH (2,2'-diphenyl-1-picrylhydrazyl) radical scavenging assay. The results revealed the presence of radical scavenging activities of all the extracts. When the antioxidant activities of commonly used 10 extracts were quantified, none had a comparable EC₅₀ to that of the positive control, vitamin C (EC₅₀ 82.3 ppm). However, *Sesbania grandiflora* (EC₅₀ 219.9 ppm) and *Brassica sativa* (EC₅₀ 249.4 ppm) had comparatively high antioxidant activities.

Antibacterial activity and antifungal activity of the 30 green extracts were conducted using disk diffusion method against, human pathogenic bacteria such as *Staphylococcus aureus*, *Enterococci faecalis*, *Pseudomonas aeruginosa*, *Klebsiella P.W.*, *Escherichia coli*, 10 MRSA strains and human pathogenic fungi, 18 strains of *Candida*. Water extracts (at a concentration of 200 µg/disk) of *Dregea volubili*, *Cardiospermum halocacabum*, *B. sativa*, *Carum petriselinum* and hexane extract of *A. sessilis* showed activity against *Staphylococcus aureus*. *D. volubili*, *C. halicacabum*, *B. sativa* and *C. petriselinum* had activity against MRSA (Methicillin resistant *Staphylococcus aureus*) strains. None of the extracts had antifungal activity against *Candida* strains. The leafy vegetables can be further explored to isolate promising antibacterial compounds.

1.18

Toxicological Studies of Venom on Mice of Two *Bungarus* Species in Sri Lanka.

Nanayakkara, D.P.

106p.

M.Phil. Degree, 2008.

Location No. 758

Abstract

Snakebite is one of the leading causes of accidental deaths in Sri Lanka. There are six species of snakes in Sri Lanka, which are considered highly venomous and include two species of *Bungarus*, namely *Bungarus caeruleus* and *Bungarus ceylonicus*. *B. caeruleus* carries the highest case fatality among the six highly venomous species. Inadequate response to the antivenom produced against the Indian species of *B. caeruleus* by the victims envenomed by *B. caeruleus* species found in Sri Lanka suggests the possibility of subspecies differences between them. On the other hand, toxicological aspects of *B. ceylonicus*, our endemic species have not been investigated to date. This study was designed to assess the median lethal doses of venom from *Bungarus* snakes found in Sri Lanka following intramuscular administration to mice and also to investigate the histopathological changes produced by them.

Protein concentration of venom of *B. caeruleus* was higher than that of *B. ceylonicus* which ranged from 647-1738 µg/ml in *B. caeruleus* venom and 150-487 µg/ml in *B. ceylonicus* venom.

The median lethal doses of *B. caeruleus* and *B. ceylonicus* were determined following administration of serial dilutions of venom to mice intramuscularly. The times of death of mice since injection of venom as well as the total number of mice dead at 24 hours in each concentration of the venom samples were recorded. Fifty percent death rate for *B. ceylonicus* venom was recorded at 7.5 µg/mouse while 100% death rate was at the dose of 8 µg/mouse. For *B. caeruleus* venom, the above death rates were observed at doses of 1.0 µg/mouse and

2.0 µg/mouse respectively. Median lethal dose calculated statistically using Probit Analysis 1.5 was 0.95 (0.81-1.12 at 95% confidence limits) µg/mouse for venom of *B. caeruleus* and 7.12 (6.79-7.50 at 95% confidence limits) µg/mouse for venom of *B. ceylonicus* for intramuscular administration (average weight of a mouse 27.37 ± 1.41 g).

Venom of *B. caeruleus* and *B. ceylonicus* were injected to different groups of mice at concentrations of 0.5, 1.0 and 2.0 µg/mouse. The mice were sacrificed with a high dose of chloroform and tissue samples of liver, brain, kidney, cardiac and skeletal muscle were obtained at different time intervals of 1,3,6,12 and 24 hours. They were fixed in formalin, processed in a series of alcohol and xylene and stained with haematoxylin and eosin. Histopathological changes of these tissues were studied light microscopically and were evident in sections from liver, kidney and brain. Congestion and inflammatory infiltration were the predominant histopathological features identified in all these tissues.

Congestion was moderate and almost similar in the liver and the kidney for either venom but in the brain, it was less marked with *B. caeruleus* venom. Inflammatory infiltrates were predominantly lymphocytic and perivascular in distribution and were intense with administration of *B. ceylonicus* venom than *B. caeruleus* venom. There was an increase in the intensity of infiltration with advancing concentration of venom of *B. ceylonicus* in these tissues which was not evident with *B. caeruleus* venom. Necrosis was always associated with inflammatory infiltration and was seen only in the liver and brain following administration of *B. ceylonicus* venom. However, histopathological changes were not observed in skeletal and cardiac muscle with either venom.

According to the present study, the median lethal dose of intramuscularly administered venom of *B. caeruleus* in Sri Lanka (0.95 µg) is significantly lower than the recorded median lethal dose of intravenously administered venom of Indian subspecies (1.9 µg).

In conclusion, the toxicity of *B. ceylonicus* venom is much lower compared to *B. caeruleus* venom following intramuscular administration to mice and the action of both *B. caeruleus* and *B. ceylonicus* venom is seen predominantly in the liver and the kidney.

M.Sc. Research Project Reports

CLINICAL BIOCHEMISTRY

1.19

Assessment of Glycaemic Control in a Sample of Diabetic Patients with Cataract and Retinopathy.

Perera, W. Nadie

77p.

M.Sc. Degree, 2004

Location No. 356

1.20

Assessment of the Effects of Selected Pre-Analytical and Analytical Factors on the Optimal Immunohistochemical Staining for ER and HER-2 in Breast Cancer.

Peiris, H.H.

53 p.

M.Sc. Degree, 2011

Location No. 1150

1.21

Assessment of the Iron Status of Patients with Chronic Renal Failure.

Kalpage, S.W.

65p.

M.Sc. Degree, 2004.

Location No. 355

1.22

Clinical Significance and Diagnostic Value of Urinary Protein Analysis of Chronic Kidney Disease Patients by Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis.

Dassanayake, D.M.S.N.B.

52p.

M.Sc. Degree, 2012

Location No. 1245

1.23

Comparison of Embryo Quality Between Intracytoplasmic Sperm Injection and In Vitro Fertilization in Couples with Unexplained Sub Fertility.

Udunuwara, U.K.N.A.

54p.

M.Sc. Degree, 2013.

Location No. 1386

1.24

Dose Response Relationship of *Salmonella* Enteritidis Infection in Guinea Pigs.

Gregory, W.A.D.S.N.

48p.

M.Sc. Degree, 2009

Location No. 837

1.25

Effect of *Lactobacillus bulgaricus* and *Streptococcus thermophiles* on Serum Lipid Profile and Total Protein Concentration in Guinea Pigs.

Herath, H.M.S.N.

59p.

M.Sc. Degree, 2009.

Location No. 838

1.26

Establishing Haematological Reference Ranges Using a Selected Population of Blood Donors

Senevirathna, D.

56p.

M.Sc. Degree, 2012

Location No. 1252

1.27

Histopathological Effects of Crude Venom and Purified Phospholipase A₂ from Russell's Viper (*Daboia russelii russelii*) in Mice.

Gunaratne, V.P.

58p.

M.Sc. Degree, 2011

Location No. 1250

1.28

Iodine Content of Five Salt Brands Available at Retail Outlets in Kurunegala Town.

Munasinghe, D.A.L.

48p.

M.Sc. Degree, 2013.

Location No. 1382

1.29

A Preliminary Study of Enzymatic Changes in a Cohort of Patients Presenting with Fever and Hepatorenal Syndrome.

Ranjith, B.M.G.

37p.

M.Sc. Degree, 2003

Location No. 352

1.30

Prevalence of Bacterial Meningitis among Children Admitted to the Teaching Hospital Kurunegala.

Jayasundera, S.N.N.B.W.M.K.K.

62p.

M.Sc. Degree, 2011

Location No. 1249

1.31

Protease Inhibitors in *Sesbania grandiflora* and *Terminalia catappa*.

Jayawardana, B.D.S.

66p.

M.Sc. Degree, 2012

Location No. 1244

1.32

Relation of Maternal Haemoglobin and Serum Protein Concentrations to Birth Weight of Newborn: A Case Study in Mannar District.

Bowatte, A.

55p.

M.Sc. Degree, 2012

Location No. 1247

1.33

Relationship between Serum Carbamazepine Concentration and Epilepsy Control.

Peris, G. Marian L. A.

57p.

M.Sc. Degree, 2004

Location No. 353

1.34

Serum Calcium and Oxidation-Reduction Status of Erythrocytes in Diabetic and Non-Diabetic Cataracts.

Amarasinghe, N. S.

92p.

M.Sc. Degree, 2004

Location No. 354

1.35

Serum Progesterone, TSH and Oxidant Stress in Subfertile Women.

Nandakumara, S.

57p.

M.Sc. Degree, 2013

Location No. 1393

1.36

Studies on Clinically Suspected Dengue Patients Using RT-PCR and Blood Parameters.

Ekanayake, D.B.G.M.

69p.

M.Sc. Degree, 2012

Location No. 1251

1.37

Study of Abnormal Hemoglobins and Thalassaemias in an Anaemic Population.

Sugathdasa, B.H.K. Rohan

82p.

M.Sc. Degree, 2003

Location No. 295

1.38

A Study of Renal Function of a Sample of Patients on Long-term Diclofenac Sodium for Rheumatoid Arthritis

Ekanayake, E.M.S.D

49p.

M.Sc. Degree, 2003

Location No. 296

1.39

A Study on Haemoglobin, Serum Protein Concentrations and Serum Total Antioxidant Capacity in First Year Female Undergraduates of the University of Peradeniya.

Santhampillai, J.M.

41p.

M.Sc. Degree, 2010

Location No. 1048

1.40

A Study on Hormonal Levels of Subfertile Men with Idiopathic Non-Obstructive Azoospermia or Oligospermia.

Chandana, N.G.A.S.S.

33p.

M.Sc. Degree, 2009

Location No. 839

1.41

Variation in Cholesterol Concentration in EDTA Plasma and Serum Prepared After Early and Delayed Removal of Formed Elements.

Senadheera, Asoka

56p.

M.Sc. Degree, 2004

Location No. 351

EXPERIMENTAL BIOTECHNOLOGY

1.42

Antigenic Analysis of Bovine *Sarcocystis* spp. in Sri Lanka.

Hettiarachchi, Chamika

37p.

M.Sc. Degree, 2004

Location No. 493

1.43

Callus Induction, Plant Regeneration and Agrobacterium-Mediated Transformation of Rice Variety BG – 250.

Abeywickrama, P.U.

72p.

M.Sc. Degree, 2011

Location No. 1065

1.44

Characterization of Germline Mutations in the Breast Cancer Gene 1 - Exon 15.

de Tissera, B.D.S.L.

70p.

M.Sc. Degree, 2004

Location No. 494

1.45

Characterization of Molecular Diversity and Physiological Properties of Rhizobial Populations in *Crotalaria juncea*.

Paramasamy, P.

37p.

M.Sc. Degree, 2013

Location No. 1384

1.46

A Comparative Phylogenic Analysis of Selected Species of *Exacum* of Sri Lanka with *Osbeckia octandra*.

Maheshwaran, S.

41p.

M.Sc. Degree, 2013

Location No. 1272

1.47

Detection of Marek's Disease Virus in Poultry Using a Polymerase Chain Reaction Based Molecular Diagnostic Assay.

Wickramage, S.A.

81p.

M.Sc. Degree, 2011.

Location No. 1248

1.48

Determination of Optimum Population Size for Higher Accuracy in Mapping Quantitative Trait Loci.

Molligoda, P.S.

97p.

M.Sc. Degree, 2008.

Location No. 736

1.49

Determination of the Sensitivity of PCR Based Non-Radiolabeled Hybridization for the Detection of *Mycobacterium tuberculosis*.

Vishwajith, K.A.D.R.

82p.

M.Sc. Degree, 2008.

Location No. 716

1.50

Development of a Low Cost, Multiflex PCR Based Diagnostic Assay for Down Syndrome.

Fernando, A.M.R.

125p.

M.Sc. Degree, 2008

Location No. 781

1.51

Development of a Specific Molecular Marker to Identify the Coconut Form Bodiri.

Punchibandara, M.M.T.

64p.

M.Sc. Degree, 2005

Location No. 492

1.52

Development of Single Step Reverse Transcriptase Polymerase Chain Reaction (RT-PCT) Assay to Detect Chikungunya Virus in Clinical Samples.

Wickramasinghe, N.T.

66p.

M.Sc. Degree, 2010

Location No. 1052

1.53

Effect of Mannan oligosaccharides on Some Nutritional and Biochemical Parameters of Mice.

Kumbukage, T.R.

53p.

M.Sc. Degree, 2009

Location No. 933

1.54

Effect of Nucleotides on Some Nutritional Parameters of Mice.

Sugeeshwari, D.M.S.

65p.

M.Sc. Degree, 2010

Location No. 1050

1.55

Effect of Selenium on Some Nutritional Parameters of Mice.

Walisinghe, H.A.

51p.

M.Sc. Degree, 2010

Location No. 1053

1.56

Enhanced Biodegradation of Photodegradable Polyethylene from Developed Microbial Biofilms.

Tennakoon, N.S.

61p.

M.Sc. Degree, 2004

Location No. 495

1.57 **Establishment of a Molecular Diagnostic System for Detecting Human Papilloma Viruses in Clinical Samples.**

Ambikaibakan, R.

116p.

M.Sc. Degree, 2008

Location No. 731

1.58 **Establishment of a Molecular Diagnostic System for Detecting Y - Chromosomal Microdeletions Which Cause Male Infertility.**

Thiruchelvar, Kariharan

123p.

M.Sc. Degree, 2006

Location No. 525

1.59 **Establishment and Validation of an Immunofluorescence Antibody Test (IFAT) to Diagnose Sarcosystis Infection in Cattle.**

Vitarana, M.C.

45p.

M.Sc. Degree, 2009

Location No. 842

1.60 **Estimation of the Effective Population Size for Coconut Genome Mapping Using Computer Simulation.**

Samarasekara, C.R.V.P.

81p.

M.Sc. Degree, 2005

Location No. 491

1.61 **Genetic Diversity and Population Structure of Wild Banana (*Musa balbisiana*) Populations in Sri Lanka.**

Jayaweera, S.L.D.

85p.

M.Sc. Degree, 2010

Location No. 1051

1.62 **Identification of a Microsatellite Marker Linked to Thrips (*Stenchaetothrips biformis*) Resistance in Rice Using Bulk Segregant Analysis.**

Gimhani, D.R.

115p.

M.Sc. Degree, 2010

Location No. 1055

1.63

Identification of the SSR Marker Rm261 for Brown Plant Hopper Resistant Gene BPH 12 (t) in *O. officinalis* Line IR 54751-2-34-10-6-2 and its Validations.

Manoshi, K.H.P.

78p.

M.Sc. Degree, 2012.

Location No. 1253

1.64

Isolation of Lipolytic Fungi and Partial Purification of Lipases.

Pathirana, S.N.J.

31p.

M.Sc. Degree, 2013

Location No. 1271

1.65

Molecular Characterization of Human Cytomegalovirus (HCMV) in Some HCMV Infected Renal Transplant Patients in Sri Lanka.

Gunasekara, I.W.

50p.

M.Sc. Degree, 2011

Location No. 1064

1.66

Molecular Characterization of Some Chikungunya Virus Isolates from 2007/08 Outbreak in Sri Lanka.

Herath, H.M.I.P.

43p.

M.Sc. Degree, 2010.

Location No. 1054

1.67

Screening, Isolation and Purification of Potential Antiparasitic Compounds from Medicinal Plants.

Manamperi, A.S.

58p.

M.Sc. Degree, 2011

Location No. 1149

1.68

Serological Detection of Antibodies to Human Rickettsia and Toxoplasma Gondii in Backyard Poultry in Kanthale Divisional Secretariat.

Abeynayake, J.S.

33p.

M.Sc. Degree, 2012

Location No. 1254

1.69

A Study on In Vitro Culture Conditions for Plant Regeneration of *Santalum album* (White Sandalwood).

Maliyadde, M.S.

117p.

M.Sc. Degree, 2010

Location No. 932

1.70

A Study on Partial Characterisation of Excretory – Secretory (ES) and Somatic Antigens of *Explanatum explanatum* and Establishment of Its Phylogenetic Relationship by Genetic Characterization.

Arachchi, R.S.M.

39p.

M.Sc. Degree, 2005

Location No. 524

1.71

Use of PCR Technique to Detect Human Rickettsia and Ehrlichial Pathogens in Ixodid Ticks.

Ussoof, S.A.

54p.

M.Sc. Degree, 2013

Location No. 1280

2 - CHEMICAL SCIENCES

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Project Reports

Ph.D. Dissertations

2.1

Allelopathic Activity Studies of Sri Lankan Flora and Chemical Investigation of Endophytic Fungi and Terrestrial *Streptomyces* Species.

Piyasena, K.G.N.P.

204p.

Ph.D. Degree, 2011.

Location No. 1114

Abstract

The first part of the present investigation is focused on the search for the allelopathic active compounds from Sri Lankan plants, with the hope of using them as herbicides. In order to trace allelopathic activity, seed germination inhibition bioassay was employed, using lettuce (*Lactuca sativa*) and barnyard grass (*Echinochloa crus-galli*) seeds. Out of 60 plant extracts tested, 14 plant extracts significantly reduced radicle growth of lettuce seeds and barnyard grass seeds. Considering preliminary activity results, the arial parts of *Mikania scandens* and the bark of *Canarium zeylanicum* were selected for further chemical and biological investigation, with the aim of isolating allelochemicals, which are responsible for the above activity. Activity guided, fractionation of the *M. scandens* extract led to the isolation of highly active compound mikanolide which showed lettuce seed inhibition activity at MIC 25.0 µg/mL. Activity guided fractionation of the *C. zeylanicum* bark extract led to the isolation of two compounds 13-hydroxy-12-methoxy-8, 11, 13-podocarpatrien-3-one and 3β-OAc,28-COOH acetyl aleuritic acid. As *M. scandens* is a highly abundant invasive plant in Sri Lanka, either this plant in crude form or as mikanolide in pure form could be developed as an environmental friendly herbicides in Sri Lanka.

The second part of the present study was focused on chemical investigation of endophytic microorganisms, especially fungi and terrestrial *Streptomyces*, with the aim of isolating biologically active compounds. In this process, isolated fungi were cultivated, extracted, and tested for biological activities. According to the chemical and biological screening nine endophytic fungal strains and three terrestrial *Streptomyces* strains were selected for further chemical investigation. From these strains, seventy compounds were isolated using chromatographic techniques. Of them seven compounds were found to be new. They are hydroxy-2-isocyanatebenzoic acid, 2-isocyanate-3-methoxy-benzoic acid, 5,6-dimethyl-2, 3-dihydro-phthalazine-1,4-dione, tectariamide, 1,3,5, 7 -tetraaza-tricyclo[6.6.1.0*4, 15*]pentadeca-2,4 (15),5,7-tetraene, 2-phenyl-2H-pyrazolo[3,4-d] pyrimidine and N-(chloro-1, 3, 4, 5, 6-pentahydroxyl-hexyl)acetamide. Structural elucidation of the new compounds and other isolates were carried out with the help spectroscopic analysis, x-ray analysis, comparison with literature data and the help of AntiBase data base.

Antibacterial activity of above compounds was tested against five control strains *E. coli* (ATCC25922), *Pseudomonas aeruginosa* (ATCC27853), *Enterococci faecalis* (ATCC 29212), *Bacillus subtilis* (ATCC6051), *Streptomyces viridochromogenes* (Tü 57) and *Staphylococcus aureus* (ATCC29213) using a disk diffusion method (40 µg/disk). Of them, cercosporamide, beauvericin and altertoxin I showed the highest activity against *Bacillus subtilis* and *E. coli*. Antifungal activity of isolates were tested against strains of human pathogenic fungus *Candida albicans* and plant pathogenic fungi *Rhizoctonia solani* and *Pythium ultimum*, using disk

diffusion method. Glauconic acid and beauvericin showed the highest activity against *Candida albicans*. Algaecide activity of isolates was tested against strains of three microalgae; *Chlorella vulgaris*, *Chlorella sorokiniana*, and *Scenedesmus subspicatus* were used in this study. Of them, only julichrome Q₃, 3 showed activity against *Chlorella vulgaris*.

2.2

Biochemical Interactions in Shot-Hole Borer Infestation of Tea and Studies of three Microbial Polysaccharides

Bombuwala, Rajaguru Mudyanseilage Thushari Priyangika

172p.

Ph.D. Degree, 2001.

Location No. 126

Abstract

The thesis consists of two parts. The first part describes some studies carried out to understand the biochemical interactions involved in shot-hole borer infestation of tea.

The first chapter consists of a general introduction to shot-hole borer (SHB) infestation of tea. The second chapter describes the general experimental conditions and the principal techniques used to obtain the results discussed in chapter three.

In plugged galleries a *Fusarium* species, *Pestalotiopsis theae* and an *Aspegillus* species were found along with the *Monacosporium ambrosium*. None of the fungi were able to inhibit the growth of *M. ambrosium*.

The total phenolic content of tea stems was determined as gallic acid and tannic acid equivalents, and was found to be higher in the susceptible tea clone TRI 2025 and highest in tea stems which were infested with SHB beetle.

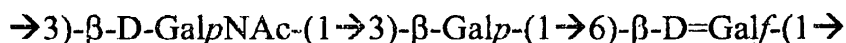
Phenylalanine ammonialyase (PAL) and polyphenol oxidase (PPO) enzyme activities were also found to be higher in the infested stems of both clones, while the highest activity was observed in the susceptible clone.

The cup plate assay was used to determine polygalacturonase (PG) and pectinase activity of culture filtrates from the symbiotic fungus *Monacosporium ambrosium*. The PG activity was observed to be weaker than those of standard PG from *Aspergillus niger*. Chitinase enzyme activity was detected in tea clones of TRI 2023 and TRI 2025, TRI 3015, TRI 3019, TRI 4053 and TRI 4078. The highest enzyme activity was detected in the healthy stem samples of the SHB resistant tea clones of the three series. The chitinase enzyme extracted from the tea stems was able to hydrolyse the chitin in the cell walls of *M. ambrosium*. The fungus *M. ambrosium* was found to produce xylanases that could free xylose from the xylan in tea stems.

Mycelial development, sporulation and spore germination of *M. ambrosium* were found to be affected by the glucose and inositol composition and/or the ratio of these sugars in tea stems, and also by the concentration of dextrose in the medium.

Part two of the thesis describes some structural studies of three microbial polysaccharides. Chapter four gives a brief introduction to polysaccharides, while chapter five describes the general experimental conditions and the principal techniques used during the studies of microbial polysaccharides discussed in the next three chapters.

The lipooligosaccharide of *Salmonella dalhem* was found to contain neuraminic acid and therefore it belongs to the O-48 sero type. The structure of the *Hafnia alvei* polysaccharide was found to consist of a tetrasaccharide repeating unit, the structure of which is,



6



1

 $\alpha\text{-Neup5Ac}$

Compositional and methylation analysis of the mycelial polysaccharide isolated from the fungus *M. ambrosium*, indicated it to be a glucogalactomannan.

2.3

Characterization and Nutritional Effect of Cell Wall Polysaccharides from Coconut Kernel.

Yalegama, C.

223p.

Ph.D. Degree, 2012.

Location No. 1243

Abstract

This study was conducted to develop methods to isolate cell wall polysaccharides from coconut kernel (CCWP), to characterize cell wall polysaccharides of coconut kernel residue based on their functional and structural properties and to study nutritional effect of fibres in coconut kernel residue using rats.

The coconut kernel residue remaining after virgin coconut oil extraction was the virgin coconut oil residue (VOR) and the coconut kernel residue remaining after coconut milk extraction was the coconut milk residue (MR) used in this study. During virgin coconut oil extraction carbohydrate content increased by 10.5 fold in VOR while it increased 5 fold in MR during coconut milk extraction. The VOR was treated further by removing residual, fat, protein and soluble sugars to concentrate coconut cell wall polysaccharides (CCWP). VOR was treated with aqueous methanol (80%), sodium dodecylsulphate and mercapto ethanol (1%) and dimethylsulfoxide (90%) to isolate CCWP(1). VOR was treated three times with 70% ethanol to isolate CCWP(2). CCWP(3) was isolated by treating the VOR with 70% ethanol and 0.1M NaOH. The CCWP(3) which had lower fat, protein, sugar and higher carbohydrate contents compared to CCWP(1) and CCWP(2) was selected to study nutritional and structural characteristics.

The oil holding capacity of VOR and MR was significantly lower than that of CCWP (1), (2) and (3). CCWP(1) had significantly higher water holding capacity followed by VOR, MR (having similar capacities) and CCWP(2) and CCWP(3) (having similar capacities). The swelling capacity of CCWP(1) was significantly higher followed by VOR, MR, CCWP(2) and CCWP(3) respectively.

The CCWPs, VOR and MR bound 80 to 90% of Fe^{2+} , 90 to 100% Cu^{2+} and 90 to 100% Zn^{2+} except MR at $\text{pH } 6.5 \pm 0.1$. The percentage bound Fe^{2+} increased significantly with increasing metal ion concentration. The binding of Zn^{2+} was not changed due to increase of Zn^{2+} except the bound percentage of Zn^{2+} to MR which significantly declined. Bound percentage of Cu^{2+} increased upto 1 ppm and then declined after 2 ppm. The binding capacity of Fe^{2+} to CCWP(3) and CCWP(1) increased with increasing pH and that of CCWP(2), VOR and MR declined after pH 4.5. Zn^{2+} resorbed at pH 2-3 and the binding significantly increased between pH 3.0-7.5 while that of Cu^{2+} increased with increasing pH.

The rats fed with 20% MR added feed maintained lowest weight during 120 days of the experimental period. The serum total cholesterol (TC) concentrations of rats fed with control, 10% VOR, 20% VOR, 10% MR and 20% MR increased by 20.5%, 22.8%, 19%, 17% and 15.6% indicating fibre incorporated feed fed groups hindered the increase of serum TC compared to control during 120 days. The serum high density lipoprotein cholesterol (HDL-C) concentration of rats fed with control, 10% and 20% VOR incorporated feed fed groups increased by 22.5% and 32% and 15.5% respectively while the rats fed with 10% MR and 20% MR fed groups declined it during 120 days. The control feed fed group had the highest percentage increase of serum triacylglyceride (TAG) concentrations (28.1%) followed by 10% MR (14.1%) and 10% VOR (13.1%) while 20% VOR and 10% MR showed a decline (16.4% and 13.7% respectively) at the end of 90 days and control group showed 46.1% increase followed by 10% VOR (16.2%) and 10% MR (37.0%) at 120 days. The 20% VOR and 20% MR feeds fed group showed 21.7% and 13.6% decline of serum TAG concentrations at 120 days. The serum TC:HDL-C ratio fluctuated during the experiment.

The serum glucose concentration of rats fed with control group showed a decline. 10% VOR and MR (10% and 20%) had the potential to reduce serum glucose concentration of rats significantly at 30 days (30.5%, 17.9% and 34.4% respectively) while those of test groups at 120 days was not significant compared to the basal concentrations.

Faecal excretion of micro minerals (Fe^{2+} , Cu^{2+} and Zn^{2+}) were significantly higher in rats fed with VOR and MR incorporated feed compared to the rats fed with control feed. However, definite pattern was not observed for macro minerals (Na^+ , K^+ , Ca^{2+} and Mg^{2+}) excretion.

The SF and CCWP(3) was incorporated to cholesterol enriched rats feed to study its effect on serum lipid profile and serum glucose concentration. The control feed and feed containing 2.5% soluble fibre (SF), 7.5% SF, 5% CCWP(3) and 10% CCWP(3) showed 100.5%, 114.5%, 22.5%, 25.6% and 19.8% increase at 90 days compared to the day 0 indicating that the increase was hindered due to the fibre incorporation. There was no definite pattern in change of serum HDL-C concentrations in rats fed with the control and fibre incorporated diets with time and significant change in rats consuming control feed and test feed was not observed. The groups fed with 7.5% SF, 5% CCWP (3) and 10% CCWP(3) showed significantly lower serum TAG concentrations at 90 days compared to that at day 0. The percentage decline of the serum TAG concentrations of the control, 7.5% SF, 5% CCWP (3) and 10% CCWP(3) were 8.4%, 28%, 42% and 50% respectively at day 90. The ratio TC: HDL-C of rats increased by day 60. However the ratios of groups fed with 7.5% SF and CCWP(3) incorporated feed declined showing a favourable effect at day 90.

The serum glucose concentrations of rats fed with control and 2.5% SF showed 29.8% and 37.2% increase respectively while 7.5% SF, 5% CCWP(3) and 10% CCWP(3) incorporated feed fed groups showed lower level of increase (22.2%, 24.2% and 13.2% respectively) indicating that they hinder the rise of serum glucose concentrations.

The excretion of macro minerals were fluctuated at 90 days compared to the excretion at the basal. Similarly there was no definite pattern of micro mineral excretion due to fibre incorporation to the feeds. The faecal excretion of Fe^{2+} was higher in groups' fed with fibre incorporated feeds. However such a relationship was not observed in faecal excretion of Cu^{2+} and Zn^{2+} .

Cell wall polysaccharides in VOR was further concentrated to obtain CCWP(3), SF, soluble neutral detergent fibre (NDF), NDF, soluble acid detergent fibre (ADF) and ADF. The hydrolysis of the polysaccharides was studied in the presence of TFA and H_2SO_4 . The release of sugars due

to hydrolysis of above cell wall polysaccharides was increased significantly with time (linear relationship) except hydrolysis of CCWP(3). The soluble NDF composed of 73.86% glucose, 19.7% xylose, 2.69% arabinose and minor amounts of mannose, galactose and rhamnose. Soluble ADF composed of 46.91% glucose, 33.45% rhamnose, 9.43% mannose, 3.6% arabinose and minor amounts of xylose. CCWP(3) did not hydrolyze completely in presence of the conditions provided. SF liberated 29.95% rhamnose, 26.38% arabinose, 21.56% xylose, 12.87% mannose and 9.2% glucose due to hydrolysis.

The CCWP(3) was separated into pectin, hemicelluloses (HCl, HClI) and celluloses (NaOH insoluble). The pectin composed of rhamnose: arabinose, mannose: and galactose in 9: 5: 93: 43 ratio. HCl composed of rhamnose, arabinose, xylose, mannose, galactose and glucose in 4: 1: 7: 15: 2: 1 ratio while HClI contained rhamnose, mannose and galactose in 11: 1: 8: 2. The NaOH insoluble (celluloses rich fraction) contained 16.35% galactose, 23.95% mannose, 22.50% rhamnose in addition to 37.05% glucose.

The retentate of SF in 100 kDa cutoff separated on sephadex G 200-120 to yield a fraction with 100% glucose indicating the presence of a glucan in SF. The dialysate on sephadex G -15 contained 56.3% glucose, 23.4% mannose, 9.13% rhamnose and 1.34% xylose indicating possible glucan main chain in structure of the polysaccharide separated with dialysate of SF from 100 kDa. The partial hydrolysis improved the xylose content of retentate of SF and it gave a fraction containing xylose: mannose: glucose in 3: 4: 1.

The soluble NDF polysaccharide separated on sephadex G-15 to release simple oligosaccharide (68.1% xylose and 31.8% glucose). The partial hydrolysis of pectin, HCl and HClI resulted in single peaks when separated on sephadex G-15. The fragment separated from pectin contained 32.2 % galactose, 52.5% mannose and 15.3% rhamnose indicating rhamnogalactomannan structure in the residue. Partial hydrolysis of HClI contained mannose (95.6%) major fraction together with lower percentages of glucose (2.7%), galactose (1.1%) and xylose 0.6%. Therefore HClI contains polysaccharide fragment containing mannan as the main chain.

2.4

Chemical Investigation of *Myristica ceylanica* and *Xylopiia nigricans* and Synthetic Studies on (2S, 3R, 1'R)-Stegobinone.

Manoranjan, Tharmarajah

168p.

Ph.D. Degree, 2006.

Location No. 638

Abstract

This thesis comprises three parts, Part I, Part II and Part III. Part I describes the isolation of compounds from the root bark, seed mace/aril and seeds of *Myristica ceylanica* (A.Dc.) belonging to the family *Myristicaceae*. All the isolated compounds were tested for mosquito larvicidal assay against the second instar larvae of *Aedes aegypti*. The hexane extract of the root bark yielded 1-(2,6-dihydroxyphenyl)tetradecan-1-one (81), malabaricone A (83), (7S,7'R,8R,8'R)-3,4:3', 4'-bis(methylenedioxy)7,7'-epoxylignane (92), (10Z,13Z)-17-(5-ethyl-6-methyl-heptan-2-yl)-10,13, dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-yl nonadeca-10,13-dienoate (148), β -sitosterol (149) and 4'-hydroxy-3,4-methylene-dioxy-4'-methoxylignane (150). The dichloromethane extract of the root bark gave malabaricone B (41), 1-(2-hydroxy-6-methoxyphenyl)-9-(4-hydroxyphenyl)nonan-1-one (86), (8R,8'R)-3,4:3,4'-bis(methylenedioxy)lignane (90) and (7S,7'R,8R,8'R)-4,4'-dihydroxy-3,3'-di-methoxy-7,7'-epoxylignane (94). Malabaricone C (42) was

isolated from the methanol extract of the root bark. The hexane extract of the mace/ aril yielded glycerol-2-hexadecanoate-1,3-di(*cis*-9-octadecanoate) (151). Its dichloromethane extract gave malabaricone D (84). The methanol extract of the mace/ aril yielded giganteone A (106) and 1-(2,6-dihydroxy-phenyl)-4-hydroxy-9-(3,4-dihydroxyphenyl)nonan-1-one (156). The hexane extract of the seeds yielded oleic acid (153).

Two esters (148) and (151) and the diarylalkanone (156) were found to be new and their structure elucidations have been described in detail. The lignanes (90), (92) and (150), oleic acid (153) and giganteone A ((106) are isolated from *M. ceylanica* for the first time although lignanes (90) and (92) have been previously reported from *M. dactyloides* and other compounds 150, 106 and 153 have been respectively isolated from *Virola calophylla* (Myristicaceae), *M. gigantia* and *Annona muricata* (Annonaceae). Structures were determined by spectroscopic analysis and chemical correlations. The lignanes (90) and (92) and the arylalkanones (81) and (84) showed moderate activity against second instar *A. aegypti* larvae.

Part II deals with chemical studies on the stem bark of *Xylopia nigricans* Hook f. AND Thoms. (Annonaceae). There has been no previous work on this plant. The oxoaporphine alkaloid, 10-methoxylirodene (176) was isolated from its dichloromethane extract together with two kauranes, kauranoic acid (231) and 15 β -hydroxykaur-16-en-19-oic acid (232). Its methanol extract yielded the oxoaporphine alkaloid, oxoxylopine (166) and the isoquinoline alkaloid, (+)-S-reticuline (208). The kaurane (231) showed moderate activity against the second instar larvae *A. aegypti*.

Part III of this thesis describes the attempted stereoselective synthesis of stegobinone, (2S,3R,1'R)-2,3-dihydro-2,3,5-trimethyl-6-(1'-methyl-2'-oxobutyl)-4H-pyran-4-one (271) the sex pheromone of the drugstore beetle, *Stegobium paniceum*. A synthetic route involving enantiomerically pure (4R,5S)-5-hydroxy-4-methylhexan-3-one (282) and (2S,3S)-3-tert-butylidimethylsilyloxy-2-methylpentanoic acid (283) as building blocks was proposed from retrosynthetic analysis. In an attempt to improve on a previous synthesis, a new route to the hydroxyketone (282) was attempted. A mixture of diastereoisomeric forms (282) and (285) of the hydroxyketone (69% yield) was prepared by treating pentan-3-one with a chiral borontriflate and purified using the lipase catalysed acylation method to give hydroxyketone (282) (68% yield, e.e >99%). (1S,2R)-norephedrine (290) was converted in two steps to (4R,5S)-3-propanoyl-4-methyl-5-phenyl-2-oxazolidinone (292) in an overall yield of 80% as part of the planned synthesis of the acid (283), which could not be completed due to time constraints. The synthesis of stegobinone could also therefore not be completed.

2.5

Chemistry and Biological Activity Studies of some Marine Algae and their Endophytic Fungi.

Haroon, M.H.

193p.

Ph. D. Degree, 2009.

Location No. 910

Abstract

Present investigation is initiated with the aim of identifying biologically active and economically important natural products from Sri Lankan marine algae (seaweeds) and their endophytic fungi. The work embodied in this thesis has been divided into two parts. **Part – A** contains chemistry and biological activity studies of some Sri Lankan seaweed extracts that have been collected from different locations of Sri Lanka. The **Part – B** of the thesis deals with chemistry and biological activity studies of endophytic fungi derived from some Sri Lankan seaweeds.

Part – A

In the present study, forty six fresh marine algal species were collected from the coastlines of Sri Lanka, and identified. Methanol extracts of seaweeds were subjected to antibacterial, antifungal, antioxidant, cytotoxic and seed germination inhibition activity assays. While none of the seaweed extracts showed activity against tested bacteria and fungi, some of the extracts showed activity against brine shrimp lethality bioassay and seed germination inhibition assay. Of the 24 seaweed species examined for the cytotoxicity, 9 showed LC_{50} value below 1000 $\mu\text{g/mL}$ against brine shrimp lethality assay. Above cytotoxic seaweeds extracts could be further investigated for potential anticancer/ antitumor activities. Sixteen seaweed extracts were tested for lettuce seed germination inhibition assay and seven of them showed significant reduction in the average radical length of lettuce seeds, showing their allelopathic activity. Of them *Caulerpa racemosa* (Forsskål) J. Agardh showed the lowest % germination value (17.5%) in the lettuce seed germination assay. At the same time *Caulerpa sertularioides* extract which gave a 25% germination value appeared to possess the smallest average radical length of 0.63 ± 0.19 cm. Above allelopathic active seaweeds could be used as environmental friendly natural herbicides. Interestingly, *Caulerpa racemosa* f. *laxa* showed seed germination stimulant activity with the highest % germination value (90%) and longest average radical length of 3.83 ± 0.11 cm. These results showed *Caulerpa racemosa*'s potential as a bio-fertilizer.

Methanol extracts of red algae, *Laurencia hetroclada*, *Amphiroa anceps* and green alga *Ulva lactuca* were chemically investigated. This investigation resulted in the isolation and structure elucidation of 12 pure compounds. Arugambenol, from *Ulva lactuca* and two brominated sesquiterpenes from *Laurencia hetroclada*, proved to be new. The known compounds algoane-1, cholesterol, caulerpin, isofucoesterol, triglyceride with two linoleic acid molecules and one stearic acid, oleic acid, sucrose, β -sitosterol and stearic acid were also isolated from above extracts. The compound caulerpin, showed a significant suppressive effect on polymorphonuclear neutrophils (PMNs) and T-cell proliferation inhibition assays.

Part B

Specimen collected from seaweeds were used to isolate endophytic fungi. Ten endophytic fungal strains were isolated from 10 algal samples. Two fungal strains isolated from red alga, *Laurencia ceylanica*, and brown alga, *Dictyota kunthi*, were chosen for the large scale cultivation of CzpeX Dox liquid medium, to investigate their secondary metabolite productions. This investigation resulted in the isolation and structure elucidation of 12 pure compounds including a new butyrolactone. The new butyrolactone showed significant activity against immunomodulatory and T-cell proliferation inhibition assays. It also showed antioxidant activity and the β -glucuronidase enzyme inhibitory activity. The known butyrolactone-1 showed significant activity against immunomodulatory, T-cell proliferation inhibition, antioxidant, β -glucuronidase and phosphodiesterase inhibition activity studies.

The previously reported compound (+)-asterrelenin also showed significant inhibition activity against glucuronidase enzyme while (+)-terrein, showed potent inhibition activity against T-cell proliferation and the urease inhibition assay. Additionally, (-)-prolylleucyldiketopiperazine and genistein were also isolated from endophytic fungal strain obtained from brown alga, *Dictyota kunthi*. The compound (-)-prolylleucyldiketopiperazine showed a significant inhibition activity against β -glucuronidase enzyme.

The above chemical investigations and bioassay results indicated that Sri Lankan seaweeds and their endophytic fungi are good sources of potential bioactive compounds. *Galaxaura lapidescens*, *Sargassum sp.-1*, *Dictyota sp.-1* and *Dictyota sp.-2* caused brine shrimps deaths below the level of positive control, and it is a strong indication of presence of potential anticancer/ antitumor active compounds and therefore, further studies should be carried out

on them. *Ulva fasciata*, *Cladophora sp.*, *Caulerpa racemosa* (Forsskål) J. Agardh, *Caulerpa sertularioides*, *Amphiroa anceps*, *Gracilaria hikkaduwendensis* and *Jania sp.* have shown statistically significant seed germination inhibition activity, and they could be used as the sources of natural herbicides. *Caulerpa racemosa* f. *laxa* extract has shown seed germination stimulant activity and this seaweed could be used as a fertilizer. Further, above investigation suggested that *Ulva lactuca* is non-cytotoxic and its methanol extract contained fatty acids such as Linoleic acid, and oleic acid; the free sugars along with other compounds. Therefore, the presence of linoleic acid and free sugars in *Ulva lactuca* further highlighted the nutritional value of this seaweed, which is widely consumed in the Far East. *Ulva lactuca* is popularly known as sea lettuce, and it is an excellent idea to introduce this nutritious seaweed to Sri Lankan diet, as it is naturally abundant in the Sri Lankan coast line.

2.6

Chemistry of Five Lichens of Sri Lanka and Sequestration of Lichen Compounds by a Lycaenid Butterfly *Talicauda nyseus*.

Kathirgamanathar, Selvaluxmy

126p.

Ph.D. Degree, 2004.

Location No. 389

Abstract

The thesis is in two parts. **Part I** deals with the chemistry of five lichens: *Pyxine consocians*, *Usnea sp.*, *Heterodermia leucomelos*, *Lepraria atrotomentosa* and *Leproloma sipmanianum* from Sri Lanka. *Pyxine consocians*, *Usnea sp.*, *Heterodermia leucomelos* are common macrolichens from the montane zone while *Lepraria atrotomentosa* (new species) and *Leproloma sipmanianum* (new record) are two lepraroid lichens. It describes the isolation and identification of a large number of compounds from five lichens and also discusses the results of mosquito larvicidal assay against the second instar larvae of *Aedes aegypti*. Of the 16 or so natural products isolated from the extracts and sometimes the powder of the lichens, three were new compounds.

The compounds, namely cabraleadiol monoacetate **55**, 4-*O*-methylcryptochlorophaeic acid **45** and lichexanthone **57** (from *Pyxine consocians*), methyl ether of stictic acid **61** (from *Usnea sp.*) and 3, 6-dimethyl-2-hydroxy-4-methoxybenzoic acid **64** (from *Heterodermia leucomelos* and *Leproloma sipmanianum*) showed moderate activity against the second instar larvae of *Aedes aegypti*.

Part II of the thesis deals with the sequestration of the compounds isolated from the lichen *Leproloma sipmanianum* by a lycaenid butterfly *Talicauda nyseus* and also describes the investigations regarding the stage of entry of lichen compounds into the life cycle of the butterfly and also its life history studies on *Bryophyllum calycinum* (host plant) and *B. laciniata* (a related species).

2.7

Chemistry of the Genus *Hortonia*.

Ratnayake, R.M. Rukmal P.

134p.

Ph.D. Degree, 2002.

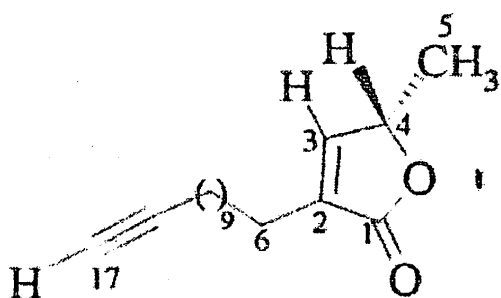
Location No. 215

Abstract

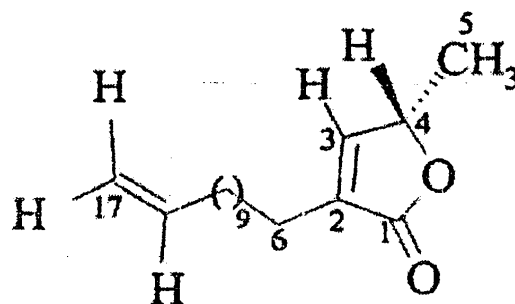
This thesis describes the isolation of bioactive compounds and biological activity studies on three endemic *Hortonia* species, namely *H. angustifolia*, *H. floribunda* and *H. ovalifolia*. A comparison of biological activity, TLC and HPLC profiles of specimens of the above three species collected from nine different geographical locations in Sri Lanka was also carried out. The bioassays used on this study were antifungal assay against *Cladosporium cladosporioides* and the mosquito larvicidal assay against the 2nd instar larvae of *Aedes aegypti*. TLC, HPLC and bio activity studies of the three *Hortonia* species collected from nine different geographical locations showed that there were no significant phytochemical differences among the three species, *H. angustifolia*, *H. floribunda* and *H. ovalifolia*. In addition, protein extraction from the leaf specimens of the three *Hortonia* species followed by gel electrophoresis produced an identical band pattern in all specimens, further corroborating the chemical identify of the three species.

The CH₂Cl₂ extract of hortonia species furnished five new butenolides identified as (4S)-4-methyl-2-(11-dodecynyl)-2-butenolide **75**, (4S)-4methyl-2-(11-dodecenyl)-2 butenolide **76**, (4S)-4-methyl-2-(2(R)-hydroxy-11-dodecenyl)-2 butenolide **77**, (4S)-4-methyl-2-(9-epoxy-11-dodecynyl)-2 butenolide **78**, (4S)-4-methyl-2-(9Z)-11-epoxy-9-dodecynyl)-2 butenolide **79**, one new tetracyclic sesquiterpene identified as 1,5,12-trimethyltetracyclic[6,3,0,0,0^{3,4,8}] dodecane (**80**) and β-sitosterol (**82**). Butenolide **75** and **76** were highly active against the 2nd instar larvae *Aedes aegypti* (LC₅₀ = 0.41 and 0.47 ppm respectively), butenolide **77** was moderately active (LC₅₀ = 1.6 ppm), butenolide **79** was less active (LC₅₀ = 7.87) and butenolide **78** was inactive against 2nd instar larvae of *Aedes aegypti*. Complete hydrogenation of the butenolide **75** in the presence of Pd-C/H₂ yielded the saturated compound identified as (4S) (2- dodecyl)-4-methyl butenolide (**81**). This compound was inactive against 2nd instar larvae of *Aedes aegypti*, suggesting that unsaturation was required for biological activity.

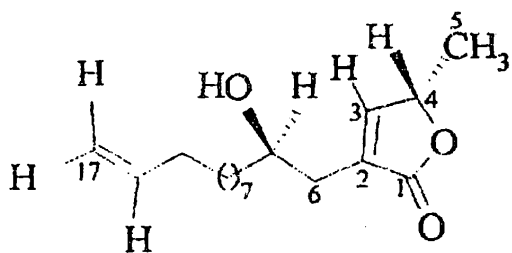
Butenolides **75**, **76**, **77**, **78**, **79** and tetracyclic sesquiterpene were active against the fungus *Cladosporium cladosporioides*.



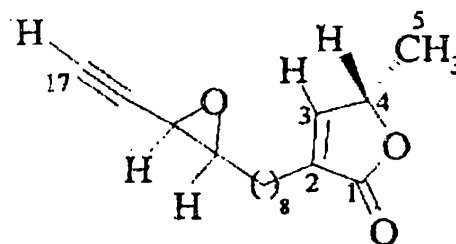
Butenolide **75**



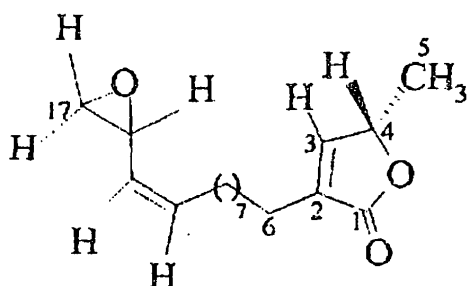
Butenolide **76**



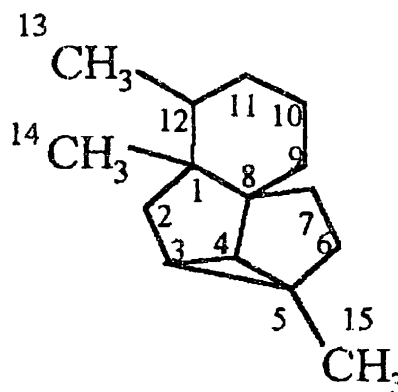
Butenolide 77



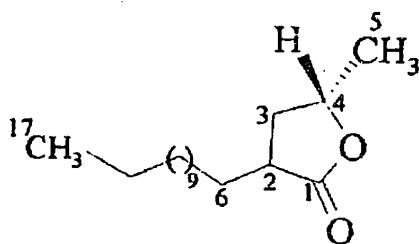
Butenolide 78



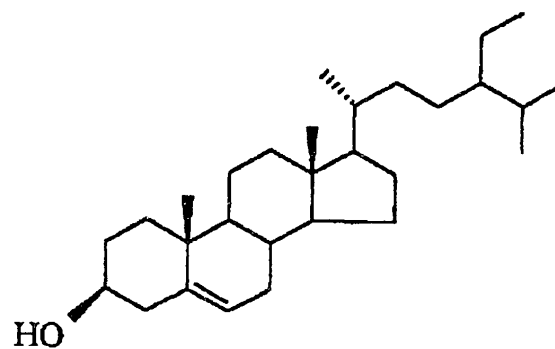
Butenolide 79



Tetracyclic sesquiterpene 80



Butanolide 81

 β -Sitosterol (82)

2.8

Development of Electroanalytical Detection Schemes for Some Selected Pesticides.

Weliwegamage, Ubhayathilaka Sisira Kumara

191p.

Ph.D. Degree, 2003.

Location No. 312

Abstract

Pesticides are considered as priority environmental pollutants and health hazards. Detection of pesticides by reliable means would therefore, be an important early step in control of environmental pollution, biosphere conservation, and avoiding most poisoning and other health problems. Development of alternative, simple methodologies has drawn much attention due to drawbacks of currently used chromatographic and spectrometric methods. In this study, development of alternative methods for the detection of pesticides, based on electrochemical techniques, in particular cyclic voltammetry and amperometry, was attempted. Different types of electrodes were used with emphasis on the electroactivity of pesticides under the influence of applied potentials.

The dithiocarbamate fungicide, thiram was found to be electroactive at unmodified glassy carbon electrodes in aqueous medium. The electrochemical behavior of this compound was extensively studied using cyclic voltammetric experiments. The amperometric method, which was developed under optimized conditions; applied potential of +0.50 V and in the supporting electrolyte of pH 10 borate buffer, produced reproducible responses with a minimum detection limit of $1.0 \times 10^{-8} \text{ mol dm}^{-3}$ based on the signal to noise ratio (S/N) of 3. This method was applied to quantify thiram in water leaches of a model soil bed, and in an agricultural bean seeds sample.

Some electrode processes are kinetically disfavoured towards oxidation and/ or reduction due to high over potentials associated. The kinetic barrier could successfully overcome by the selection of a suitable electrocatalytic scheme. Electrocatalysts are capable of catalyzing electrochemical processes, as they decrease the overpotential for oxidation/ reduction. Use of both chemical and biological catalysts for the detection of pesticides is reported here.

A voltammetric biosensor containing apple tissue (10% w/w) as the biological component was able to detect thiram at levels as low as $1.0 \times 10^{-6} \text{ mol dm}^{-3}$. During this process, the inhibition of the enzyme polyphenol oxidase present in apple tissue by thiram was observed. The response of the biosensor was optimum for a period of 2-3 weeks.

Transition metal oxides with variable oxidation states were found to be excellent electrocatalysts for many pesticides, if conditions such as electrolyte, working potential/ potential range and the catalytic loading were optimized. The phenoxy acid herbicide, MCPA (4-chloro-2-methylphenoxyacetic acid), was detected at a catalytic carbon paste electrode, containing MnO_2 black powder (10% w/w). The amperometric sensor produced a minimum detection limit of $9.7 \times 10^{-7} \text{ mol dm}^{-3}$, based on $S/N = 3$. This method was successfully applied to quantify the active ingredient in an old commercial formulation. The sensor showed a satisfactory lifetime of about 8-10 weeks. Cyclic voltammetric investigation revealed the possible interaction between Mn^{2+} and MCPA, according to the variations of solution electrochemistry of Mn^{2+} ions.

Another organochlorine herbicide, propanil, was determined at a carbon paste electrode, constructed using 10% (w/w) CuO , with a minimum detection limit of $6.0 \times 10^{-8} \text{ mol dm}^{-3}$ ($S/N=3$) amperometrically. The sensor response was optimum over a period of 6-7 weeks.

Metalloporphyrins are another group of electrocatalysts, used in the electrochemical reduction of organohalogenes. The metallic electrodes; Pt and Au, together with glassy carbon electrodes modified with 5,10,15,20-tetraphenyl porphyrinatoiron(III) chloride [Fe(III)TPPCI] catalyzed the reduction of some organochlorine pesticides. In this case it was found that the detection was more sensitive with metallic electrodes.

Glassy carbon electrodes modified with Fe(III)TPPCL were used for the detection of propanil in water, leached out from a model rice bed. Simple gravity column preconcentration could enhance the sensitivity of electrochemical detection. Such studies indicate the practical applicability of electroanalytical techniques in real sample analysis.

2.9

Effect of Tea Metabolites on Development and Behaviour of Selected Insects and the Transformation of Steroids by *Monacrosporium ambrosium*.

Karunaratne, Weeraman Subodhi

197p.

Ph.D. Degree, 2004.

Location No. 388

Abstract

Part I is a ten generation study on the effect of secondary metabolites, on the shot hole-borer beetle, *Xyleborus fornicates* (Coleoptera: Scolytidae) of tea, *Camellia sinensis* L. The uninhibited growth of the beetle in a sterol free medium indicated the invalidity of the hypothesis, which claimed that the resistance of tea clones is due to high saponin content reducing availability of tea sterols to the beetle. Progeny production was almost completely inhibited in media containing 100 ppm caffeine but the effect was reversible if exposure was for less than 48 hours. No significant differences were observed from control which tea saponins were introduced.

In behavioral studies in an olfactometer, females showed a density dependent attraction turning into a strong repulsion against increasing numbers of females. Males were attracted to non-mated females but not to mated individuals. GC analysis of tea bark showed its main constituents to be β -pinene, terpenolene, hexanol, linalool, geraniol, methyl salicylate and eugenol. Olfactometer studies showed the beetle to be significantly attracted towards ethanol and mixtures of ethanol with α -pinene, eugenol and hexanol.

When both non-infested and infested tea stems were offered to beetles, a higher number entered the non-infested stems of both clones in the first hour while entry to infested TRI2025 stems was significantly delayed by 2-3 hours and to infested TRI2023 stems by over 24 hours, indicating an induced resistance on infestation. Caffeine is known to be the main antifungal compound in the tea plant. A quantitative analysis using HPLC showed that caffeine content varied depending on the part of the plant and the infestive stage. Non-infested TRI2025 stem contain more caffeine than non-infested TRI2023 stem, while bark contained more than stem and inter-nodal bark more than nodal bark. The caffeine content of both clones was significantly higher in infested plants with the increase being greater in TRI2025 than TRI2023.

Part II describes olfactometry studies on the social behavior and host discrimination of the cow pea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae). The occurrence of density dependent pheromones and odour responses to its host plant *Vigna unguiculata* were studied. Apteræ responded with positive anemotaxis to air passed over both apteræ and alatae in groups of less than ten individuals, but negatively to air that passed over groups greater than twenty. Alatae responded similarly to groups of apteræ but were repelled by alatae. Both were able to distinguish between other hosts and their original host, cow pea. When attacked by aphids, plants responded with a temporary increase in attraction that reached a maximum in 48 hours.

In **Part III**, the insecticidal activity of *Vernonia anthelmintica* (Family: Asteraceae) seeds is described. The dichloromethane extract showed activity against *Aedes aegypti* second instar

larvae. In the residual film bioassay, the extract was active against *Callosobruchus maculatus* adult. Activity guided fractionation gave a crystalline substance identified as a mixture of angelicin and psoralen whose toxicity to *A. aegypti* was highest in the presence of sunlight. In the absence of sunlight, 100% growth inhibition was observed. With *C. maculatus*, the substance showed 40% moribundancy in 24 hours in the residual film bioassay and 90% reduction of ovulation and 0% adult emergence in seed treatment bioassays.

When separated neither were as active as the original mixture and when combined, none of the combinations showed the activity of the isolated mixture.

Part IV of the thesis describes the biotransformation of steroids by *Monacrosporium ambrosium*, the fungus associated with the shot hole borer beetle *X. fornicatus*. 5 α -Androstan-17 β -ol, 5 α -androstan-17-one, 5 α -androstan-3-one and 5 α -Androstan-3 β -ol were prepared from 17 β -hydroxy-5 α -androstan-3-one and incubated with the fungus. Results suggest that *M. ambrosium* is not specific in its microbial reactions effecting hydroxylations, oxidations and reductions often leading to mixtures of products. Of the transformations observed, the 11 α -hydroxylation of 3-oxygenated steroids appear to have some potential.

2.10

Insecticidal Compounds from some Sri Lankan Plants.

Bandara, Kasturiarachchige Nimal Premarathne

176p.

Ph.D. Degree, 1997.

Location No. 07

Abstract

The activities of the dichloromethane and methanol extracts of *Curcuma zedoaria* and *Zingiber purpureum* (Zingiberaceae) rhizome and *Microcos paniculata* (Tiliaceae) stem bark, their fractions and constituents against the second instar of *Aedes aegypti* (Diptera: Culicidae), *Plutella xylostella* (Diamond back moth, DBM) (Lepidoptera: Yponomeutidae) and cowpea bruchid, *Callosobruchus maculatus* (Coleopteran: Bruchidae) were studied. Their comparative efficacies under semi-field conditions were also investigated to explore their possible use in small-scale pest management. More suitable bioassay methods for screening were also developed.

The dichloromethane and ethanol extracts of *C. zedoaria* rhizome showed mosquito larvicidal activity (LC₅₀ = 18.7 and 43.8 ppm respectively). The active constituent with LC₅₀ of 1.6 ppm was identified as a furanodiene, (1E, 4E)-8,12-epoxygermacra-1(10),4,7,11-tetraene (66). The dichloromethane extract showed antifeedant, toxic and repellent effect on DBM larvae (AF₅₀=286 ppm, LC₅₀ =1820 ppm), but furanodiene showed comparatively poor toxic and feeding deterrent effects (AFC₅₀=897 ppm, PLC₅₀=575 ppm). The extract also showed contact/residual and fumigant toxic effect on adult bruchid. Cowpea seeds treated with extract reduced settlement, oviposition, egg hatchability and adult emergence of bruchids.

Both extracts of *Z. purpureum* rhizome showed mosquito larvicidal activity ((LC₅₀=7.6 and 4.8 ppm respectively). The active constituent with a LC₅₀ of 6.5 ppm against the second instar was identified as (E)-4-(3',4'-dimethoxyphenyl)buta-1,3-diene (61). The dichloromethane extract showed toxic and antifeedant effects against DBM larvae. Although the phenylbutanoid (61) was toxic to the larvae it failed to show a feeding deterrent effect. The extract also showed repellent and toxic effects (RLC₅₀=2.9 mg) on adult bruchids. The extract and phenylbutanoid (61) showed oviposition deterrent and ovicidal effects against bruchids. Embryos did not develop in most of the eggs and a transparent egg wall could be seen. Weak, non-developed

larvae or eggs with embryos concentrated on one side leaving the rest of the area clean were seen in partly affected eggs. Although the phenylbutanoid and its toxicity to the larvae of *Spodoptera littoralis* has been previously reported, its insecticidal activity against the three insects studied and its ovicidal and maternally applied larvicidal activity against cowpea bruchids is being reported for the first time.

Both extracts of *M. paniculata* stem bark showed moribund/ toxic and growth inhibitory effects on mosquito larvae ($MC_{50}=1.0$ ppm, $LC_{50}=17.2$ and 16.0 ppm). Their active constituent was identified as the alkaloid, N-methyl -6 β -(deca-1',3',5'-trienyl)-3 β -methoxy-2 β -methylpiperadine (105). The dichloromethane and methanol extracts showed repellent, feeding deterrent and growth inhibition effects against DBM larvae ($AFC_{50}=117.1$ and 104.8 ppm, LC_{50} 48 HAI=788.5 and 801.0, $PLC_{50}=84.5$ and 765.8 ppm and $ALC_{50}=12.2$ and 490.7 ppm respectively. The alkaloid (105) showed similar effects ($AFC_{50}=4.3$ ppm, LLC_{50} at 72 HAI=11.4 ppm, $PLC_{50}=5.9$ ppm and $ALC_{50}=4.3$ ppm) on DBM larvae. Comparative studies revealed that its anti-insect properties were comparable with those of the azadirachtins. The dichloromethane extract and the alkaloid (105) reported moribund/ toxic effect on adult bruchids ($MC_{50}=5.6$ and 0.1 , $LC_{50}=6.9$ and 0.3 mg). Comparative efficacy studies of these three plant extracts against DBM and cowpea bruchid under semi-field conditions showed that they were potentially useful against the pests.

2.11

Isolation and Bioactivity Studies of Lichen Substances from Sri Lankan Lichens.

Bombuwala, Bombuwalage Don Karunananda
171p.

Ph.D Degree, 2001.

Location No. 127

Abstract

This thesis describes the isolation of bioactive compounds from four lichen species collected in Sri Lanka: *Usnea* sp., *Heterodermia diademata*, *Roccella montagnei* and *Leproloma sipmanianum*.

The bioassays used in this study are the antifungal assay against *Cladosporium cladosporioides* and the mosquito larvicidal assay against the 2nd instar larvae of *Aedes aegypti*. The bioassayscreening results of 50 lichen specimens collected mostly from the montane region are listed separately in the appendix 3. From the CH_2Cl_2 extract of an *Usnea* sp. collected from Ambewela in the Central province, three compounds namely, ambewelamide A (35), ambewelamide B (36) and usnic acid (37) were separated. Ambewelamides A (35) and B (36) are new members of a family of highly modified diketopiperazines and constitute the first examples of this family of compounds isolated from a lichen. The MeOH extract of the same lichen furnished two new depsidone lactones (38) and (39), and β -sitosterol (45).

Ambewelamide A was active against the 2nd instar larvae *Aedes aegypti* ($LC_{50}=1.70$ ppm) and was also highly active against five fungi: *Cladosporium cladosporioides*, *Colletotrichum musae*, *Colletotrichum gloeosporioides*, *Curvularia trifolii* and *Monacrosporium ambrosium*. Ambewelamide A was found possess potent *in vitro* cytotoxicity (murine leukemia P388: IC_{50} 8.6 ng/mL) and significant *in vivo* antineoplastic activity (P388: %T/C 140 @ 160 μ g/Kg).

Usnic acid showed mosquito larvicidal activity against larvae of *Aedes aegypti* ($LC_{50} = 0.89$ ppm), antifungal activity for above five fungi and also antitermite activity against *Glyptotermes dilatatus* (80% mortality at 10mg).

Seven compounds were isolated from the *Roccela montagnei* lichen collected from Bamunakotuwa in the Kurunegala district, North Western Province: from the CH₂Cl₂ extract, aspisilin (40) was separated; the MeOH extract yielded erythrin (41), methylorsellinate (42), erithritol (43), rocellic acid (44), β -sitosterol (45) and β -carotene (46). Compared to erythrin (41), its biosynthetic precursor methylorsellinate (42) showed significantly higher antifungal activity against the same test fungi as given above.

The third lichen studied was *Heterodermia diademata* collected from a rock beside a small stream in Labukelle, in the Nuwara Eliya district. The hexane extract of the above lichen provided three compounds: 5-chloro-3-formyl-4-hydroxy-2-methoxy-6-methylbenzoic acid (47), methyl β -orcinol carboxylate (48), and zeorin (49). From the CH₂Cl₂ extract, atranorin (3) and chloroatranorin (51) were separated. The MeOH extract yielded β -sitosterol(45) in addition to atranorin (3). To the best of our knowledge, 5-chloro-3-formyl-4-hydroxy-2-methoxy-6-menthylbenzoic acid (47) has not been reported before. Atranorin (3) exhibited moderate mosquitolarvicidal activity but showed fungicidal activity comparable to the standard fungicide, Benlate.

Leproloma sipmanianum specimens were collected in the upland area of Nuwara Eliya on proterozoic rocks of gneiss and quartz schist which are exposed at road edges in the rather extensive areas around Beragala. *Leprolomma sipmanianum* has previously been reported from South Africa, Colombia and Brazil. This is the first report of the lichen from the Asian region. The butterfly *Talicadia nyseus nyseus* (Guer) (Red Pierrot) was found to be closely associated with *Leproloma sipmannianum*. The CH₂Cl₂ extract of *Leproloma sipmannianum* contained five compounds namely, (+) usnic acid (37), atranorin (3), β -sitosterol (45), zeorin (49), and a long chain fatty acid ester (51). Compound (51) is new to lichens. Upon comparison, the extracts of the adult *Talicadia nyseus nyseus* (both the collected adult butterflies and the ones which emerged from pupae) contained all of the above compounds. The presence of the above five compounds in the butterfly was confirmed by a combination of TLC and GCMS. The presence of lichen substances in the adult *Talicadia nyseus nyseus* indicates that their larvae feed on *Leproloma sipmannianum*. To the best of our knowledge, there are no previous reports of the butterfly family (*Lycaenidae*) feeding on lichens.

2.12

Mechanistic, Spectroscopic and Molecular Model Probing of the Arsenic-Gibbsite Interface.

Wijesekara, H.K.D.K.

82p.

Ph.D. Degree, 2007.

Location No. 639

Abstract

Because of its toxicity, arsenic is of considerable environmental concern. Its solubility in nature is strongly influenced adsorption – desorption processes. Majority of arsenic adsorption in natural systems indicate iron hydroxides as main sorbents. Relatively few studies have focused on adsorption properties at the gibbsite -water interface. In this work, I have characterized, systematically, the gibbsite - water interface by pH and pAs titrametric methods in combination with vibration spectroscopy and molecular modeling methods.

Analysis of As(V) adsorption data with the charge distribution multisite ion complexation model (CD-MUSIC) show that the formation of the surface complex is accompanied by a redistribution of charge in the interfacial region due to the binding structure in which anion partially coordinates with the surface. In principle, four surface structures are suggested i.e.

bidentate binuclear complex, bidentate mononuclear complex, monodentate mononuclear complex and monodentate binuclear complex. The vibration spectroscopic data have confirmed that As(V)-surface complex is bidentate binuclear complex. Semi-empirical molecular methods using MOPAC and PM3 were used to optimize the geometry of this surface complex resulting inter-atomic distances of As(V)-Al, As(V)-O as 3.21 Å and 1.67 Å respectively.

Analysis of As(III) adsorption data such as ionic strength dependence, kinetic data and adsorption isotherms suggest that As(III) is outer spherically bonded weakly to surface sites. No considerable pH change in the As(III) treated samples assumed that there is no proton exchange upon As(III) adsorption on gibbsite. Calculated relative abundance of As(III) species using ECOSAT program and corresponding thermodynamic data have shown only H₃AsO₃ is the most dominant throughout the pH range considered. Two surface configurations are suggested i.e. bidentate binuclear complex and monodentate mononuclear complex. Analysis of As(III) adsorption data with the charge distribution multisite ion complexation model (CD-MUSIC) show that the possible surface configuration is a bidentate binuclear complex. Semi-empirical molecular methods using MOPAC and PM3 calculations predicted that the distance between two adjacent >AlOH²⁺ sites is 2.80 Å. The terminal -OH groups of As(OH)₃ reside at a 3.10 Å distance apart.

2.13

Microbial Insecticides from *Bacillus thuringiensis* and Fungal Metabolites from *Hirsutella thompsonii*.

Siriwardhana, D.A.S.

261p.

Ph.D. Degree, 2011.

Location No. 1142

Abstract

The excessive use of synthetic pesticides in agriculture leads to bio-accumulation of toxic chemicals and development of pest resistance. Use of microbial agents such as *Bacillus thuringiensis* (*Bt*) in such situations is an alternative. *B. thuringiensis* is a bacterium that produces δ-endotoxins with a spectrum of insecticidal activity against dipteran, lepidopteran and coleopteran mainly. *Hirsutella thompsonii* (Fisher) is a terrestrial fungus that is reported to have acaricidal activity.

The objectives of this study were to investigate the insecticidal potential of *Bt* and *H. thompsonii* of Sri Lanka origin to be used as biopesticides against lepidopteran pests of cruciferous vegetables and characterize the active strains and fungal metabolites.

Sri Lankan *Bt* strains were isolated and identified by microbiological and biochemical methods and the existence and expression of insecticidal *cry*, *cyt* and *vip* genes were determined by PCR analysis. Active strains were mass cultured using fermentation technology and insecticidal activity was evaluated against cruciferous vegetable pests, *Plutella xylostella* L., *Agrotis ipsilon* Hufnagel and *Chrysodeixis eriosoma* Doubleday.

Gene activity relationship was established for lepidopteran, dipteran and coleopteran insect orders using LC₅₀ values and *cry*, *cyt* and *vip* genes. Two *Bt* strains, AB 125 and AB 142, were evaluated for field efficacy. Fish toxicities of these strains were assessed against *Puntius cumingi*, *P. nigrofasciatus*, *Poicellia reticulata*, *Oreochromis niloticus* and *Cyprinus carpio*.

Cry gene analysis data of *Bt* isolates indicated that all fifteen isolates contained dipteran toxic *cry4* and 10 genes while only eleven strains contained *cry11* gene. Two isolates contained *cyt* 1 genes, four isolates contained lepidopteran toxic *cry* 1, 2, 9 and *vip3A* genes and three isolates

contained coleopteran toxic *cry3*, 7 and 8 genes in different compositions. The expression of dipteran toxic *cry* and *cyt* gene produced 130, 78, 67 and 27 kDa proteins, lepidopteran toxic *cry* and *vip* genes produced 130, 70, 60 and 88 kDa proteins and coleopteran toxic *cry* genes produced 130 and 73 kDa proteins.

Gene-Activity data for lepidopterans indicated that *cry1*, 2 and 9 genes contribute to high lepidopteran activity and absence of *cry2* or *cry1* gene in *Bt* strains can reduce the activity. However, reduction can be minimized by the presence of *cry9* and *vip3A* genes. Gene- Activity relationship data for dipterans highlighted that *cry4* and *cry11* genes and its subtypes increase the activity and absence of *cry4D* gene remarkably reduce the activity and *cyt* genes enhanced the activity.

Among *Bt* isolates, *Bt* AB 125 showed highest insecticidal activity against *Plutella xylostella* ($LC_{50} = 1.6 \times 10^4$ spores/mL) and *A. ipsilon* ($LC_{50} = 1.77 \times 10^5$ spores/mL) and *Bt* AB142 against *C. eriosoma* ($LC_{50} = 9.83 \times 10^4$ spores/mL).

Formulations prepared for field assays, namely invert oil and gel suspension formulations, met the standard requirements for quality parameters, such as suspensibility, storage stability, emulsion stability, acidity and microbial purity.

In the 1st field assay, *Bt* AB 142 showed 33% and 41 % population reductions of *P. xylostella* and *C. eriosoma*, respectively, 10 days after treatment. In the 2nd field assay, the maximum population reduction was 82.3, and 86.8% by *Bt* AB 142 and AB 125, respectively after 4 days of application. In the 3rd field assay, *Bt* AB125 showed 91% population reduction of *P. xylostella* during 24 - 72 h of the application. In the 4th field assay, *Bt* AB125 and AB142 showed 89 and 77% population reductions of *P. xylostella*, respectively. Population was reduced to zero after 4 days. In the 5th field assay, *Bt* AB 125 gel suspension formulation was able to reduce *A. ipsilon* population to the lowest rate of increase.

Dipteran and lepidopteran toxic *Bt* strains were found to be non toxic against the tested fish species and water quality parameters were not affected adversely in the fish toxicity study. Medium study data of *H. thompsonii* indicated that Beer waste and sugar liquid medium yielded highest mycelium (5.556 g) and broth extract (9.614 g) and rice hay and rice bran medium yielded highest spore production (2.4×10^9 conidia/g). Spore suspension and broth extracts of *H. thompsonii* showed good insecticidal activity against *Brevicoryne brassicae* ($LC_{50} = 2.91 \times 10^8$ conidia/mL and 731.42 ppm, respectively).

Chromatography guided fractionation of the ethyl acetate extract of the mycelium of *H. thompsonii* afforded two new cytochalasins type compounds which were identified as 1-hydroxy-1, 7, 13-trirnethyl-4-(3-rnethylbutyl)-8-oxatricyclohexadeca-2, 11-dien-4- ylbutanoate and 6,7-epoxy-18,21-dihydroxy-5,6, 16, 18,24-hexamethyl-10-isopropyl- cytochalasa-13,19-dien-1-one by spectroscopic methods. Compounds 1 and 2 were identified as new cytochalasin type compounds from *H. thompsonii*.

2.14

A Novel Approach to the Control of *Aedes aegypti*, a Vector of Dengue Fever and Pollution Abatement by the Use of Porphyrin Derivatives.

Herath, H.M.A.M.C.

209p.

Ph.D. Degree, 2005.

Location No. 459

Abstract

The discharge of hazardous chemicals by the activities of mankind has been a serious threat to the environment. Among the pollutants, pesticides, coloured dyes and heavy metals are significant in terms of their detrimental consequences to living organisms. Therefore, the development of efficient and reliable techniques for the removal of these pollutants from the environment is essential. In the pollution abatement studies, it was demonstrated that porphyrin derivatives such as haematoporphyrin dihydrochloride (HPDHC) and protoporphyrin dimethylester (PPDME), in the presence of visible light and oxygen, could be utilized for the destruction of coloured organic dyes in aqueous media.

The visible light irradiation of oxygenated aqueous solutions of coloured dyes magenta (MaG), crystal violet (CrV) and hematoxylin in the presence of HPDHC or PPDME showed complete colour bleaching after 12 hours. The rate of photobleaching was found to be sensitive to the medium pH. At low pH (pH = 3.2), a higher oxidative degradation rate for MaG was observed in comparison to the low rate at pH 6.0. Analysis of photoproducts of MaG and CrV in acidic as well as basic media showed the formation of micro molar levels of NO_3^- ions resulting from the destruction of amine moieties of the dyes.

Photobleaching experiments were carried out in the presence of different quenchers such as 1,4-diazabicyclo[2.2.2]octane (DABCO) for singlet oxygen and 1,4-benzoquinone (BQ) for superoxide anion ($\text{O}_2^{\bullet -}$). Only BQ was able to stop photobleaching suggesting that the photo oxidation of these dyes are mainly caused by $\text{O}_2^{\bullet -}$, which is generated by an electron transfer from the excited sensitizer to ground state oxygen in the photosensitization process. The participation of singlet oxygen in dye destruction process is comparatively low.

Solubility of porphyrins in water is an essential requirement when they are used in aqueous medium. Water soluble cationic porphyrin derivatives 5,10,15,20-tetrakis(4-*N*-pentyl- pyridyl) porphyrin, $[(\text{TPePyP})\text{H}_2]^{4+}$, and its zinc analogue $[(\text{TPePyP})\text{Zn}^{II}]^{4+}$ were synthesized by introducing cationic pyridyl groups into the *meso* positions of the porphyrin core. Photobleaching studies carried out in aqueous solutions of varying pH show that, in the presence of oxygen, $[(\text{TPePyP})\text{H}_2]^{4+}$ undergoes fast photo degradation when the solution is irradiated with 560 nm light. The steady-state singlet oxygen quantum yields (Φ_Δ) measured in DMF for $[(\text{TPePyP})\text{H}_2]^{4+}$ and its Zn analogue was 0.80 and 0.85, respectively. These values are in the same order of magnitude as those of well-known porphyrins such as HPDHC and PPDME.

The aggressive and destructive nature of $\text{O}_2^{\bullet -}$ towards most of the organic materials is an important advantage in pollution abatement. A method generally employed to indirectly test for $\text{O}_2^{\bullet -}$ is the study of an $\text{O}_2^{\bullet -}$ driven reaction in the presence of a scavenger like superoxide dismutase or benzoquinone. It was found that $\text{O}_2^{\bullet -}$ was effectively quenched when 1,2,3-triketohydrindene hydrate (NHy) was added to an oxygen-saturated solution, where $\text{O}_2^{\bullet -}$ is electrochemically generated at a glassy carbon electrode by applying a potential of -0.75V vs Ag/AgCl wire. The suppression of the oxidation peak of $\text{O}_2^{\bullet -}$ with the addition of NHy in cyclic voltammetry was in close agreement with results obtained in rotating ring disk voltammetric experiments. It was revealed that the decolouration of MaG by the $\text{O}_2^{\bullet -}$ produced by HPDHC in the presence of light in DMF was retarded in the presence of NHy.

The syntheses of porphyrin dyads in the combination of free-base and Zn porphyrin units with different redox potentials was attempted. In this respect, several porphyrin derivatives, *meso*-5-(4-hydroxyphenyl)-10,15,20-trisphenyl porphyrin (HPTTrPP), *meso*-5-(4-hydroxyphenyl)-10,15,20-tris(4-methoxy phenyl)porphyrin (HPTTrMPP), *meso*-5-(4-hydroxyphenyl)-10,15,20-tris(4-sulfonatophenyl)ammonium porphyrin $[\text{NH}_4]_4[\text{HPTTrSPP}]$ and their Zn derivatives were synthesized and characterized by UV-Visible, ^1H NMR spectroscopy and cyclic voltammetry.

The porphyrin sensitized photoinactivation of the 2nd and late 3rd instar larvae of the urban dengue mosquito *Ae. aegypti* was investigated as a novel approach in controlling the mosquitoes. In this study it was revealed that haematoporphyrin dimethylester (HPDME), HPDHC, PPDME and haematoporphyrin (HP) caused a high level of photo toxicity to the 2nd and late 3rd instar larvae of *A. aegypti* in Pyrex and clear plastic containers. In contrast, the mortality under natural conditions was less in coconut shells, in caps and PVC gutters. Least larvicidal activity was observed in tires. These results suggest that the efficacy of mortality depends on the amount of light reaching the photo sensitizer (this is maximum only in the case of Pyrex glass and clear plastic containers), the nature of the surface of the container, the concentration of the sensitizer and unit volume per larvae.

Out of the four sensitizers tested, a high level of larvicidal activity was observed with aqueous solutions of HP, which showed the highest phototoxic effect at 2.5 ppm in laboratory experiments. Field experiments set up inside and outside houses also showed that a high larvicidal activity with HP (100% mortality in four days) in the presence of light (outside). Conversely, the mortality was less inside the houses (36.79%).

The phototoxic studies extended using HP and HPDHC towards other fresh water fauna, mayfly larvae, *Poecilia reticulata* (guppy) and *Bufo melanostictus* (tadpole) did not show any apparent toxic effect even after seven days at 100 ppm. This concentration is 40 times higher than that used in bringing about effective killing of *Ae. aegypti* larvae. Based on field experiments as well as toxicity studies, both HP and HPDHC could be used effectively and safely to hasten the larval killing process, thus controlling the adult mosquito population.

2.15

Pesticidal Compounds from Plants and Effect of Host Plant Odours on Aphids.

Alagesan, Kayalvily

189p.

Ph.D. Degree, 1999.

Location No. 86

Abstract

The thesis consists of two parts. The first part describes phytochemical and bioactivity studies on the Sri Lankan plants, *Clausena lansium* (Rata karapincha), *Alstonia macrophylla* (Havari-nuga), *Piper sylvestre* (Wal-gam-miris-wel) and *Gnidia glauca* (Nagadhun). Dichloromethane extract of the root and stem bark of *C. lansium* contained terpenes, hydrocarbons, sitosterol, the six coumarins, chalepentin, chalepin, gravelliferone, augustifoline, imperatorin and 5-methoxyimperatorin and three carbazole alkaloids, indizoline, 3-formyl carbazole including the new 2,7-dihydroxy-3-formyl-1-(3'-methyl-2'-butenyl)carbazole. The structures of the compounds were established chemically and spectroscopically.

Both extracts were shown to possess larvicidal activity against *Aedes aegypti* and the activity was shown to be mainly due to chalepentin.

The dichloromethane extract of *Alstonia macrophylla* root bark, which contained alstophylline, demethoxy-alstophylline, talcarpine and macralstonine, was shown to have anti-fungal and nematocidal activity. Talcarpine was shown to be responsible for the activity.

The dichloromethane extract of the leaves and stem of *Piper sylvestre* was shown to be strongly active against *A. aegypti* larvae with an LC₅₀ of 16.48 ppm. The activity was shown to be due to N-isobutylnona-2E,4E-dienamide with an LC₅₀ of 0.94 ppm. Other compounds isolated included a weakly active long-chain hydrocarbon with LC₅₀ of 46 ppm and the moderately active lignan, hinokinin with an LC₅₀ of 5.61 ppm.

Dichloromethane extract of the stem bark of *Gnidia glauca* was shown to be active against *Aedes* mosquito larvae and the activity to be due to the weakly active 3'-methoxyflavone with an LC_{50} of 13.25 ppm.

The second part of the thesis describes the influence of volatiles of cowpea, *Vigna unguiculata* on aphid attack. Volatiles from uninfested, infested and systemic infested plants of cowpea, *V. unguiculata*, were collected by air entrainment using Porapak and SPME (solid-phase-microextraction) followed by extraction. The compounds present were identified using GC and GC-MS and the differences between uninfested and infested plants were statistically analysed.

The main constituents of the volatiles were shown to be hydrocarbons, terpenes, caryophylline, methyl salicylate and homomyrcene and their roles in attraction/ repulsion studied using olfactometer experiments.

2.16

Physicochemical Investigations on Synthetic Spinel ($MgAl_2O_4$) and Sri Lankan Geuda.

Udawatte, Chandana Premakumara

159p.

Ph.D. Degree, 1997.

Location No. 02

Abstract

Part I

Crystal growth and characterization of transition metal doped mg-Al Spinel

Although spinel is a very common gem mineral in many countries, the understanding of its colour formation is still rather poor. Recent studies on natural spinels had not shed much light on the subject either. The magnesium aluminate spinel $MgAl_2O_4$ system is coloured in a wide variety of colour by different transition metal ions indicating a complex crystal chemistry of natural spinels. This complexity is of considerable scientific interest. There is little difference between natural and synthetic spinels. The study aims to understand the colour formation of spinel using synthetic spinel matrix.

The site preferences for ions in spinel are of considerable interest because the incorporation of these ions causes marked changes in properties such as colour, magnetism, cohesive energy and thermal conductivity of the mineral. This study particularly investigates electronic spectra and the oxidation state of the doped elements in the spinel structure.

The gem quality bowels of $MgAl_2O_4$ spinel both pure and incorporated controlled amounts of Ti^{3+} , V^{3+} , Mn^{2+} , Mn^{3+} , Fe^{2+} , Fe^{3+} , Co^{2+} and Ni^{2+} were synthesized by a flux method. Spinel crystals over 0.5-10.0 mm in size have synthesized both undoped and doped with first period of transition elements at $1200^{\circ}C$ by a flux-grown method under controlled atmospheric conditions; $Na_2B_4O_7$ was used as the flux. The samples were allowed to cool to room temperature at a cooling rate of $1-2^{\circ}C/h$. Each crystal was characterized by measuring the chemical composition and lattice parameter using a Cemeca SX50 electron microprobe and a Phillips PW1710 x-ray powder diffractometer. Using thin polished slices as specimens, the absorption spectrum of each crystal was measured from $5000-35000\text{ cm}^{-1}$ and band centers and order of magnitude Oscillator strength were calculated from the spectrum for each specimen. For the well characterized crystals, the absorption spectra were interpreted satisfactorily in terms of crystal field theory when the complete individual spectrum as well as the spectrum of the host matrix was considered. The valence states of the dopant ions were investigated using a Zeiss MPM 800 spectrophotometer.

Chemical analysis of the crystals showed the presence of 65-70% wt Al_2O_3 and 25-28% wt MgO .

Concentrations of the transition metal oxides are in the range of 0.8-10% wt. Two broad intense bands occurred for the spin-allowed transitions with high absorption coefficients in octahedrally coordinated Cr^{3+} ions. The spectrum of V-bearing spinel consisted of two strong absorption bands in the visible region which are assigned to ligand field transitions of V^{3+} in octahedral or distorted octahedral oxygen polyhedra. The optical spectrum of Fe^{3+} doped spinel showed spin-forbidden bands with very narrow and sharp absorption maximum. Three spin-allowed absorption peaks were observed for Co^{2+} doped spinel in the tetrahedral coordination site. Very strong spin-allowed bands with high molar extinction coefficients were observed for the Ni^{2+} -bearing spinel. It was deduced that the high energy band of the Ni^{2+} is in the octahedral coordination. Absorption spectra of the Mn-doped sample was dominated by three intense bands and these are assigned to spin-allowed d-d transitions.

The entire variety of colors in spinel is due to the relative concentration of the doped elements. Most of the doped transition metal ions are accommodated in the 6-coordinated octahedral symmetry.

Part II

Heat treatment of natural corundum base gem stones

Thermal treatment is one of the oldest processes used for color enhancement in gemstones. However, blue sapphires had never been heat treated in Sri Lanka in the olden days. Value addition to non-gem quality corundum stones (geuda) through heat treatment to convert them into gem-quality stones will result in a significant increase in foreign exchange earnings for the country. There is a substantial amount of scientific research carried out by Sri Lankan scientists on value addition to geuda. Yet, there are still some difficulties encountered in reducing the color of "kalu ottu" (opaque; deep blue coloured low-quality corundum) and increasing the color of yellow and red geuda. The present study aims to develop optimal heat-treatment procedures to convert stones of the above geuda varieties into gem-quality blue and yellow sapphires and rubies.

Chemical analysis of selected different kinds of yellow and red geuda and "kalu ottu" was carried out by an X-ray fluorescence analyzer. Thin sections of each sample were prepared and polished on both sides. Optical absorption spectra of the samples were taken from 200 to 1100 nm at room temperature using a UV-visible spectrophotometry before and after the heat treatments. Different heat treatment procedures under oxidizing and reducing conditions were carried out using a Lakmini furnace and an electrical furnace and their absorption spectra were re-recorded. Total Fe, Ti and Cr of the analyzed geuda samples were in the range of 0.1-5.0 wt% and 0.01-2.0 wt% respectively. Two broad intense bands occurred in the untreated red geuda samples for spin-allowed transitions with high absorption coefficients in octahedral coordinated Cr^{3+} ions. The spectra of the heat-treated samples did not change with respect to the peak positions of Cr^{3+} bands, but generally exhibited distinctly visible peaks. In addition to the Cr^{3+} peaks, spectra of the unheated samples show

$\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$ charge transfer absorption and internal spin-allowed d-d transition of Fe^{2+} .

Chemical analysis of natural yellow sapphires showed that they contain high amounts of Fe_2O_3 (0.1-0.2 wt%), which is the major colour producing impurity in the corundum matrix. Among the other transition metal ions Ti is the dominant element and its concentration was found to be in the range of 0.01-0.1wt%. After heat treatment, the colour and the clarity improved by about 80%. The resulting yellow colour varied in intensity from very light to golden yellow or dark brownish yellow. Some material did not show any colour variation and remained milky white, while some turned to blue or became either colourless or bi-colour can be observed. A few samples, especially those of light to dark yellow color, became brownish yellow after heating. Some samples that became colorless did not revert to yellow. However, the majority

of samples remained yellow.

Untreated yellow geuda have several major features in their absorption spectra. First, there is a sharp intense absorption band centered at 350nm, and broad bands with maxima at 450, 700 and 1030nm. The sharp intense band at 350nm was assigned to the spin-forbidden transition of Fe³⁺ in the octahedral co-ordination (⁶A_{1g} → ⁴A_{1g}, ⁴E_g). The bands at 700 and 1030nm were assigned to the single Fe³⁺ ion and the band at 450nm was assigned to Fe³⁺-Fe³⁺ ion pairs. An appreciable increase in peak intensities of the broad bands in most samples was observed after heat treatment. However, absorption spectra of samples having considerably high Ti concentrations showed reduction of the same peak intensities after heat treatment. The intensity of the yellow coloration obtained is sensitive to oxygen partial pressure inside the heating chamber of the furnace. This coloration can be enhanced or reduced under selected heat treatment conditions. The cause of the yellow color in sapphires can be attributed to spin-forbidden single iron transitions and exchange-coupled pair transitions of single or double pairs of ferric iron.

Iron and titanium are the most common impurities in "kalu ottu". Other trace elements are almost non-existent and concentrations of Cr and V are not significant in "kalu ottu". The coloring agents of "kalu ottu" should be as far as possible first and foremost Fe/Ti and fewer Fe²⁺/Fe³⁺ ion pairs, which are not chromatically interfered by Cr and V. These elements occur in different concentrations in natural gemstones and this factor leads to less attractive color qualities.

2.17

Preformed and Induced Chemical Resistance of Tea Leaf against *Exobasidium vexans* Infection.

Punyasiri, P.A. Nimal

199p.

Ph.D. Degree, 2006.

Location No. 548

Abstract

Levels of (-)-epicatechin in tea cultivars (*Camellia sinensis*) resistant to blister blight leaf disease (*Exobasidium vexans*) were significantly higher than those in susceptible cultivars, while the reverse was true for (-)-epigallocatechin gallate suggesting that epicatechin was involved in the resistance mechanism. The content of the methylxanthines, caffeine and theobromine in the leaf increased significantly in the initial translucent stage of the disease, probably as a defense response to fungal attack. Epicatechin and epigallocatechin levels were significantly less than in healthy tissues at this stage, but increases in the corresponding gallate esters suggested that they were being converted into esters. Although epicatechin and epigallocatechin levels decreased from translucent to mature blister stages, the decrease was not significant. The decrease in levels of epicatechin, epigallocatechin and their esters on infection and the formation of cyanidin and delphinidin on oxidative depolymerization of the blisters suggest that proanthocyanidins may play a role in the defense mechanism. The very high resistance of a purple-green leafed cultivar is attributed to the additional catechin source provided by the high levels of anthocyanins present. Cyanidin and delphinidin were identified as two anthocyanidins in the red tea cultivar TRI 2043.

Infection of leaves of tea which were susceptible to blister blight resulted in a shift of the proanthocyanidin stereochemistry away from 2,3-*trans* (e.g. catechin and gallic acid) and towards 2,3-*cis* (e.g. epicatechin and epigallocatechin). Infection also resulted in increased gallic acid esterification of the initiating subunits of proanthocyanidins. This was shown by both

mass spectroscopy and phloroglucinolysis. Proanthocyanidins isolated from healthy tissue had a predominantly 2,3-*trans* stereochemistry which accounted for 53% and 61% of the total initiating and extension units of proanthocyanidin, respectively. Conversely, in infected tissue, proanthocyanidin subunits with a 2,3-*trans* stereochemistry accounted for 26% to 40% of the total initiating and extension units, respectively. Infection had little impact on the hydroxylation state of the B-rings of proanthocyanidins. The products of acid hydrolysis under oxidative conditions had a slight excess of di-hydroxylated B-rings with cyanidin accounting for $58.3 \pm 0.05\%$ and $60.4 \pm 0.2\%$ of the total anthocyanidin recovered following hydrolysis of proanthocyanidins isolated from infected and healthy leaves, respectively. Similar results were obtained by phloroglucinolysis. Thus, it is possible that increased resistance of some tea cultivars to may be a result of higher levels of epicatechin or changed proanthocyanidin composition. The occurrence of flavan-3,4-diols (leucoanthocyanidins) in the site of infection was also proved by supplementation experiments with flowers of genetically defined *Matthiola incana*.

Leaves of tea contain extraordinary large amounts of (-)-epigallocatechin, (-)-epicatechin, (+)-gallocatechin, and (+)-catechin and derivatives of these compounds that show positive effects on human health. The health-promoting effects of flavan 3-ols, especially those of green tea, are of scientific and public interest. Furthermore, they play a crucial role in the defense against pathogens of tea. Therefore, biosynthesis of these flavanoid compounds was investigated. The anthocyanidin reductase enzyme recently described from *Arabidopsis* and *Medicago* was shown to be present in tea with very high activity and produces epicatechin as well as epigallocatechin from the respective anthocyanidins, thus explaining the very high contents of these compounds. A strong combined dihydroflavonol-4-reductase/leucoanthocyanidin-4-reductase activity was demonstrated and catalyzes the key steps in catechin and galocatechin formation. Therefore, in this study we have elucidated the activities of chalcone synthase (CHS), chalcone isomerase (CHI), flavanone-3- β -hydroxylase (FHT), dihydroflavonol-4-reductase (DFR), leucoanthocyanidin-4-reductase (LAR), flavanone-4-reductase (FNR), and anthocyanidins reductase (ANR) in the tea plant for the first time.

2.18

Preparation, Characterization, Electrical Properties and Applications of 2:1 Layered Silicate/ Conducting Polymer Nanocomposites.

Krishantha, D.M. Milan

187p.

Ph.D. Degree, 2006

Location No. 547

Abstract

Looking ahead from the inception of the 21st century, nanoscience can be visualized as a field of study that will contribute at the highest level to the scientific and technologies development. Hybrid Organic-inorganic nanocomposites will play a major role in the development of advanced functional nanomaterials. Such materials can be synthesized by combination of the corresponding properties of the host material and the guest polymers. This thesis is concerned with the preparation, characterization, electrical properties and application of 2:1 layered silicate (montmorillonite (MMT)) and electrically conducting polymers (polyaniline (PANI)/ polypyrrole (PPY)) nanocomposite. One series of PANI-MMT nanocomposite samples were prepared where PANI is present only within the intergallary space of MMT [EMIS-MMT series]. For that, anilinium ions exchanged MMT was thoroughly washed several times with deionized water (Including washing procedure). A procedure for the successive introduction of PANI chains within the interlayer space of MMT was developed. The d-spacing, measured after heat treatment at various temperatures serves as a measure of the

amount of polymer inserted in the clay intergalleries. FTIR spectroscopy reveals the presence of host-guest interactions of a hydrogen-bonded nature. In addition, particular attention has been given to the orientation of organic molecules when they are intercalated in the silicate structures. The DC conductivities of MMT containing successive introduced polyaniline samples i.e. once, twice and thrice polyaniline loaded MMT (EMS1-MMT, EMS2-MMT and EMS3-MMT) are $4.5 \times 10^{-5} \text{ S cm}^{-1}$, $3.0 \times 10^{-4} \text{ S cm}^{-1}$ and $1.0 \times 10^{-3} \text{ S cm}^{-1}$ respectively. They were found to increase with the amount of PANI intercalated. In addition, parallel batch of experiments were carried out with 1:1 non-expandable clay (kaolinite). Anilinium ions supported on kaolinite tended to dislodge from the surface upon repeated washing with deionized water as shown by the absence of polymer formation on such samples upon treatment with the oxidant.

Another series of nanocomposites of PANI-MMT were prepared in which PANI is present within the interlayers as well as is present adsorbed on to the external surfaces of the clay particles (excluding washing procedure) [ES-MMT (2) series]. Conductivities of the corresponding samples prepared by excluding the washing procedure had the values $4.0 \times 10^{-4} \text{ S cm}^{-1}$, $1.0 \times 10^{-2} \text{ S cm}^{-1}$ and $1.0 \times 10^{-1} \text{ S cm}^{-1}$ respectively. The ES-MMT (2) members show higher electronic conductivities than EMS-MMT members. The FTIR band appears around 1140 cm^{-1} , which is assigned to $\text{B-NH}^+ = \text{Q}$, gives supportive evidence whether the synthesized material is a good conductor or not. AC impedance analysis shows that ES-MMT (2) system possesses electronic conduction and it increases with successive loading with polyaniline. Under the identical conditions of sample preparation, the d-spacing enhancement upon the polymer intercalation is the same regardless of whether the polymer is present only within intergalleries or both internal and external surfaces of MMT [ES-MMT]. The decrement of Si-O-Si band area in the progressively intercalated samples shows the continued incorporation of PANI to the interlayer space of MMT. This trend is not such in the kaolinite/ polyaniline [ES-Kn] system. The influence of AN^+ (mol): MMT (g) ratio on the formation of ES-MMT series of nanocomposite is also studied. Ratio of the number of moles of anilinium ions to the mass of the MMT clay influences greatly on the formation of conducting form of polyaniline of these classes of materials. When the ratio of AN^+ (mol): MMT (g) is decreased, the band at 1140 cm^{-1} , which is attributed to the $\text{B-NH}^+ = \text{Q}$, disappears, confirming the reduction of the conductivity. In addition, a batch of experiments was carried out with non-aqueous medium. In order to render the clay more organophilic and intercalate more anilinium ions, instead of water dimethylformamide (DMF), highly dipolar organic solvent is used. It is found that samples prepared under such conditions neither exhibit well crystalline peak in XRD analysis nor possess high conductivity. Cyclic voltammetric studies reveal that the electroactivity of the composite material is limited by the accessibility of solution species into the intergalleries in a diffusion-controlled manner. The EIS studies reveal that the ES-MMT (2) members have both electronic and ionic conductivities with similar transport numbers even when the polymer is in its fully electronically conducting state. Four different and mutually independent techniques used to characterize the composites give strong evidence to confirm that there is a limit to the repetitive polymer loading within the intergalleries of clay particles. The limited interspacing with all repeated polymer-loading may be due to the saturation of all ion-exchangeable sites of montmorillonite by the positive charges of the polymer. For better comparison, Fuller's earth clay and polyaniline system is also studied.

In addition, polypyrrole/ montmorillonite (PPY-MMT) nanocomposite is further studied to understand variation of chemical and physical properties. Pyrrole molecules were exchanged for lithium ions in MMT. As in the case of anilinium exchanged montmorillonite, similar procedure was followed to polymerize the pyrrole. FTIR spectra of the corresponding samples prepared by including washing procedure do not show the characteristic bands of polypyrrole while that of PPY-MMT series followed by excluding the washing procedure shows giving

indication of the formation of polypyrrole in *in-situ* and *ex-situ* of MMT. The ionic conductivity of PPY-MMT (excluding washing procedure) is higher than that of lithium ion exchanged MMT. Further, this PPY-MMT nanocomposite possesses high electronic conductivity.

The clay-polymer nanocomposite can also be prepared by spontaneous polymerization of the monomer within the interlayer spaces. Cupric ion-exchanged montmorillonite [Cu(II)-MMT] is first prepared. The Cu(II)-MMT sample is then treated with 0.1 M pyrrole in 0.1 M HCl(aq) solution. This has resulted in the intercalation of pyrrole within the interlayer regions of Cu(II)-MMT host followed by one-step spontaneous polymerization to result in Cu(I)-PPY-MMT nanocomposite material. Interestingly, pyrrole ions are polymerized spontaneously within the confined environment of Cu(II)-MMT but the same does not take place in the aqueous solution containing Cu(II) ions. This Cu(I)-PPY-MMT material possesses both ionic and electronic conductivity and ionic conductivity is predominantly due to Cu⁺ ions. This has been shown by the assembly of an electrochemical cell with Cu(I)-PPY-MMT material. Cu⁺ ions migrate through material forms Cu₂SO₄ at the cathodic plate giving evidence that the motion ions are Cu⁺. The conjugation length and the electronic conductivity decrease as the temperature is increased as confirmed by the FTIR spectroscopy. However, the ionic component of the conductivity increases with temperature. These materials behave as fast ion conductors. The effect of the cation, clay composition and the solvent for the synthesis of these types of materials is also studied.

2.19

Semisynthesis and Bioactivities of Lichen Substances.

Thadani, Vinitha M.

170p.

Ph.D. Degree, 2007.

Location No. 640

Abstract

Lichens constitute a class of small perennial plants, which are a combination of two organisms a fungal partner (mycobiont) and one or more photosynthetic partners (photobiont) growing together in symbiotic association.

In an attempt to isolate compounds from natural sources, three lichens, namely *Parmotrema grayana*, *Cladonia sp.* and *Heterodermia obscurata* were chemically investigated. Isolated compounds were subjected to various bioassays.

Chemical investigation of these lichens led to the isolation of atranorin (1), + usnic acid (2), divercatic acid (3), methyl haematommate (4), methyl orsellinate (5), orcinol (6), orsellinic acid (7), lecanoric acid (8), zeorin (9), methyl-β-orcinolcarboxylate (10), lobaric acid (11), and sekikaic acid (12).

The depsides divercatic acid (3), lecanoric acid (8), sekikaic acid (12), and the depsidone lobaric acid (11) showed very significant antioxidant activity in SOI, the IC₅₀ values being lower than the standards (propyl gallate). Simple aromatic compounds namely orcinol (6) and orsellinic acid (7) showed high urease inhibition, even higher than the standard thiourea. Methyl-β-orcinolcarboxylate (10), methyl orsellinate (5), and the triterpenoid zeorin (9), showed significant inhibition against α-glucosidase, with IC₅₀ values several folds less than the respective standard.

The second part of thesis deals with the conversion of major lichen metabolites into minor ones and testing their bioactivities.

The depside, erythrin (**13**) isolated in 7.6% yield from *Rocella montagnei* was successfully converted into its isomeric diphenyl ether (**15**) via a Smiles rearrangement. Oxidative coupling of these diphenyl ether using palladium (II) acetate, lead to an efficient and unambiguous approach to substitute dibenzofurans. To the best of our knowledge, this is the first report on the formation of diphenyl ethers and dibenzofurans using naturally occurring depsides, via Smiles rearrangement.

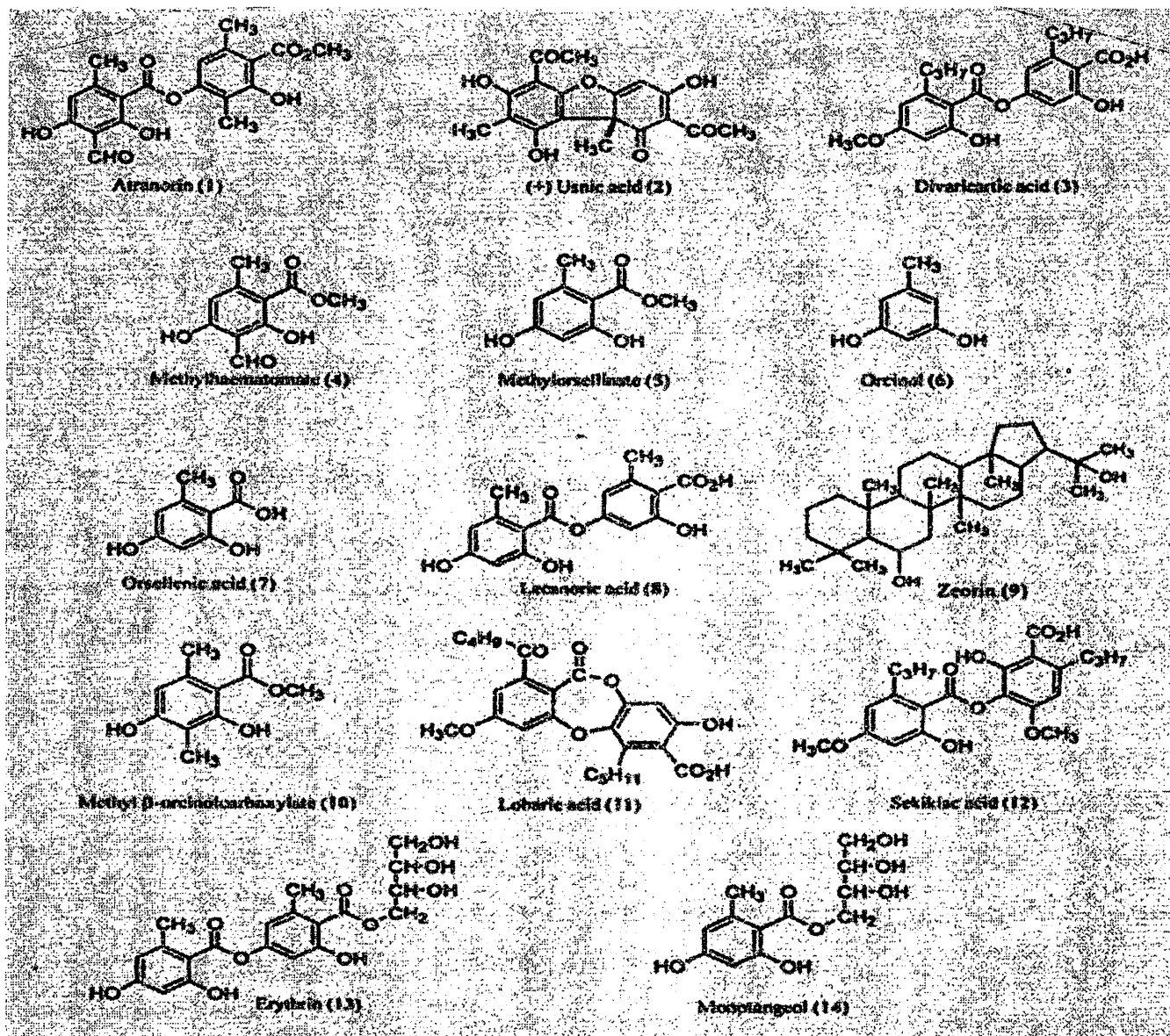
The oxidative coupling of fully protected diphenyl ether (**17**) led to dibenzofuran (**18**) and (**19**). Dibenzofuran (**19**), earlier synthesized by completely synthetic route, has been converted to pannaric acid (**24**) and schizopeltic acid (**25**) derivatives by previous workers. Thus, our synthesis of the dibenzofuran (**19**) constitutes a formal synthesis of the above natural products, in a resourceful manner.

Although fully protected diphenyl ethers such as compound **17** had been used previously in the preparation of dibenzofurans, unprotected diphenyl ethers had not been subjected to oxidative coupling in the presence of palladium acetate. Oxidative coupling of free carboxylic acid containing diphenyl ethers **15** and **16** led to the dibenzofurans **21** and **20** respectively.

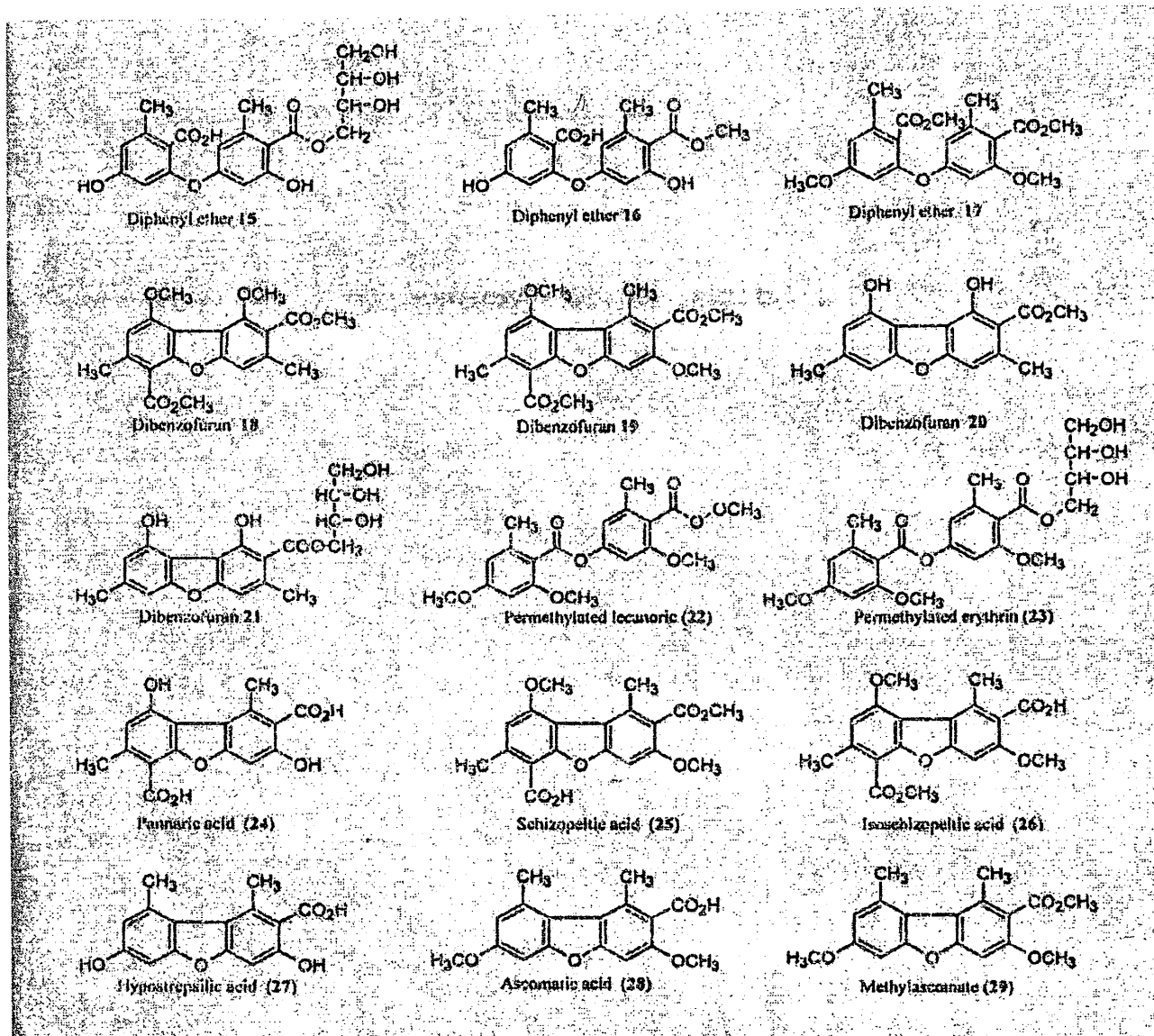
The dibenzofuran **20** and **21** are structural analogue of naturally occurring dibenzofuran hypostrepsilic acid (**27**). Thus, this study opens way to form these new analogues in a versatile manner using oxidative coupling of carboxylic acid containing diphenyl ethers such as **15** and **16**.

Even though the bioactivities of hyperstrepsilic acid (**27**) and its related class of dibenzofurans are not known, very interestingly, their structural analogues **20** and **21**, showed very promising activities. Both dibenzofurans showed very good activity in DPPH radical scavenging assay, and dibenzofuran **21** also was active in SOI radical scavenging assay. Dibenzofuran **20** showed antibacterial activity against *Pseudomonas aeruginosa*, whereas dibenzofuran **21** showed very high β -glucuronidase enzyme inhibitory activity at level higher than the standard.

The final part of thesis deals with the structure-reactivity relationship of lichen compounds (both natural and synthetic) in various bioassays. Comparison studies revealed that depsides and depsidones showed good antioxidant activity in SOI due to the extended conjugation of such compounds. Thus, lichens have natural mechanisms or components to combat oxidative stress, which is probably why they have shown very promising antioxidant activities in SOI assay. On the other hand, the synthetic dibenzofurans showed good activity in DPPH assays. Interestingly, all the simple aromatic compounds, namely orsellinic acid (**7**), orcinol (**6**), methyl- β -orcinolcarboxylate (**10**), methyl haematommate (**4**), and methyl orsellinate (**5**) showed very good inhibition against the enzyme urease.



Comparison studies also revealed that by simple conversion such as hydrolysis of the depside brings about drastic change to the respective bioactivity. For example, erythrin (13) was inactive against all fungi tested whereas methyl orsellinate (5), showed significant antifungal activity against all the tested fungi.



2.20

Structure - Activity Studies of Aryl Alkenes and Synthesis and use of Chiral Inductors in Iridoid Synthesis.

Priyadarshani, A.M.A

148p.

Ph.D. Degree, 2000.

Location No. 96

Abstract

This thesis consists of two parts. Part one of the thesis describes the synthesis of insecticidal active aryl alkenes. Previous study of *Zingiber purpureum* had shown the presence of an aryl alkene, (E)-1-(3', 4'- dimethoxyphenyl)butadiene, which was active against *Aedes aegypti* with LC₅₀ of 6.5 ppm and against the bruchid, *Callosobruchus maculatus* with LC₅₀ of 2 mg. The compound also showed oviposition deterrent and ovicidal effects against the bruchid.

The aryl alkene was however, unstable when exposed to light and air. Structurally related compounds, were therefore synthesized in order to study the structure-activity relationship to obtain stable aryl alkenes with the same or enhanced activity. Arylalkynes were synthesized using the Wittig reaction. Aromatic aldehydes substituted with hydroxy and methoxy groups at

different positions on the aromatic ring were reacted with ylides of different length (1 to 4 carbons).

Para methoxy substituted aryl alkenes were generally found to have strong insecticidal activity against *Callosobruchus maculatus* in the residual film bioassay. In the seed treatment bioassay, these compounds showed oviposition deterrent and ovicidal effects against the bruchid.

However, the result against *Aedes aegypti* did not show any consistent pattern in relationship between structure and activity.

Part two describes the synthesis of Gastrolactone, which is a key intermediate in the synthesis of sex pheromones, Nepetalactones and some Iridoidal compounds. Some Nepetalactones, Nepetalactones and other terpenoids with iridoidal skeleton are chemical messengers among aphids.

The key step in our synthesis is an intramolecular [4+2]-cycloaddition of an enamine derivative of 8-oxocitral, wherein the enamine moiety acts as the chiral inductor.

2-Methyl-, *tert*-Butyl-, Phenyl-indoline were used as chiral inductors in the cycloaddition step and three different cycloaddition products were obtained in different diastereomeric ratios. 2-Phenylindoline was the best chiral inductor for the cycloaddition step judging by the yield of the reactions and the diastereomeric ratios of the products.

Racemic 2-phenylindoline was resolved into its enantiomers separated by first converting them to urea derivatives using (R)-(+)- α -methylbenzylisocyanate. The diastereomers of the urea derivative were then separated by medium pressure column chromatography and finally they were released as separate samples of (R)- and (S)-2-phenylindoline after reaction with diborane in refluxing THF. The enantiomeric purity of the two enantiomers were checked by chiral gas chromatography.

2.21

Studies on the Utilization of Some By-Products in Building Materials, Ceramic and Catalyst Industry.

Lokuliyana, Dhananjaya Ramya Kumara

224p.

Ph. D. Degree, 1999.

Location No. 03

Abstract

Experiments were carried out to recycle plaster of paris from discarded plaster moulds. It was found that the physical properties of the product depend on the method of production, heating rate and the particle size. The results also showed that open burning of used moulds is the most suitable method for large scale production of plaster of Paris. The optimum conditions of producing were determined and the properties of the product were determined.

It was found that the strength of the rice hull ash cement could be increased by adding china clay, ball clay, fly ash and Portland cement. The cements prepared with 20% of burnt china clay, burnt ball clay, fly ash or Portland cement can be used for plastering purposes and making concrete.

A good quality low-cost cement was produced by intergrinding a mixture of rice hull ash and Portland cement (40%). The results indicated that the cement can be used for all the applications where the portland cement is required. The strength development of the cement in later stage is superior to ordinary portland cement. The other advantage is that the cement

showed sulphate resisting properties.

NO_x reduction efficiency of some low-cost catalysts prepared using waste materials such as fly ash, rice hull ash, waste ceramic products and green salt was studied in a fluidized bed reactor. It was found that the reduction capacity of these catalysts depends on the particle size, type of the raw material and FeSO₄ content. Fine particles of catalysts prepared with 12% Fe showed about 100% efficiency.

Experiments were carried out to produce a low-cost alumino silicate type refractory using rice hull ash and china clay. A good quality refractory material was produced using 60% china clay which can be used for lining of kilns in cement, ceramic and glass industries.

Low-cost building blocks were produced using saw dust, Portland cement, rice hull ash and china clay. The results indicated that the physical properties of the blocks depend on the type of raw material, degree of compaction strength of CaCl₂.

2.22

Study of Diversity and Taxonomy of Lichens in the Horton Plains National Park with a View to Biomonitor the Ecosystem Health.

Jayalal, R.G.U.

462p.

Ph. D. Degree, 2010.

Location No. 1040

Abstract

This study was carried out to provide a taxonomic description of lichen flora at Horton Plains National Park (HPNP) and correlate the distribution of lichens to ecological continuity in different forest types. In the present study, lichens from 12 transects within continuous forest and forest islands were selected using a remote sensing map of HPNP. Types of lichens and their diversity in relation to light density, temperature, tree species, density, height, diameter and the distribution pattern of trees within each transects were recorded. Further, ecological continuity was determined between continuous forest and forest islands using selected indicator macrolichen genera. Air quality monitoring in the HPNP was also carried out to determine the lichen species sensitivity to the disturbance or air pollution in HPNP.

A total of 379 lichen species belonging to 67 genera and 24 families were identified. This study documented several new lichen taxa for Sri Lanka that consists of 6 genera and 46 species. The 6 new genera were composed of 3 foliose (*Anzia*, *Menegazzia*, *Kroswia*), 2 crustoses (*Parathelium*, *Pleurotheliopsis*) and 01 fruticose (*Polichidium*) lichens. Similarly, the 46 new lichen species were composed of 5 species of crustose, 38 species of foliose and 3 species of fruticose lichens. The total number of lichen taxa recorded in this study was more than 50% of the lichen taxa already recorded from Sri Lanka.

A principal component analysis (PCA) of site data, tree data and lichen cover shows that most lichens are highly correlated with bark pH and light intensities. Most of the lichens present in the study plots preferred relatively high pH range (5.0 – 6.0). The most dominant lichen species (314 species) within this pH range were macro lichens like *Lobaria retigera*, *Pseudocyphellaria beccarii*, *Heterodermia microphylla* and micro lichens like *Graphis* sp. *Myriotrema* sp.. The number of lichen colonies increased with diameter class from 5-10 cm up to 11-20 cm and they decreased with increasing diameter size of the lichen host species. The highest number of lichen colonies was found on hosts of 11-20 cm diameter class in both forest types. Smooth bark type had the highest diversity of lichens in both forest types and this was followed by smooth to rough bark type. The least lichen diversity was observed on deeply furrowed bark

type in the continuous forest, while in the forest islands, this was observed on flaky bark type.

Cluster analysis conducted on cover and frequency of genera selected as indicators of ecological continuity showed two marked clusters depicting continuous forest and forest patches, the former supporting fewer taxa at lower frequency and cover. Indicator taxa restricted to the forest patches included species of *Nephroma* and *Teloschistes*. Large foliose species of *Pseudocyphellaria*, *Lobaria* and *Sticta* occurred in both forests, but at lower frequency and cover in continuous forest.

The data revealed that the concentrations of ambient NO_2 and SO_2 were very low in HPNP. The variations of ambient NO_2 and SO_2 concentration during the study period showed insignificant positive correlation ($p \geq 0.05$) with the rainfall pattern. Considering the variations of two pollutants with RH and number of vehicles visiting HPNP, both pollutants had insignificant positive correlation. The IAP value obtained for the whole area of the HPNP was 54.22. This value belonged to the quality level 5 which represent the 'very low' pollution level. The results including lichen data and air quality data could confirm that the ambient air quality at HPNP is very high. The high diversity of lichens and the minimal levels of air pollutants suggest that the forest health at HPNP is highly conserved. Therefore, it is a must to maintain at least the current conditions of HPNP in order to conserve the forest and its biodiversity.

2.23

Synthesis, Characterization and Molecular Modeling of $\gamma\text{-Fe}_2\text{O}_3$ Nanoparticles: Water Treatment and Drug Delivery.

Jayarathna, I.P.L.

136p.

Ph.D. Degree, 2013

Location No. 1336

Abstract

Bare and hybrid nanoparticles have great potential for various fields, such as, biotechnological and biomedical applications, energy, electronics, etc. In this research, $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles and succinic acid- $\gamma\text{-Fe}_2\text{O}_3$ core-shell nanoparticles were synthesized in a simple co-precipitation method. Bare $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles synthesized were subjected to adsorption of fluoride and iodide in drinking water system and core-shell particles were developed to the drug delivery system with streptomycin. The particles prepared were first characterized by XRD, TEM, EDS, FT-IR and TGA analysis. The calculated average size of the particles was found to be between 5-20 nm. TEM images and XRD analysis conformed that synthesized iron oxide particle has a nanometer range within crystalline and with " γ " phase. Zero point charge is around $\text{pH} = 8.13$ for $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles and is comparable with the calculated value.

In the present work, removal of fluoride and iodide from drinking water was tested using synthesized $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles. Batch adsorption studies were performed for the adsorption of fluoride and the results revealed that $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles possess high efficiency towards adsorption. A rapid adsorption occurred during the initial 15 min by removing about 95% and reached equilibrium thereafter. Fluoride adsorption was found to be dependent on the aqueous phase pH and the uptake was observed to be greater at lower pH. Fourier transform infrared (FT-IR) spectroscopy was used for the identification of functional groups responsible for the adsorption and revealed that the direct interaction between fluoride and the $\gamma\text{-Fe}_2\text{O}_3$ particles was observed. The mechanism for fluoride removal was explained using the dehydroxylation pathway of the hydroxyl groups by the incoming fluoride ion. FT-IR spectroscopic data and other results from the ionic strength dependence strongly indicated the formation of inner-spherically bonded complexes. The results for iodide

adsorption revealed that $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles possess high efficiency towards adsorption. A fast adsorption occurred during the initial 50 min by removing about 10 % and de-adsorption occurred thereafter. Iodide adsorption was found to be dependent on the background ionic strength. FT-IR spectroscopy was revealed that there is an outer-sphere interaction between iodide and the $\gamma\text{-Fe}_2\text{O}_3$ particles.

A new approach to prepare surface-functionalized $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles by synthesis of succinic acid- $\gamma\text{-Fe}_2\text{O}_3$ co-shell nanoparticles in aqueous solution is reported. Succinic acid- $\gamma\text{-Fe}_2\text{O}_3$ co-shell nanoparticles were fabricated and calculated nanoparticle size is around 14 nm. Streptomycin drug was attached to the co-shell nanoparticle surface. The FTIR study confirmed the chemical adsorption of succinic acid and streptomycin on the $\gamma\text{-Fe}_2\text{O}_3$ nanoparticle surface, and suggested a bi-dentate bi-nuclear complex and bridging complex respectively. The succinic acid- $\gamma\text{-Fe}_2\text{O}_3$ co-shell nanoparticles were demonstrated as potential targeted drug carriers by adsorbing streptomycin via carboxylate attachment. Computer modeling techniques were used to elucidate the structure of iron oxide cluster and succinic acid and streptomycin attached iron oxide. The interaction between fluoride, succinic acid, streptomycin and iron oxide cluster has been theoretically studied using density functional theory (DFT). Conformations of complexes formed have been fully optimized and vibrational analysis performed. Simple $\text{Fe}_2(\text{OH})_6(\text{H}_2\text{O})_4$ structure was used to represent the surface of the $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles and cluster was extended to $\text{Fe}_6(\text{OH})_{18}(\text{H}_2\text{O})_6$ cluster to obtain better results. Cluster configurations and IR frequency calculations of $\text{Fe}_6(\text{OH})_{18}(\text{H}_2\text{O})_6$ were performed using the DFT hybrid B3LYP function with 6-31G (*d*, *p*) basis set. The experimental infra-red spectrum of the $\gamma\text{-Fe}_2\text{O}_3$ has been compared directly to the calculated frequencies of iron oxide cluster. The most important peaks have been assigned to the corresponding normal modes.

Molecular clusters were found to be in good agreement with experimental observations. The average bond lengths of Fe-Fe and bulk Fe-O entities as 2.93 Å and 1.92 Å respectively. The calculated bond lengths are comparable with the crystallographic data. Vibrational frequency calculations and experimental data are in good agreement with the observations in the range of 900 to 1024 cm^{-1} . However, OH stretching frequencies within 1640, 3000, 3500 cm^{-1} $\gamma\text{-Fe}_2\text{O}_3$ is significantly different due to the H-bonding nature.

2.24

Synthesis of Monomers and Polymers Based on Metal [Pd(II), Pt(II), Ru(II) and Cu(II)] Functionalised 3,4 - Ethylenedioxythiophene Complexes and their Characterization.

Velauthamurthy, K.

258p.

Ph. D. Degree, 2010.

Location No. 962

Abstract

Ruthenium, palladium and platinum metals with phosphine ligands are known to have applications in various fields of catalysis, including hydrogenation, isomerization and hydroformylation reactions. The application of metal phosphine and metal-cyclam functionalized EDOT complexes in some exciting new areas currently opening up to inorganic chemists, for example, modified electrodes and conducting polymers. Functionalizations of electrodes with the redox-active and catalytically active metal complexes are of particular interest, since these have potential applications in sensing, electrocatalysis and especially in electrochromics.

More recently, a range of new EDOT derivatives functionalised with phosphine ligands, either pendant from the ethylene bridge (59 and 63) or attached directly to the thiophene 2-position

(50) were investigated. Stable Pd(II), Pt(II) and Ru(II) complexes with these ligands were prepared. Normally tetraazamacrocyclic complexes of 3d metals are electrocatalytically active. As such the synthesis and characterization of EDOT derivatives functionalised with 1,4,8,11-tetraazacyclo tetradecane (cyclam) ligand pendant to the ethylene bridge and prepared stable Cu(II) and Ni(II) complexes with these ligands were investigated.

Further, stable Pt(II), Pd(II) and Ru(II) bis-EDOT derivatives functionalized with phosphines (69) were prepared. Interestingly, these complexes succeeded in making copolymers containing intact complexes, whereas the corresponding EDOT complexes failed to give the polymer. Using the co-polymerization technique, all the complexes of co-polymers were prepared. The functionalised PEDOT copolymer films were formed using electrolyte solutions containing functionalized EDOT complexes and EDOT (1:5 mole ratio; 0.01 M total monomer concentration), using repetitive scan cyclic voltammetry, on Pt, G.C, Au and ITO coated glass electrodes.

The copolymer was characterized by using electrochemical methods such as cyclic voltammetry, electrochemical impedance spectroscopy, X-Ray photoelectron spectroscopy, X-Ray fluorescence spectroscopy and Electron dispersive spectroscopy. These characterization techniques established that the polymers made in the presence of $[MCl_2(50)_2]$ consisted only of poly-(3,4-ethylenedioxythiophene), whereas polymers made in the presence of other metal complexes were genuine co-polymers containing Ru(II), Pd(II), Pt(II) complexes.

This represents a new technique for depositing catalytically-active metal complexes of functionalized PEDOT-phosphine and PEDOT-cyclam matrices, for instance, on array supports for high-throughput synthetic devices or microfluidic systems. The successful polymerization of metal-cyclam functionalised EDOT further opens up the possibility of using the electrogenerated polymers as electrocatalysts in the reduction of alkyl halides. Also it was found that this method affords a better control of the metals concentration in the polymer matrix.

M.Phil. Theses

2.25

Adsorption of 2-Chlorophenol and 2,4-Dichloroaniline on Silica and Adsorption and Desorption of Phosphate on Kaolinite.

Karunathilake, T.H.N.M.

109p.

M.Phil. Degree, 2007.

Location No. 637

Abstract

2-Chlorophenol, 2,4-dichloroaniline and phosphate which come from herbicides, pesticides and industrial effluents contaminate water bodies and cause adverse effects on human beings. The objective of this study was to investigate the influence of adsorption of 2-chlorophenol and 2,4-dichloroaniline on silica and the influence of adsorption and desorption of phosphate on kaolinite under different experimental parameters. Effects of pH, ionic strength, initial concentration and contact time were studied for the adsorption of 2-chlorophenol and 2,4-dichloroaniline on silica. Adsorption and desorption studies of phosphate on kaolinite were studied as a function of pH, initial phosphate concentration and contact time. Adsorbed and desorbed amount of phosphate was determined using the Phosphovanadomolybdate method.

The effect of pH was determined in the pH range of 2 to 12. The highest adsorption capacities

for 2-chlorophenol and 2,4 dichloroaniline were observed around pH 6 and 7 respectively. After the treatment the pH of the medium was higher in the acidic region and vice versa in the basic region. $\text{-H}_2\text{O}$ molecules coming to the solution as a result of surface interactions of 2-chlorophenol or 2,4 dichloroaniline with silanols lower the solution pH in the acidic region. Formation of bidentate complex releases -HCl to the medium and lowers the solution pH in the basic region. Further, hydrogen bond formation between neutral 2-chlorophenol or 2,4 dichloroaniline molecules with surface silanols enhances the adsorption capacity. Ionic strength of the medium was inversely proportional to the adsorption amount. Competition between the counter ions and the formation of the electric diffuse double layer retard the adsorption process. Surface charge of the adsorbent also influenced the adsorption amount. Outer sphere complexes were predominant during the adsorption process of both the systems.

Effect of concentration on adsorption was studied at pH 6 for 2-chlorophenol and at pH 7 for 2,4 dichloroaniline. Linear behavior of the adsorption concentration and the equilibrium concentration was observed. Saturated condition was not observed due to capillary condensation effect of silica. The adsorption data fitted well into the Freundlich adsorption isotherm model in both the systems. Regression coefficient values were greater than 0.9 in all cases. This further confirms that adsorption processes are multilayeric over a heterogeneous adsorbent surface.

Adsorption kinetics was evaluated at pH 6 for 2 chlorophenol and at pH7 for 2,4 dichloroaniline. The rate of adsorption was rapid initially and then slowed down gradually until it attained an equilibrium. Equilibrium condition was reached after 5 hours for 2-chlorophenol and after 3 hours for 2,4 dichloroaniline. It was found that adsorption of 2-chlorophenol and 2,4 dichloroaniline on silica was of first order according to the integrated rate law and Lagergren rate equation.

Interactions between silica and 2-chlorophenol or 2,4 dichloroaniline were investigated by means of Fourier Transform Infrared (FTIR) spectroscopy. Appearance of new peaks and reduction of intensities of the peaks gave evidence of the adsorption mechanism. In both systems reduction of peaks intensities in the region of $3000 - 3600 \text{ cm}^{-1}$ proved the surface interactions with -OH groups. Conspicuous changes of the peaks were observed in the range of $800 - 1700 \text{ cm}^{-1}$. Changes in that region showed the presence of -C-Cl , -C=C- , -C-O , -C-N silica under different experimental conditions. Shifting and broadening of the peaks were observed at different pH conditions. However, the reduction of intensities and the peak broadening in the region of $1000-1400 \text{ cm}^{-1}$ clearly showed the interactions with the surface -Si-O and Si-O-Si- groups. These changes were similar at all experimental conditions.

Influence of pH on the adsorption of phosphate on kaolinite was studied in the pH range of 1-12. It was found that the adsorption capacity increased from pH 1 to 3 and decreased from pH 3 to 12, showing the maximum capacity, from pH 3 to 5. Percent adsorption was inversely proportional to the initial phosphate concentration. Adsorbed concentration increased linearly at low phosphate concentrations and it reached equilibrium when the equilibrium phosphate concentration was 0.08 mg dm^{-3} . Experimental results fitted well with the Langmuir isotherm model confirming the monolayeric and chemisorption process.

Desorption was maximum in the pH range of 5 to 7. It was higher when increasing the solution to clay ratio at different time intervals than at constant solution to clay ratio. Surface charge of kaolinite and the interactions between phosphate and kaolinite govern the desorption capacity. Desorption reaction was of second order at pH 5 and 7.

Intensities of bands in FTIR spectrum decreased with disappearing of peaks at 3555 cm^{-1} , 4373 cm^{-1} and 3434 cm^{-1} upon the adsorption of PO_4^{3-} . Deprotonated phosphate (H_2PO_4^-) showed a

major peak at 1074 cm^{-1} and weak peaks at 1160 cm^{-1} , 940 cm^{-1} and 870 cm^{-1} . The dominant phosphoric acid H_3PO_4 species showed doublets at 1179 cm^{-1} and 1006 cm^{-1} . Interaction between hydroxyl of the Al-OH group and the phosphate shifted peak positions in the treated sample.

2.26

Alkaloids of *Erythroxyllum zeylanicum* O.E. Shulz (*Erythroxyllaceae*).

Gunatilake, M.D.L. Priyankara

71p.

M.Phil. Degree, 2002.

Location No. 382

Abstract

This thesis describes a study of alkaloids in *E. zeylanicum* of the family Erythroxyllaceae. Only five species of the family Erythroxyllaceae are found in Sri Lanka including *E. zeylanicum* which is the only endemic *Erythroxyllum* species. The leaf of this plant is used in traditional medicine as a very effective anthelmintic agent for round worms. There are no reports of phytochemical work on Sri Lankan *Erythroxyllum* except for *E. monogynum*.

The roots (with bark) of *E. zeylanicum* contained four alkaloids including two new alkaloids, namely 1R,3R,5S,6R-6-acetoxy-3-(3',4',5'-trimethoxybenzoyloxy) tropane, *cis*-3 β -(cinnamoyloxy)tropane, 3 α -(3',4',5'-trimethoxybenzoyloxy)tropane and *trans*-3 β -(cinnamoyloxy)tropane. 1R,3R,5S,6R-6-acetoxy-3-(3',4',5'-trimethoxybenzoyloxy)tropane and *cis*-3 β -(cinnamoyloxy)tropane were new and subsequently named as Erythrozeylanine A and Erythrozeylanine B. 3 α -(3',4',5'-trimethoxybenzoyloxy)tropane and *trans*-3 β -(cinnamoyloxy)tropane were previously isolated from *E. monogynum* and *E. hypericifolium* respectively.

E. zeylanicum twigs and leaves contained two alkaloids including a new natural product namely *cis*-6 β -acetoxy-3 α -(cinnamoyloxy)tropane and *trans*-6 β -acetoxy-3 α -(cinnamoyloxy)tropane. The new alkaloid *cis*-6 β -acetoxy-3 α -(cinnamoyloxy)tropane was named as Erythrozeylanine C. The structures of the new alkaloids were established using spectroscopic and quantum chemical CD calculations. This is the first record of using CD calculations for the establishments of stereochemistry in structure elucidation of tropane alkaloids.

2.27

Antioxidant Capacity of Spices in Retarding Oxidation of Lipids during Storage of Cooked Herring.

Senarath, H.P.S.

139p.

M.Phil. Degree, 2012.

Location No. 1240

Abstract

Fish lipids are susceptible to oxidative deterioration during processing due to high content of polyunsaturated fatty acids (PUFAs). Lipid oxidation is the one of main causes for changes in organoleptic and nutritional qualities in lipid containing foods. Studies were carried out to investigate the antioxidant activity of selected spices (chillie, black pepper, turmeric, clove, cinnamon, garlic, ginger and garcinia) and spice mixtures using total phenolic content (TPC), DPPH (2,2-diphenyl-1-picrylhydrazyl) assay and FRAP (Ferric ion reducing antioxidant power) assay. Further, the oxidation of fish lipids during cooking

under different conditions was studied. Variables used were the different spices, different cooking methods (boiling in a clay pot, microwave cooking, pressure cooking), different spice extracts and different storage periods (storage at ambient temperature after 1 h of cooking and after 24 h of cooking). Herring fish (*Amblygaster sirm*) was selected as fish species for the study as herring fish curry is common dish in Sri Lankan diet. Changes in peroxide value (PV), % free fatty acid (FFA) and fatty acid composition (FAC) were analyzed in each experiment.

Results of total phenolic content revealed that methanol extract of clove had the highest total phenolic content (5.6 ± 0.1 mg gallic acid equivalents/g of spice) among the selected spices. The ethanol extract of clove exhibited the highest DPPH radical scavenging activity ($95.05\% \pm 1.2$) and FRAP (1475 ± 11 mmol FeSO₄ equivalents/g of sample) value. According to results, low level of PV (56.1 ± 4.9 meq/kg) and % FFA ($4.54\% \pm 0.04$) were shown in herring fish cooked with a spice mixture that commonly used in house-hold cooking of fish. Results revealed that addition of a spice-mixture into the cooking medium protects fish against the heat induced lipid oxidation. The most abundant fatty acids found in raw herring were palmitic (C16:0) ($22.94\% \pm 0.04$), oleic (C18:1) ($11.8\% \pm 0.9$), decosahexaenoic (C22:6 n-3, DHA) ($33.12\% \pm 0.46$) and eicosapentaenoic (C20:5 n-3, EPA) ($7.27\% \pm 0.03$) acids. The FAC data of cooked sample followed the same pattern as in raw sample. The heat treatment facilitates the breakdown of health beneficial PUFAs in control (8% reduction in PUFA when compared to raw sample). The addition of spice-mixture into the cooking medium helps in preserving PUFAs especially the health beneficial n-3 PUFAs. Among the spices selected for the study, clove showed the lowest PV (42.7 meq/kg ± 6.3) and pepper showed the lowest % FFA (11.5 ± 1.4) value. It was also shown that the most of the selected spices such as ginger, garcinia, turmeric have higher contribution towards retarding the lipid oxidation in cooked fish. Further, the addition of clove, turmeric and pepper preserved the fatty acid composition of cooked herring and also in cooked herring stored for 24 h.

It was found that all of the evaluated method of cooking; boiling in a clay pot, microwave cooking, pressure cooking has an effect on the oxidative stability of lipids in cooked herring. It was indicated that microwave cooking of herring caused a higher level of PV (214.6 ± 18.7 meq/kg) in the cooked fish when compared to that of fish subjected to boiling and also with the pressure cooked sample. The highest level of % FFA was found in control-boiled sample ($11.6\% \pm 1.1$). It was confirmed that higher degradation of PUFA was found in microwave cooked herring when compared with the pressure cooked sample and fish cooked in clay pot. All the evaluated cooking processes protect the content of PUFA in herring fish curry due to presence of spices which are rich in antioxidants. In the experiment of determining the effect of spice extract on the oxidative stability of cooked herring, it was confirmed that the methanol extract of clove was highly effective in retarding the lipid oxidation in cooked herring.

2.28

Bioactivity of *Pongamia* sp. and Effect of Saponins on the Fungal Symbiote of Shot-Hole Borer Beetle.

Jayasinghe, Gamini Sarath Bandara

110p.

M.Phil. Degree, 1998.

Location No. 89

Abstract

This thesis consists of two parts. The first part describes the isolation and characterization of a biologically active compound from the dichloromethane extract of the root bark of *Pongamia*

pinnata, while the second part discusses the relationship between tea stem saponins and the resistance of tea clones to attack by the shot-hole borer beetle, *Xyleborus fornicatus*.

The dichloromethane extract of *P. pinnata* root bark which, in preliminary screening studies showed activity against the second instar larvae of *Aedes aegypti* with an ED₅₀ of 18.6 ppm, was subjected to bioactivity guided fractionation. The active compound was identified as 3,7-dimethoxy-3',4'-methylenedioxyflavone (demethoxykanugin). Eight other compounds were isolated and their structures determined using spectroscopic methods. These included the two chalcones, 2'-hydroxy-3',4,4',6'-tetramethoxychalcone and 2'-hydroxy-4',6'-dimethoxy-3,4-methylenedioxy-3',γ,γ-dimethylallylchalcone, five flavones, 3'-methoxyfurano[2'',3'':7,8]flavone, 3',4'-methylenedioxyfurano[2'',3'':7,8]flavone, 3,3'-dimethoxyfurano[2'',3'':7,8]flavone, 3-methoxy-6'',6''-dimethylpyrano[3'',3'':7,8]flavones and 3-methoxy-3',4'-methylene-dioxy-6'',6''-dimethylpyrano[2'',3'':7,8]flavone and the isoflavone, 4'-methoxy-7-prenyloxyisoflavone. Of these, 3'-methoxyfurano[2'',3'':7,8]flavone, 3,3'-dimethoxyfurano[2'',3'':7,8]flavone and 2'-hydroxy-4',6'-dimethoxy-3,4-methylenedioxy-3',γ,γ-dimethylallylchalcone are being reported for the first time. 4'-Methoxy-7-prenyloxyisoflavone is also the first isoflavone reported from *Pongamia pinnata*. In the second part of this thesis, the saponin content of a resistant and susceptible clone of tea was estimated using Froth test and it was confirmed that the stem of the tolerant clone, TRI 2023 had a higher saponin content than that of the susceptible clone, TRI 2025.

The shot hole borer beetle has a symbiotic relationship with the ambrosia fungus, *Monacrosporium ambrosium*. An attempt was made to establish whether saponin played a role in resistance by inhibiting the growth of this fungus. When a crude tea saponin mixture was introduced into the cultures of the ambrosia fungus, they decreased mycelial weight, although they did not appear to affect fungal sporulation. Saponins could therefore play a role in helping the tea plant resist attack by the shot hole borer beetle.

Although a crude tea saponin mixture could be isolated from tea stem, attempts at obtaining pure saponins using normal and reverse phase chromatography, High Speed Counter Current Chromatography (HSCCC) and High Performance Liquid Chromatography (HPLC) proved unsuccessful.

2.29

Bioactivity Studies of Some Sri Lankan Flora and Bioactive Xanthenes from *Calophyllum thwaitesii*.

Napagoda, M.T.

97p.

M.Phil. Degree, 2005.

Location No. 534

Abstract

Antimicrobial properties of several *Calophyllum* species, *Garcinia xanthochymus*, *Hypericum mysorensense* and few other plant species were evaluated in the present study and active compounds were isolated using activity guided fractionation. Structure elucidation of isolates were carried out using spectroscopic methods and partial synthesis.

The crude extracts of above plants were subjected to preliminary screening for antibacterial activity against human pathogenic bacteria, *Enterococci Faecalis*, *Escherichia coli*, *Klebsiella*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. In addition, the active extracts were tested against 17 methicillin resistant *Staphylococcus aureus* (MRSA) strains isolated from hospitals in Sri Lanka. The antifungal activity of crude plant extracts were investigated against

plant pathogenic fungi, *Aspergillus* and *Cladosporium* and different strains of human pathogenic fungi *Candida*. Disk diffusion method was used to determine the antimicrobial activities of plant extracts against bacterial and the fungi *Aspergillus* and *Candida*, while TLC bioautography method was used to detect the antifungal activity against *Cladosporium*.

The results of the preliminary screening suggested that the methanol extracts of root stem of *Calophyllum thwaitesii* possessed both antibacterial and antifungal activities. Activity guided fractionation of the above methanol extract resulted in several active fractions. Isolation and chemical characterization of these fractions contained seven xanthenes. Apart from the previously isolated 1,7-dihydroxyxanthone from the root bark of the same plant species, other compounds, 1-hydroxy-5,6-dimethoxyxanthone, 1,6-dihydroxy-5-methoxyxanthone, 1-methoxy-5-hydroxyxanthone, 1-hydroxy-5-methoxyxanthone, 1-hydroxy-7-methoxy xanthone and 1,5-dihydroxy-6-methoxyxanthone have not been reported before. The isolation of methylated xanthenes in the present study suggests the presence of methylating enzymes in the root stem of *Calophyllum thwaitesii*, contrary to previous reports.

The above xanthenes along with thwaitesixanthone isolated from the inner bark of *Calophyllum thwaitesii* were screened for antibacterial and antifungal activities following the same procedures used previously. In addition, antioxidant activities of these compounds were determined both qualitatively and quantitatively by DPPH radical scavenging method. None of the xanthenes showed prominent antibacterial nor antioxidant activities, although the crude plant extract exhibited those activities. This could possibly be due to the presence of other active minor constituents in the plant extract or some synergistic effect of combination of compounds present in the plant extract. However, four xanthenes including 1-hydroxy-5,6-dimethoxyxanthone, 1,6-dihydroxy-5-methoxyxanthone, 1-methoxy-5-hydroxyxanthone and 1-hydroxy-5-methoxyxanthone were found to possess antifungal activity against *Aspergillus* and *Cladosporium*. Minimum Inhibitory Concentrations of the active compounds were found to be in the range of 50-200 µg/spot. None of the xanthenes were active against any of the *Candida* strains.

2.30

Biochemical Studies in Shot-Hole Borer Infestation of Tea.

Bandaranayake, Niwandana Kumara

85p.

M.Phil. Degree, 1997.

Location No. 83

Abstract

The thesis deals with the study of biochemical interactions involved in the Shot-hole Borer beetle (*Xyleborus fornicatus*) attack on tea (*Camellia sinensis* var. *assamica*) plants.

An introductory account of shot-hole borer (SHB) infestation of tea plants, and the factors which affect both the life cycle of SHB and the symbiotic fungus *Monacrosporium ambrosium* associated with the beetle, are also included.

The gram-negative bacterium associated with SHB was isolated and identified to be *Enterobacter cloacae*. The effect of this bacterium on growth of the symbiotic fungus *M. ambrosium* and other fungi found in beetle galleries (*Fusarium* spp., *Aspergillus niger*) revealed that *E. cloacae* does not have any effect on growth of these fungi. The lignin content of pencil thick tea stems from the tea clone least susceptible (TRI 2023) and the tea clone most susceptible (TRI 2025) to attack by SHE were determined and found to be similar.

The neutral sugar composition of the two tea clones (TRI 2023 and TRI 2025) and some

alternative hosts (*Gliricidia sepium*, *Ricinus communis*, *Theobroma cacao* and *Cassia fistula*) of SHB were studied. The two clones were found to contain the same neutral sugars (sucrose, mannose, galactose, glucose and inositol). The glucose: inositol ratio (glc/ino) in the two tea clones was found to be approximately 5: 1 in TRI 2023 and 3: 1 in TRI 2025. Glucose and inositol were detected in all the stem samples which were analysed. The ratio of these two sugars was found to be 24: 1 in *G. sepium*, 4: 1 in *T. cacao* and 3: 1 in *C. fistula*.

An acidic polysaccharide fraction and a neutral polysaccharide fraction were isolated from pencil thick stems of the least susceptible tea clone (TRI 2023). Arabinose xylose, galactose and a small amount of galacturonic acid were the sugar components of the acidic polysaccharide. The acidic polysaccharide (molecular weight 40,000 - 70,000 Da) was found to be composed of a backbone of (1 →4)-β-linked xylopyranosyl residues. Rhamnose, fucose, arabinose, xylose, mannose, galactose and glucose were detected in the neutral polysaccharide

High performance liquid chromatography showed that ergosterol, known to be the precursor of the moulting hormone ecdysone in SHB, was the only sterol found in fungal mycelia. *M. ambrosium* was grown in liquid media containing water extracts of tea stems from the two clones respectively. The fungus was also grown in media containing combinations of glucose and inositol (5: 1 and 3: 1). A significant difference in ergosterol content was not observed in the different types of media.

Cellulose agar disks containing different concentrations of caffeine and CH₂Cl₂ extracts of healthy tea stems of TRI 2025 were used for choice tests with SHB to determine whether caffeine acted as an attractant or a deterrent. The beetle was neither attracted nor repelled by caffeine and CH₂Cl₂ extracts of tea stems.

2.31

Chemical and Biochemical Modifications of Electrode Surfaces for Sensor Applications.

Susantha, R. Nalaka

94p.

M.Phil. Degree, 2005.

Location No. 508

Abstract

Development of electrochemical methods and electrochemical biosensors for the detection of pesticides and hydrogen peroxide are described. Carrot callus tissues and rice plant tissues are utilized as molecular recognition elements to construct tissue modified biosensors with selectivity for the analytes interested. Bare and chemically modified glassy carbon electrodes are utilized in voltametric and amperometric analysis for the detection of some important pesticides.

Cyclic voltametric technique consisting of three electrodes system was used to determine Paraquat, the active ingredient of the herbicide Gramoxone. Sensor calibration was accomplished by employing an amperometric method based on glassy carbon electrode. Noise of the amperometric signals has been lowered by surface modification of the glassy carbon electrode with non electroactive stearic acid. Levels of interference caused by structurally resembling compound, Diquat is also reported.

The development of an amperometric biosensor of hydrogen peroxide and the sensor application in determining hydrogen peroxide in milk is described. In vitro-cultured carrot callus which contains a high peroxidase activity was used as a molecular recognition element. The callus tissue was incorporated into the carbon paste matrix along with ferrocene as an

electron mediator. This system is based on the enzymatic reduction of hydrogen peroxide by peroxidase and subsequent electron transfer from a carbon paste electrode to the enzyme via a ferrocene mediator. The sensor exhibits a remarkably long lifetime of about more than 45 days if it is stored in a pH 6.5 buffer solution at 4 to 10°C when it is not in use. Other important characteristics of the sensor include fast response time and very low detection limit.

The employment of rice plant tissues as a molecular recognition element for designing of biosensor for the detection of 3,4-DPA, the active ingredient of the herbicide Propanil, is examined. The resistance of rice plant to Propanil is attributed to its ability to metabolize Propanil into 3,4 Dichloro aniline by aryl carboxyl amidase. Rice plants containing aryl carboxyl amidase was utilized as molecular recognition element for the construction of biosensor.

2.32

Chemical Investigation and Biological Activity of *Gliricidia sepium*.

de Silva, K.W.D. Susila

107p.

M.Phil. Degree, 2001.

Location No. 175

Abstract

Gliricidia sepium is native to tropical America and it was introduced to Sri Lanka as a shade plant to the tea plantation. Later it was found that *G. sepium* acts as a good diversionary host plant for tea termite *Glyptotermes dilatatus* that causes great damage to the low country tea plantations.

Chemical investigation of CH₂Cl₂ extract of heartwood of *G. sepium* gave 7,4'-dihydroxy-3'-methoxyisoflavan as a new natural product. Six other compounds formononetin, afromosin, medicarpin, 4-hydroxy-3-methoxycinnamaldehyde, isovestitol and β-sitosterol which are new to the species were also isolated from the same extract. In addition to those compounds, 7,2'-dihydroxy-3', 4'-dimethoxyisoflavan was also isolated which has previously been reported from the heartwood of this plant. Further chemical investigation of hexane extract of *G. sepium* gave a higher yield of β-sitosterol. It was found in all parts of this plant.

Chromatographic separation of the hexane extract of stem bark yielded betulinic acid for the first time from *G. sepium*. The CH₂Cl₂ extract of the stem bark gave two new natural products, 3, 4-dihydroxy-*trans*-cinnamic acid octacosyl ester and more polar stigmastanol glucoside and stigmasterol glucoside.

Shade dried flowers of *G. sepium* were extracted with CH₂Cl₂ and chemical investigation of CH₂Cl₂ extract afforded three compounds, sitosterol glucoside, kaempferol and an oleanane triterpene, soyasapogynol B. These compounds are also new to the plant.

All these compounds were isolated with the aid of various column (gravity, MPLC, flash) and preparative thin layer chromatographic techniques. Structure elucidation of the isolated compounds was carried out using spectroscopic methods, IR, UV, Mass, ¹H NMR, ¹³C NMR, DEPT, COSY, HMQC, HMBC, etc.

The toxicity experiments were carried out for tea termites, *Glyptotermes dilatatus*. Hexane and CH₂Cl₂ extracts of heartwood have shown high activity. The activity-guided fractionation indicated that the first fractions of those extracts showed the highest toxicity to the termites. From that fraction of hexane extract, four toxic compounds (very less polar) were isolated and structures of them have not been investigated. Other fractions of hexane and CH₂Cl₂ extracts showed moderate activity. MeOH extract and its fractions have not shown any activity. Toxicity

of some isolated compounds, β -sitosterol, formononetin, 3',4'-dihydroxy-trans-cinnamic acid octacosyl ester and kaempferol was observed. Only kaempferol has shown remarkable toxicity at low concentration and the others have shown moderate toxicity.

Olfactometer experiments were carried out for identifying the attractive components present in *G. sepium*.

2.33

Chemical Investigation of *Goniothalamus gardneri* (Annonaceae).

Weerasinghe, A.G.A. Jayantha

76p.

M.Phil. Degree, 2004.

Location No. 457

Abstract

This thesis describes the chemistry of *Goniothalamus gardneri* with special reference to the Annonaceous acetogenins. It describes the isolation and characterization of three acetogenins and their biological activities against the second instar mosquito larvae of *Aedes aegyptii* and the fungus *Cladosporium cladosporioides*. Among the three acetogenins two were found to be new **80** AND **83**. Among the three acetogenins compound **80** showed potent biological activity against the second instar larvae of *A. aegyptii*. Interestingly none of them showed activity against the fungus *C. cladosporioides*. Comparing the activity of the isolated acetogenins, we can conclude that activity varies with the number of hydroxyl functions of the molecule.

The flowers of *G. gardneri* also yielded a styryl lactone, goniotalamin **88**, the sterol poriferasterol **89**, the stigmasta-4, 22-dien-3-one **91** and a new unsaturated fatty acid **92**.

2.34

Chemistry and Activity of *Acronychia pedunculata* Fruits.

Ahilan, Yasodha

77p.

M.Phil. Degree, 2006.

Location No. 533

Abstract

Chemical investigation on the hexane and dichloromethane extracts of the fruits of *Acronychia pedunculata* (L. Miq.) has resulted in the isolation of six compounds including two novel compounds, 7-acetyl-4,6-dihydroxy-5-(methyl-2-butenyl)-2-(1-methyl-ethyl)benzofuran and a new benzopyran derivative. They were isolated along with three known acetophenone derivatives, acrovestone, demethylacrovestone and dimethylacronylin and the sesquiterpene, clovan-2,9-diol. While demethylacrovestone has been previously isolated from *Achronychia pedunculata* fruits, acrovestone is isolated from *Achronychia pedunculata* fruits for the first time although it has been isolated from its bark and demethylacronylin has been reported to be present in *Achronychia laurifolia*. Clovan-2,9-diol is being reported from *Acronychia* species for the first time. Biological activities of these compounds were evaluated against the second instar larvae of *Aedes aegyptii*. Acrovestone and the new benzofuran derivative showed moderate activity with LC_{50} of 3.6 ppm and 2.5 ppm while the new benzopyran and demethylacrovestone showed weak activity with LC_{50} of 10 ppm and 12.5 ppm respectively.

2.35

Chemistry and Antiviral/Anti-HIV Activity Studies of Family Clusiaceae.

Marasinghe, G.P.K.

154p.

M.Phil. Degree, 2000.

Location No. 98

Abstract

This thesis describes the chemistry and antiviral/HIV activity studies of *Calophyllum cordato-oblongum* and *Calophyllum moonii*. The twigs of *C. cordato-oblongum* have been shown to contain the 12-*O*-methylcordatolide A, 12-*O*-methylcordatolide B, 12-*O*-methylcordatolide C, three reported pyranocoumarins; (cordatolides A and B, oblongulide), friedelin, canophyllol and sitosterol. Methylation of cordatolide B and attempted methylation of cordatolide A under acidic conditions gave the 12-*O*-methylcordatolide B and 11,12-anhydrocordatolide. These findings together with the results of the methylation of soulattrolide and inophyllum A have led to the proposed mechanism for the methylation of the 12 hydroxy group of *Calophyllum* pyranocoumarins. The methyl ethers of cordatolide A, B and C as well as 11,12-anhydrocordatolide are new compounds.

The root bark of the *C. cordato-oblongum* afforded friedelin, sitosterol and an acid mixture. The acid mixture was esterified under acidic condition and methyl esters of cordato-oblongic acid and *isocordato-oblongic* acid were isolated. This is the first report of the occurrence of *isocordato-oblongic* acid in nature.

The buds of the *C. moonii* gave friedelin, sitosterol, inophyllum A and soulattrolide. They were previously reported from the leave of the same species. The presence of pyranocoumarins (inophyllum A and soulattrolide) in the buds of *Calophyllum moonii* indicates the protective role of pyranocoumarins in tender plant tissues.

All the above compounds were isolated by various separation techniques such as PTLC, MPLC, gravity column chromatography, flash chromatography and crystallization. Their structures were elucidated by spectral (IR, UV, NMR, HPLC) analysis, physical (mp, $[\alpha]_D$) methods and chemical conversions.

Methanolic extracts of the various plant parts of *C. cordato-oblongum* were subjected to the Aspartic Proteinase Bioassay and the stem bark extract showed the promising activity. Therefore, the stem bark extract was further purified by Anion Exchange Chromatography and some of the fractions showed inhibition but the percentage inhibition of the major peak fractions was low.

As cordatolide A and cordatolide B have shown significant activity on HIV-1 RT assay, oblongulide and 12-*O*-methylcordatolide B were subjected to the RT assay and they have shown insignificant activity. However, the inactivity of oblongulide and 12-*O*-methylcordatolide B indicated the important role of the three chiral centers and in particular the 12-OH of the pyranocoumarin in the activity.

2.36

Chemistry and Bioactivity of some Sri Lankan Buxaceae and Rubiaceae.

Kumarihamy, B.M. Mallika

139p.

M.Phil. Degree, 2002.

Location No. 220

Abstract

This thesis includes chemistry and bioactivity studies of *Sarcococca zeylanica* of the family Buxaceae and *Hedyotis lawsoniae* and *Lasianthus gardneri* of the family Rubiaceae.

Methanol extract of the aerial parts of *Sarcococca zeylanica* was processed for non-quaternary alkaloids. Chromatographic separation of these alkaloids furnished (20S,2'Z)-20-(N,N-dimethylamino)-3 β -(2-methyl-2Z-butanamido)-pregn-5-en-4-one (19), 3 β -methoxy-20 α -dimethylamino-pregn-5-ene (15), iso-N-formyl-5-en-chonemorphine (68), 3 β -methylamino-pregn-20-one (69), 3 α -monomethylamino-20 α -dimethylamino-pregn-5-ene (70). Compounds 19 and 15 have been previously reported from *Sarcococca saligna* and *Sarcococca brevifolia* respectively. Compounds 68, 69, and 70 are new natural products. Compound 19, 15 and 69 showed strong antifungal activity against *Cladosporium cucumerinum* and *Cladosporium cladosporioides*, while 68 and 70 showed moderate activity for the same fungi. Compounds 19, 15, 69 and 70 showed antibacterial activity against *Bacillus subtilis* and compounds 19, 15 and 69 showed anthelmintic activity against *Caenorhabditis elegans*.

Chromatographic separation of hexane and methanol extract of the stem of *S. zeylanica* yielded three triterpenes, lupenone (77), lupeol (78), ursolic acid (72), and β -sitosterol (71) and some polar compounds, which are highly unstable at room temperature. Chromatographic separation of the hexane, dichloromethane and methanol extract of flowers of *Hedyotis lawsoniae* furnished six compounds namely, friedelin (73), taraxerol (74), β -sitosterol (71), ursolic acid (72), hederagenin (75) and β -sitosterol-D-glucoside (76).

Methanol extract of stem of *Lasianthus gardneri* showed the presence of alkaloids in minute amounts. Chromatographic separation of the *n*-butanol soluble fraction of the methanol extract yielded lupenone (77), lupeol (78), β -sitosterol (71), ursolic acid (72) and stigmasterol- β -D-glucoside (79). This is the first chemical investigation carried out on *L. gardneri*. Antifungal, antibacterial, molluscicidal, anthelmintic, antifeedant, plant growth regulatory and nematocidal activities of some Sri Lankan Buxaceae and Rubiaceae are reported.

2.37**Chemistry and Bioactivity of Some Sri Lankan Menispermaceae and Rubiaceae.**

Jayasooriya, J.A.C.P

97p.

M.Phil. Degree, 2003.

Location No. 308

Abstract

This thesis includes two parts. Part I describes the chemistry and bioactivity studies of the leaves of *Diploclisia glaucescens* of the family Menispermaceae and part II describes antimicrobial activity studies of thirteen Sri Lankan plant species of family Rubiaceae.

Part I

Diploclisia glaucescens is a creeper climbing up about twenty-five meters high and is totally glabrous. It is distributed in the mid country regions of South India and Sri Lanka. It has been reported that the leaves of this plant are used to treat biliousness and venereal diseases.

Chromatographic separation of the ethyl acetate extract yielded three ecdysteroids low polar than 20-hydroxyecdysone, which is generally considered as the moulting hormones in insects. They were identified as makisterone A, dihydrorubrosterone and *epi*-pterosterone. This is the first report of dihydrorubrosterone and *epi*-pterosterone from the family Menispermaceae. Makisterone A has been previously reported from the seeds of *D. glaucescens*.

Chemical investigation of the *n*-hexane extract of the leaves of *Diploclisia glaucescens* furnished stigmasterol. Chromatographic separation of the methanol extract afforded two ecdysteroids, 20-hydroxyecdysone and a new ecdysteroid, 3-deoxy-1 β -20-dihydroxyecdysone and three saponins, β -sitosteol-D-glucoside, 3-O- β -D-glucopyranosyl-(1 \rightarrow 3) β -D-glucopyranosyl-28-O- β -D-glucopyranosyloleanolic acid and 3-O- β -D-xylopyranosyl-(1 \rightarrow 2) β -D-glucopyranosyl-28-O- β -D-glucopyranosyloleanolic acid. Latter two triterpenoidal saponins are reported for the first time from the family Menispermaceae.

Structure elucidation of the isolates was mainly based on spectroscopic techniques such as NMR, HMBC, HMQC, H-H COSY, NOE, etc. and chemical methods such as acid hydrolysis, acetylation, etc.

All isolates were tested for their antifungal activity against *Cladosporium cladosporioides* using TLC bioautography method. None of them showed any activity.

Part II

Ninety solvent extracts (*n*-hexane, dichloromethane and methanol) obtained from the leaves and bark of thirteen Sri Lankan Rubiaceae plants; *Benkara malabarica*, *Canthium coromandelicum*, *Canthium dicoccum*, *Haldina cordifolia*, *Ixora calycina*, *Morinda tinctoriya*, *Mussaenda frondosa*, *Psychotria gardneri*, *Psychotria nigra*, *Psychotria stenophylla*, *Saprosma foetens*, *Tarenna asiatica* and *Wendlandia bicuspidata* were tested for antibacterial activity against *Escherichia coli* (Gram-), *Micrococcus luteus* (Gram+), *Bacillus subtilis* (Gram+), and antifungal activity against *Saccharomyces cerevisiae*, *Ustilago maydis* and *Aspergillus niger* by Disk diffusion method.

Morinda tinctoriya, *Mussaenda frondosa*, *Psychotria gardneri* and *Psychotria stenophylla* displayed the widest spectrum of antibacterial activity.

2.38

Chemistry and Bioactivity of the Fruits of *Artocarpus altilis* and *Flacourtia indica*.

Amarasinghe, Nilupa R.

133p.

M.Phil. Degree, 2007.

Location No. 684

Abstract

This study consists of two parts. Part I describes the chemistry and bioactivity of the fruits of *Artocarpus altilis* (Par.) Fosb. and Part II describes the chemistry and bioactivity of the fruits of *Flacourtia indica* (Burm. F.).

Part I

Artocarpus altilis (Sinhala: rata-del) is a moderate size tree and widely cultivated in tropics. It is commonly found in home gardens and economically important as a staple crop. The fruits of *A. altilis* are known as breadfruit and it is cooked as a starchy staple.

The dried powdered whole fruits of *A. altilis* were defatted with *n*-hexane and extracted with ethyl acetate and methanol at room temperature. Preliminary investigations indicated the presence of antifungal compounds in both extracts on TLC bio-autography method against *Cladosporium cladosporioides*. Chromatographic separation of the ethyl acetate and methanol extracts afforded twelve compounds and identified as (E)-2,4,3'5'-tetrahydroxystilbene (60), (E)-4-(3-methyl-E-but-1-enyl)-3,5,2'4'-tetrahydroxystilbene (81), (E)-4-isopentenyl-3,5,2'4'-tetrahydroxystilbene (10), 2-(3,5-dihydroxyphenyl)-benzofuran-6-ol (82), 2-(2,4-

dihydroxyphenyl)-5,7-tetrahydrochroman-4-one (5), 5,7,2',4'-tetrahydroxyflavone (83), 6-(3-methyl-E-but-1-enyl)-5,7,2',4'-tetrahydroxyflavone (7), 6-isopentenyl-5,7,2',4'-tetrahydroxyflavone (84), cycloartenyl acetate (73), 3 β -acetoxyolean-12-en-11-one (85), β -sitosterol (80), 3-O- β -D-glucopyranosylsitosterol (86) by the detailed analysis of NMR and mass spectral data. Antifungal activities of compounds 5,7,10,81,82 and 84 were tested against seven plant pathogens (*Alternaria* sp., *Aspergillus* sp., *Colletotrichum* sp., *Cladosporium cladosporioides*, *Fusarium* sp., *Geotrichum* sp. and *Rhizctonia* sp.) using disc diffusion method and TLC bio-autography method for *C. cladosporioides*. Only compounds 7,10,81 and 82 showed an antifungal activity. Compounds 10, 81 and 82 were active against all the fungi and among them 82 showed the highest activity on all the fungi. Compound 7 did not show any activity against *Aspergillus* sp., *Colletotrichum* sp. and *Geotrichum* sp. under the tested concentrations.

Qualitative and quantitative analysis of the antioxidant activity of these isolates were carried out using DPPH (2,2'-diphenyl-1-picrylhydrazyl) radical scavenging assay. 2-(3,5-dihydroxyphenyl)-benzofuran-6-ol (82) showed the highest antioxidant activity having a IC₅₀ value 2 ppm in comparison with ascorbic acid (3,4 ppm) and butylated hydroxyl anisole (3.0 ppm).

Cytotoxicity of these isolates was carried out using brine shrimp (*Artemia salina*) micro-well cytotoxic assay. Compound 82 showed a highest cytotoxic activity having a LC₅₀ of 20 ppm.

Lettuce seed (*Lactuca sativa*) germination assay was carried out to study the phototoxic activity. Only compounds 10 and 82 showed a phototoxic activity. Compound 82 completely inhibited the germination of the seeds at 1000 ppm level while the shoot growth was completely inhibited at 250 ppm.

Part II

Flacourtia indica (Sinhala: uguressa) is a tree of moderate size and widely cultivated in tropics and subtropics. In Sri Lanka it is cultivated in mid and low country for its edible fruit as well as an ornamental plant.

The red coloured juice of the fruit of *F. indica* was filtered through a Büchner funnel. The *n*-BuOH extract of the fruit juice was chromatographed over columns of silica gel, RP-18 silicagel, sephadex LH-20 and PTLC. The final purification using reverse phase HPLC furnished four compounds including a new natural product, 4-oxo-2-cyclopentenylmethyl 6-O-(E)-*p*-coumaroyl- β -D-glucopyranoside (48) named flacourside, together with three known compounds, methyl 6-O-(E)-*p*-coumaroylglucopyranoside (52), α and β anomers of 6-O-(E)-*p*-coumaroylglucopyranose (53/54).

Qualitative and quantitative analysis of the antioxidant activity of 48, 52, 53 and 54 were carried using DPPH radical scavenging assay. None of them showed a significant activity.

2.39

Chemistry and Bioactivity of the Fruits of *Averrhoa carambola*.

Gunawardena, D.C.

100p.

M.Phil. Degree, 2010.

Location No. 995

Abstract

This study describes the detailed study of chemistry and bioactivity of the fruits of *Averrhoa carambola* L. and some bioactivity studies of the crude extracts of the fruits of *Limonia acidissima* L., *Eleocarpus serratus* L. and *Aegle marmelos* L. Preliminary bioassay screening of

these extracts indicated that the significant phytotoxic activity and antioxidant activity of crude extracts of *A. carambola* fruit juice than other extracts.

Preliminary studies on both ethyl acetate and *n*-butanol extracts of the fruit juice of *A. carambola* indicated the presence of antioxidant and phytotoxic compounds. Chromatographic separation of the combined ethyl acetate and *n*-butanol extracts over combination of chromatography over silica gel, sephadex LH-20, reverse phase silica and HPLC furnished *cis*-abscisic acid (1), *trans*-abscisic acid (2), *trans*-abscisic alcohol (3), vomifoliol (4), *cis*-abscisic acid β -D-glucopyranosyl ester (5), *trans*-abscisic alcohol β -D-glucopyranoside (6), roseoside (7), *cis*-abscisic alcohol β -D-glucopyranoside (8) and epicatechin (9) identified by detail analysis of NMR and mass spectral data. Qualitative analysis of the antioxidant activity of compounds 1-9 was determined against DPPH (2,2'-diphenyl-1-picrylhydrazyl) radical by TLC bioautography method. Only the compound 9 showed off white spot on TLC when concentration reduced to 1 μ g/ spot. Hence, the antioxidant property of 9 was qualitatively determined by the spectrophotometric method and 9 showed the strong antioxidant activity with the IC₅₀ 2.80 ppm compared to the butylated hydroxyl anisole (BHA) (4.10 ppm) and ascorbic acid (3.50 ppm).

Phytotoxicity of 1-9 was evaluated against lettuce seeds (*Lactuca sativa*) germination assay. Compound 4,5,8, and abscisic acids showed strong phytotoxicity with the IC₅₀ 10, 5, 10 AND 5 ppm respectively while 3 and 6 showed moderate phytotoxicity, IC₅₀ 80 ppm for both compounds. Compounds 7 and 9 did not show any phytotoxicity.

Crude ethyl acetate and *n*-butanol extracts of *L. acidissima*, *E. serratus* and *A. marmelos* were subjected to antioxidant activity (against DPPH), phytotoxicity (against *L. sativa*), cytotoxicity (against *Artemia salina*) and antifungal activity (against *Cladosporium cladosporioides*).

Ethyl acetate and *n*-butanol extracts of *A. carambola* showed strong antioxidant activities in comparison to the crude extracts of *A. marmelos*, *L. acidissima* and *E. serratus*. Ethyl acetate extracts of both *A. carambola* and *E. serratus* were showed strong phytotoxicity. Among the crude extracts of *A. carambola*, *A. marmelos*, *L. acidissima* and *E. serratus* only the ethyl acetate and *n*-butanol extracts of *A. marmelos* showed the antifungal activity against *C. cladosporioides*. The crude extracts of *A. marmelos*, *L. acidissima* and *E. serratus* showed the strong cytotoxicity against the *Artemia salina* at 500 and 1000 ppm levels while crude extracts of *A. carambola* did not show any cytotoxicity against the *Artemia salina*.

2.40

Chemistry and Bioactivity Studies of *Garcinia mangostana* L.

Piyasena, K.G.N.P.

108p.

M.Phil. Degree, 2005.

Location No. 510

Abstract

Garcinia mangostana L. is a tree found in Southeast Asia including Sri Lanka, and very popular due its delicious fruit. Medicinal uses such as for the treatment of diarrhea, dysentery, skin infections and as an anti-inflammatory agent are reported. Prenylated xanthenes benzophenones, terpenoids and sugars have been isolated from this species. α -mangostin, one of the xanthenes reported from *G. mangostana* has shown antibacterial activity against methicilin resistant *Staphylococcus aureus* (MRSA). Outbreaks of MRSA and vancomycin resistant *Enterococci* (VRE) infections in hospitals are frequently reported from different parts of the world. Prompted by above reports, chemistry and antimicrobial activity studies of *G.*

mangostana were initiated with a special reference to MRSA and VRE. Further antifungal and antioxidant activity of isolates were also investigated.

In the present study, chemical investigation of the latex, fruit hull, stem bark and the root bark of *G. mangostana* yielded α -mangostin, β -mangostin, γ -mangostin, methoxy- β -mangostin, Garcinone E, Gartanin and new natural products 3-hydroxy-4-geranyl-5-methoxy biphenyl and cycloart-22, 25 diene-3 β -ol. α -mangostin was converted to 5,9-dihydroxy-8-methoxy-2,2-dimethyl-7-(3-methylbut-2-enyl)-2H,6H-pyranol(3,2-b) xanthen-6-one and methoxy- β -mangostin by cyclodehydrogenation and methylation respectively. Structural elucidation of two new compounds 3-hydroxy-4-geranyl-5-methoxybiphenyl and cycloart-22, 25 diene-3 β -ol and other isolates were carried out with the help of spectroscopic analysis, partial synthesis and comparison with literature data.

Antibacterial activity of above compounds was tested against five control strains *Staphylococcus aureus* (NCTS 6571), *Enterococci faecalis* (NCTS 12697), *Pseudomonas auregenosa* (NCTC 10662), *Klebsiella* PW (Pamilo Water strain) and *Escherichia coli* (NCTC 10418) and seventeen MRSA strains isolated from hospitals, using disk diffusion method. Of them α -mangostin, γ -mangostin and 5,9-dihydroxy-8-methoxy-2,2-dimethyl-7-(3-methylbut-2-enyl)-2H,6H-pyranol(3,2-b)xanthen-6-one showed activity against *S. aureus* (NCTC 6571), at MIC values 1.04, 4.16 and 16.66 $\mu\text{g}/\text{mL}$ respectively. Further, α -mangostin and γ -mangostin showed activity against *E. faecalis* (NCTC 12697) at MIC values 1.04 and 4.16 $\mu\text{g}/\text{mL}$ respectively. Anti VRE activity studies carried out with the collaboration of Osaka Prefectural Institute of Public Health, Japan; showed the activity of above isolates α -mangostin at MIC of 6.25 $\mu\text{g}/\text{mL}$ respectively. Synergisms between α -mangostin and commercially available antibiotics against VRE and MRSA strains were also observed. Above antibacterial studies were carried out with the hope of preventing VRE and MRSA infections by introducing new natural products. MRSA and VRE activity of α -mangostin and γ -mangostin are comparable with the presently used antibiotic gentamicin.

Antifungal activity of above isolates were tested against strains of human pathogen *Candida* and plant pathogens *Aspergillus* and *Cladosporium*, using disk diffusion method. β -mangostin and γ -mangostin showed activity against *Cladosporium*.

Qualitative analysis of antioxidant activity of above isolates was carried out using free radical reagent 2,2-diphenyl-1-picrylhydrazyl (DPPH). α -mangostin, γ -mangostin and Garcinone E showed antioxidant activity. EC_{50} value of each compound was calculated using EPA probit analyzer and γ -mangostin exhibited a higher activity with EC_{50} value of 61.6 $\mu\text{g}/\text{mL}$, which is more active than the positive control ascorbic acid ($\text{EC}_{50} = 82.3 \mu\text{g}/\text{mL}$). Garcinone E showed EC_{50} value of 110.2 $\mu\text{g}/\text{mL}$.

The presence of the above highly bioactive compounds in *Garcinia mangostana* should be the causative factor for its medicinal value in indigenous medicine. Therefore, above antibacterial compounds should be investigated further in appropriate *in vivo* models.

2.41

Chemistry of some Annonaceae Plants.

Puvanendran, S.

140p.

M. Phil. Degree, 2008

Location No. 789

Abstract

This thesis describes the chemistry and biological activities of *Xylopia championii* Hook. f. & Thoms., and *X. parvifolia* (Wight) Hook. f. & Thoms, antioxidant and mosquito larvicidal activities of some endemic *Annonaceae* plants, and antifeedant activity of *Goniothalamus gardneri* Hook. f. & Thoms.

The first section deals with the antioxidant and antifungal activities of alkaloids and terpenoid isolated from *X. championii*. Seven alkaloids, *O*-methylmoschatoline (**9**), (-)-discretine (**97**), (+)-laudanidine (**100**), oxopurpureine (**160**), dimethyl-10 xylopinine (**161**), nordicentrine (**162**) dehydrocorytenchine (**163**), were isolated. The alkaloids (+)-laudanidine (**100**) and (-)-discretine (**97**) showed potent antioxidant activity in the DPPH assay. (-)-Discretine (**97**) and nordicentrine (**162**) showed potent antifungal activity against fungus *Cladosporium cladosporoides*. In addition, a terpenoid *ent*-kaur-16-en-19-oic acid (**23**) isolated from *X. championii* showed moderate antifungal activity and weak antioxidant activity. However, it showed a good activity against the second instar larvae of *Aedes aegypti* (L.). None of the isolated pure alkaloids showed a positive response in the mosquito larvicidal assay against the second instar larvae of *A. aegypti*. Interestingly, these alkaloids seem to be stimulating the growth of larvae when compared to the control. Another terpenoid, 15 β -hydroxy-(-)-kaur-16-en-19-oic acid (**77**) along with *ent*-kaur-16-en-19-oic acid (**23**), *O*-methylmoschatoline (**9**), (-)-discretine (**97**), (+)-laudanidine (**100**), oxopurpureine (**160**), nordicentrine (**162**), dehydrocorytenchine (**163**) was isolated from the stem bark of *X. parvifolia*.

The next section deals with the antioxidant and mosquito larvicidal activities of some endemic *Annonaceae* plants namely, *Alphonsea hortensis* H. Huber, *Desmos zeylanica* Hook. f. AND Thoms., *Enicosanthum acuminata* (Thw.) Airy-Shaw, *Goniothalamus hookeri* Thw., *G. salicina* Hook. f. AND Thoms., *Phoenicanthus coriacea* (Thw.) H. Huber, *Uvaria semecarpifolia* Hook. f. AND Thoms., *U. sphenocarpa* Hook. f. AND Thoms., *Xylopia championii* Hook. f. AND Thoms., and *X. nigricans* Hook. f. AND Thoms. The results obtained from the DPPH assay revealed that some of the extracts had superior ability to neutralize free radicals. For example, the MeOH extract of stem of *A. hortensis* (56.30%), MeOH extract of leaves of *U. semecarpifolia* (57.33%), CH₂Cl₂ and MeOH extracts of stem bark of *X. championii* (67.05% and 79.03%, respectively), MeOH extracts of leaves of *G. salicina* (59.98%) and MeOH extract of seed of *X. nigricans* (62.06%) showed high radical scavenging activity compared to the standard DL- α tocopherol (55.84%). In the mosquito larvicidal assay, the CH₂Cl₂ and MeOH extracts of *G. Hookeri* demonstrated high larvicidal activity (LC₅₀ = 1.9 and 2.1 ppm, respectively) while its leaves exhibited even higher activity (LC₅₀ = 0.4 ppm). The CH₂Cl₂ extracts of stem of *A. hortensis* and leaves of *E. acuminata* (LC₅₀ = 46.9 and 41.5 ppm, respectively) and the MeOH extracts of seeds of *D. zeylanica* and bark of *A. hortensis* (LC₅₀ = 44.6 and 46.9 ppm, respectively) showed significant activity. The most active was the CH₂Cl₂ extracts of leaves of *G. Hookeri* with an LC₅₀ value of 0.4 ppm.

The latter part of the study describes the antifeedant activity of two acetogenins **164** and **165** isolated from *G. gardneri* Hook. f. AND Thoms. Both **164** and **165** showed potent antifeedant activity against second instar larvae of *Plutella xylostella* (L.).

The results obtained from this study revealed that the family *Annonaceae* is a good source of antioxidants and larvicides.

2.42 **Clay Polymer Nanocomposites: Investigation of their Electrical Properties for Industrial and Technological Applications.**

Rajapakse, R.M.M.Y.

89p.

M. Phil. Degree, 2009.

Location No. 909

Abstract

Pioneering researches on hosts that can hold vast number of inorganic and organic materials have opened a new era on development of composite materials over the past years. Among them clay minerals belong to the smectite group have shown ample range of distinct properties such as hosting capabilities for numerous cations and layer expansion abilities upon guest intercalations. Montmorillonite (MMT) and Fuller's Earth (FE) are insulating smectite hosts that can be transferred into highly conducting polymer nanocomposites upon spontaneous polymerization of conducting polymers within their nanometer level interlayer spaces by pre-exchanged oxidizing agents. Clay conducting polymer nanocomposites made by this phenomenon showed remarkable electronic, ionic or even mixed conducting properties over their un-modified pure forms.

This research was mainly focused to improve the conductivity of the low cost conducting polypyrrol (PPY) nanocomposites prepared by solution-phase ion-exchange process with the use of Ce^{4+} , Cu^{2+} modified MMT and Fe hosts. The resulted clay-conducting polypyrrol nanocomposites with the reduced form of the oxidizing agents have been extensively characterized by X-ray diffraction (XRD) technique for interlayer spacing variations and by Fourier Transform Infra Red (FT-IR) spectroscopy to study the interactions between the clay and polymer functional groups. Thermal gravimetric analysis (TGA) and differential scanning calorimetric (DSC) techniques were used to determine the thermal behavior of those. DC polarization technique with both blocking and non-blocking electrodes was used to distinguish the ionic and electronic transport numbers and recognize the type of mobile ion species. AC impedance analysis further resolved the electrical conduction of these materials while electrochemical performance and application prospects were determined by cyclic voltametry.

The XRD analyses for MMT, FE and Cu^{2+} ion intercalated smectites show similar d spacing of $\sim 15 \text{ \AA}$ suggesting that they contain two water layers within interlayer. However, for Ce^{4+} modified smectites it gives the d spacing of $\sim 18 \text{ \AA}$, suggesting higher interlayers of water capacity. Heat treatments for the above reduce the d spacing to a value of $\sim 10 \text{ \AA}$ due to the removal of all interlayer water. As the monomer pyrrol is introduced to the modified smectites, the enhancement of the d spacing by $\sim 7 \text{ \AA}$ is observed. These layer expansion due the ion induced in situ polymerization of pyrrol do not change upon heat treatments revealing the thermal stability of formed PPY within smectite interlayers. Further, it is revealed that for a desired amount of modified clay, inter layer polymer saturation can be achieved by gradual loading of PPY with increasing the monomer concentration. For [Cu(I)-PPY-MMT], (the interlayer saturation) the optimum layer expansion is $\sim 17 \text{ \AA}$ that does not change upon further loading.

FTIR analyses observed for raw and ion-modified clays clearly coincide with the typical bands observed for natural MMT whereas for polymerized clay the bands ($\nu = 1198 \text{ cm}^{-1}$, 1304 cm^{-1} , 1460 cm^{-1} and 1550 cm^{-1}) suggest the formation of PPY. Further, the band intensity variations of (1638 cm^{-1} , $3200\text{-}3400 \text{ cm}^{-1}$) prior and following the PPY formation is a clear suggestion for the transformation of hydrophilic ion- modified clays into hydrophobic clay PPY nanocomposites.

TGA and DSC data overlap with the XRD and FTIR data suggesting raw and ion-modified clays contain interlayers water that can be overcome upon heating to 200°C. These analyses justified that polymerized clays are hydrophobic and PPY within the clay is stable at even ~ 350°C, where polymer begins decomposition.

Bulk conductivity analyses carried out for the copper ion intercalated PPY smectites suggest mixed conducting nature as observed by preliminary analyses (DC polarization tests) whereas cerium ion intercalated PPY nanocomposites show almost electronic conducting nature. The optimum electronic conductivity observed upon PPY saturation within clay interlayers is 0.53 S m⁻¹ for [Cu(I)-PPY-MMT]. Dual transmission model facilitates the necessary theoretical background to explain AC impedance results on mixed conducting clay PPY nanocomposites while a theory proposed by Hsu et al. assists to identify the behavior of [Ce(III)-PPY-MMT] [110].

Cyclic voltammetry analyses undoubtedly show the electrochemical behavior of ion-modified and polymerized clays. Peaks obtained for Cu²⁺ and Ce⁴⁺ intercalated smectites almost coincide with copper and cerium redox potentials. The well defined nature of the CV's for PPY nanocomposites precisely unveil the overcoming of non conducting environment of the hosts while further analyses on [Ce(III)-PPY-MMT] reveal its oxygen reduction ability suggesting promising, cheap, ease of fabrication and environment friendly alternative for high cost cathode materials in fuel cells.

2.43

Development of Amperometric Sensors for Detection of Cyhalothrin and Propanil.

Hafil, Ashraff Mohamed

131p.

M.Phil. Degree, 2003.

Location No. 309

Abstract

An electrochemical oxidation of cyhalothrin, 3(2-chloro-3,3,3-trifluoro-1 propenyl)-2,2 dimethylcyclopropane carboxylic acid cyano(3-phenoxyphenyl) methyl ester which is an active ingredient of Grenade 5 EC insecticide was carried out at a bare glassy electrode in an aqueous solution of 0.1 mol. dm⁻³ NaCl using cyclic voltammetry and amperometry techniques.

Cyhalothrin is a synthetic pyrethroid and the acute oral LD₅₀ value for male rats is 243 mg/kg. The solubility of cyhalothrin in water at 25°C is 0.004 mg/l. It is used to control *haematobia* irritants on cattle and lice.

Preliminary electrochemical characterizations were conducted by cyclic voltammetry and which indicated that the oxidation of cyhalothrin occurred at +0.72 V vs SCE, and it is a completely irreversible system. The amperometric detection of cyhalothrin at bare glassy carbon electrode was interfered with noise signals at the optimum potential +0.08 V vs SCE. The noisy signals could be successfully eliminated by using a thin coating by dipping with electro-inactive coating of stearic acid on top of the glassy carbon electrode surface at optimized potential +0.08 V vs SCE, and it results in the reduction of instrumental responses. Sensitivity of the sensor was estimated to be 0.0592 A mol⁻¹ d³ using calibration plot and, the linear dynamic range was found from 1.75 x 10⁻⁶ to 1.40 x 10⁻⁵ mol dm⁻³. The lifetime of the sensor was found for at least ten days. The response time (t₉₀) was measured as 5.4 s. The sensor responded for very low concentration with the minimum detection limit of 1.75 x 10⁻⁷ mol dm⁻³ when signal to noise ratio is 3. The coefficient of variation (CV) was 1.72%.

Propanil (3,4-DPA), N-(3,4dichlorophanyl) propanamide is a contact herbicide used in post

emergence control of grasses (*Echinochloa*) and broad leaf weeds in rice and potato fields. It is toxic to most leaf plants (inhibit photosynthesis) to most leaf plants and non-toxic to tolerant plants as such plant contain the enzyme aryl acylamidase which can metabolize propanil into 3,4 dichloroaniline (3,4-DCA) and propionic acid. 3,4-DCA is the primary residue of the propanil which could exist in the environment, through subsequent pathways and more toxic than propanil. As a result of the application of propanil, its residues can get into the environment, which remain in the agricultural commodities and the foodstuffs. Furthermore, propanil is stable only in the pH range of 7-10 and it degrades under extreme pH conditions. In this study we specifically aimed at the residue analysis of propanil both in the commercial samples and as a residue in the rice grains through cost effective electroanalytical methods. The cyclic voltammetry is a basic electroanalytical technique and is used to study the electrochemical behavior of the propanil residues. Subsequently it was possible to develop the amperometric sensor to detect 3,4-DCA as the propanil residue.

The steady-state amperometric measurements were obtained at stearic acid modified glassy carbon electrode in 0.1 mol dm⁻³ phosphate buffer (pH = 7) at the optimized potential at + 0.07 V vs SCE and, the amperometric calibration curves were obtained for 3,4-DCA. The linear dynamic range for the sensor was from 1.0 x 10⁻⁴ to 5.3 x 10⁻³ mol dm⁻³ and the sensitivity was obtained to be 0.005 A dm³ mol⁻¹. The minimum detection limit of the sensor was 2.0 x 10⁻⁵ mol dm⁻³ at signal to noise ratio is 3.

2.44

Development of Dye-sensitized Solar Cells Using Atomized Spray Pyrolysis Technique.

Anuradha, S.G.

77p.

M.Phil. Degree, 2012.

Location No. 1241

Abstract

In this study, a novel technique for preparing thin films has been developed for applications in dye-sensitized solar cells (DSC). The Atomized Spray Pyrolysis (ASP) is the technique that was developed in this work, which is an automated system in which particles are selected prior to spray deposition. In an aerosol, finer particles are separated out from larger ones. The ability of spraying an aerosol as a thin beam of particles results in a highly uniform arrangement of particles on the substrate. This uniform arrangement allows the light to pass through with minimum scattering to result in transparent films. In fabricating transparent Dye-sensitized Solar Cells (DSCs), these films were used as working electrodes. By sandwiching I₃⁻/I⁻ redox couple containing liquid electrolyte between the above working electrode and lightly platinized Fluorine doped Tin Oxide coated glass (counter electrode), the DSCs were constructed. D358 indoline dye or N719 ruthenium based dye was used as the sensitizer.

A power conversion efficiency of 8.2 % was recorded for DSCs fabricated by using TiO₂ film deposited by the ASP system which has a 60 % optical transmittance. Other I-V characteristics of the cell are J_{sc} = 16.4 mA/cm², V_{oc} = 729 mV, and FF = 0.69.

Transparent DSCs were fabricated using SnO₂/ZnO composite film based active electrodes. DSCs with active electrodes of SnO₂ alone show inferior performances. Herein the performance has been enhanced by constructing a thin insulating core-shell around SnO₂ particles. ZnO as a wide band gap material was chosen as the material for the thin outer coating. Using ASP system a transparent composite electrode was prepared which results an average optical transmittance of 30-40 %. The IV characteristics of these DSCs are higher than those of the DSCs prepared by using SnO₂ or ZnO alone.

Composite films of $\text{SnO}_2/\text{CaCO}_3$, SnO_2/MgO and SnO_2/ZnO were prepared by using the ASP system and were utilized to fabricate transparent DSCs by sandwiching a polymer gel electrolyte in between the two electrodes. The power conversion efficiencies of these DSCs were 4.40 %, 5.20 % and 5.12 % respectively.

A transparent solid state DSC with overall conversion efficiency of 1.17 % was developed by replacing the liquid electrolyte with a p-type semiconductor CuI. In this cell, a thin layer of optically transparent CuI was deposited on the dyed TiO_2 film by using the ASP system.

Ammonium pyrrolidene dithiocarbamate and lithium diethyl dithiocarbamate were employed as surface modifiers of the semiconductor particulate film. The contribution of dithiocarbamates in enhancing the performance of the DSC was positive as they improve the V_{oc} of the DSC.

2.45

Development of Organic/Inorganic Composite Electrolyte Materials based on Poly (Ethylene Oxide) and Montmorillonite (PEO/MMT) for Applications in Electrochemical Devices.

Manoratne, C. Hemapa

130p.

M.Phil. Degree, 2005.

Location No. 458

Abstract

The widespread research activities and the understanding of some apparently inert and electrically insulating materials which, can promote the ionic conductivity of polymer electrolytes have opened up a new page in the development of conducting materials. Montmorillonite (MMT) is an inert and electrically insulating material in its pure state, and one of the clay minerals of smectite group, which shows unique features of marked cation exchange properties, film formation from fine dispersions in water or other organic solvents, expandability, taking up water or other organic molecules between their interlayer spacing. Organic/ inorganic composite polymer electrolytes formed by incorporating MMT as a plasticizer into PEO based electrolytes show enhanced ionic conductivities compared to the MMT free electrolytes.

In this research work, an attempt was made to improve the ionic conductivity of the systems of MMT/ poly(ethylene oxide) (PEO)/ cations (Li^+) and the polymer electrolyte system of $(\text{PEO})_9\text{LiCF}_3\text{SO}_3$ by incorporating montmorillonite (MMT) as the plasticizer. The ionic conductivity, thermal properties, crystallinity, and the bonding were systematically characterized by ac-impedance spectroscopy, differential scanning calorimetry (DSC), X-ray diffraction spectroscopy (XRD), and fourier transformed infrared spectroscopy (FTIR), respectively.

The XRD revealed that the MMT has a d-spacing of 15.49 Å, which is attributed to the presence of Na^+ and two water layers within interlayers at room temperature. The removal of water brings the d-spacing to 9.97 Å. The Li^+ exchange gives a d-spacing of 15.57 Å which on dehydration gives a d-spacing of 9.97 Å. Solution intercalation of PEO into MMT and MMTLi results in the enhancement of d-spacing up to ~18.73 Å which readily takes up water enhancing the d-spacing to ~23.33 Å. These results show clearly that PEO is readily intercalated in MMT at a composition of 6% PEO. The enhancement of d-spacing at 6% PEO composition has not been observed previously. FTIR spectroscopy is a powerful tool in the characterization of microscopic properties in electrolytic systems [1, 4]. Ordinary montmorillonite (MMTNa)

shows typical vibrational modes at 916 cm^{-1} $\nu(\text{Al-O-H})$, 1040 cm^{-1} $\nu(\text{Si-O})$ and a band in the region 3300 cm^{-1} - 3700 cm^{-1} due to $\nu(\text{OH})$ stretching modes. Clearly two types of $\nu(\text{O-H})$ are seen: isolated OH groups and those involved in hydrogen bonding. The Li^+ exchange decreases the extent of isolated hydroxyl groups, but the extent of H-bonding increases. This suggests that Li^+ is coordinated by octahedral unit of the MMT, through the O atoms (ions) of free Al-O-H groups. The enhancement of ionic conductivity measured using ac impedance analyzer supports this arrangement. The intercalation of PEO in MMTLi reverses the above process by forming H-bonds with Li^+ . The amount of free O-H then increases and the extent of hydrogen bonded O-H decreases.

The comparison of FTIR spectra of MMT, PEO, $(\text{PEO})_9\text{LiCF}_3\text{SO}_3$, and $(\text{PEO})_9\text{LiCF}_3\text{SO}_3 + 5\text{ wt\% MMT}$ clearly shows that the interactions take place between these constituents, as the intensities of typical stretching vibrational modes of 916 cm^{-1} $\nu(\text{Al-O-H})$, 1040 cm^{-1} $\nu(\text{Si-O})$ and $3300 - 3700\text{ cm}^{-1}$ $\nu(\text{OH})$ in MMT, and the vibrational modes of CH_2 rocking at 948 and 840 cm^{-1} and C-O stretching at 1149 and 1090 cm^{-1} in PEO are changed. The change of symmetric bending mode of $\text{CF}_3[\delta_s(\text{CF}_3)]$ at 752 cm^{-1} in lithium triflate has altogether supported the conformation of the electrolyte system and the corresponding conductivity enhancements. The specific, balanced interactions with the corresponding properties can only be found in the system of $(\text{PEO})_9\text{LiCF}_3\text{SO}_3 + 5\text{ wt\% MMT}$.

The ac impedance data reveal that the ionic conductivity of $(\text{PEO})_9\text{LiCF}_3\text{SO}_3$ system is changed with the concentration of MMT. Maximum conductivity of $4.15 \times 10^{-7}\text{ S cm}^{-1}$ at room temperature was observed for the system of $(\text{PEO})_9\text{LiCF}_3\text{SO}_3 + 5\text{ wt\% MMT}$. The DSC and XRD data clearly show that the crystalline nature of PEO is reduced when MMT is added and the glass transition temperature and the melting temperature are also reduced. The resulting amorphous environment evidently contributes to the enhancement of ionic conductivity.

2.46

Development of Polyaniline Conducting Polymer Systems for Sensor Applications.

Premasiri, H.D.S.

92p.

M.Phil. Degree, 2004.

Location No. 381

Abstract

Polyaniline (PANI), a conducting polymer can exist in six different structural forms. The six forms are interconvertible and they have their own characteristic properties. In this study, the polymer was developed for use as an electrocatalytic substance and as a gas sensor.

The electrochemistry of L-Ascorbic acid in 0.1 mol dm^{-3} of NaCl (aq) in the potential range -0.4 V to $+1.0\text{ V}$ at pH 2 shows that one oxidation peak centered at $+0.55\text{ V}$ and 0.38 V with respect to SCE on Glassy Carbon and Pt electrodes in contrast to Polyaniline modified electrode shows a oxidation peak centered at 0.33 V . Thus the PANI modification on Pt and Glassy carbon bare electrodes has resulted in 0.22 V and 0.15 V negative shifts for the Ascorbic Acid oxidation compared to glassy carbon and Pt bare electrodes. The latter system follows the Langmuir adsorption isotherm and monolayer coverage of ascorbic acid on PANI surface facilitates the oxidation reaction at a lower potential. The fact that relatively low potential is sufficient to oxidize ascorbic acid on PANI indicates the suitability of a PANI modified electrode as an electrochemical catalyst to sense ascorbic acid in biological samples.

The qualitative changes of different forms of PANI when exposed to various gases such as NH_3 , HCl vapour, H_2S and Cl_2 were studied. The adsorption of the above gases were accompanied by

colour and conductivity changes in the PANI.

Exposure of emeraldine salt form of PANI deposited on glass plates to NH_3 gas results in decreasing of conductivity as increase of the concentration of NH_3 gas and the colour changes from green to blue. When the emeraldine base forms of PANI on glass plates are exposed to HCl vapour, conductivity is increased in a systematic way with the concentration of HCl vapour with no visible colour change. The exposure of pernigraniline base form of PANI to various doses of H_2S gas results in an initial decrease followed by an increase of the resistance. The colour changes from violet, blue, green and finally to yellowish green. When emeraldine salt form of the polymer is exposed to an oxidizing gas such as Cl_2 , the polymer gets oxidized resulting in the reduction of its conductivity with the colour changing from green to violet.

These conductivity and colour changes of the polymer film with the concentration of gas indicate the applicability of the polymer as a gas sensor for quantitative and qualitative determination of acidic, basic and redox gases.

2.47

Development of Self-Cleaning and Anti-Microbial Textile Material.

Bandara, I.M.C.C.D.

90p.

M.Phil. Degree, 2013.

Location No. 1337

Abstract

In this study, convenient and low-cost method for the fabrication of self-cleaning and anti-microbial cotton textile, which stands against common microbes, was developed by surface modification and microwave assisted particle generation to mimic hierarchical structure of the lotus effect. Microwave irradiation was used as economically viable and environmentally benign method in the fabrication process. Here, natural cellulose substrate is modified with chloroacetic acid in basic medium, followed by drying and curing. It is then immersed in a titanium tetraisopropoxide solution and a uniform seed layer of titanium dioxide is formed on cotton fibre. Next, TiO_2 or ZnO particles were grown *in-situ* on the seed layer, by microwave irradiation, in order to achieve the necessary multilevel roughness mimicking a natural hydrophobic surface topology in microscale on the cotton surface and are made hydrophobic by the introduction of an organic layer on top of the semiconductor material. The morphology and composition of modified cotton fabrics were characterized by a combination of SEM, EDX, FTIR and TGA measurements. Wettability of cotton was measured in terms of water contact and roll-off angles.

Method for determining water contact angle and the roll-off angle was developed for the characterization of the cotton textile in the laboratory. By this method, anti-bacterial and hydrophobic textile with a water/textile contact angle of 143° and roll off angle of 13.8° were obtained for TiO_2 cotton. ZnO particle grown cotton, the best water/textile contact angle of 154° and roll-off angle of 16.5° were reported. Further, physical property testing showed that the method can be adopted without damaging the cotton fibres and their tensile properties.

Various size silver nanoparticles were synthesised and their cytotoxic studies against brine shrimp larvae have shown that toxicity of Ag nanoparticles increase with the size decreases. Iron oxide nanoparticles were synthesised and their anti-microbial activity was tested against gram-positive and negative bacteria, but the results were not reproducible.

2.48

Development of Solar Cells Based on Dye-Sensitized Titanium Dioxide with Solid-State Electrolyte.

Mahendralingam, Anushya

71p.

M.Phil. Degree, 2003.

Location No. 333

Abstract

Nano structural dye-sensitized solar cells based on titanium dioxide traditionally use a liquid electrolyte such as acetonitrile, which causes many difficulties. In this study, quasi-solid state dye-sensitized Photoelectrochemical cells of the type, FTO/TiO₂/dye/(15%) Polyacrylonitrile, (35%) ethylene carbonate, (50%) propylene carbonate, tetrapropylammonium iodide, iodine/Pt/FTO have been fabricated and characterized using current-voltage measurements. The short-circuit current (I_{sc}) obtained at 1000 Wm⁻² was 6 mA and efficiencies obtained for solid electrolyte solar cells with and without 4-tertiary butyl pyridine are 2.9 and 1.6% respectively. A mechanism involving "trapping" of the liquid electrolyte on the Polyacrylonitrile (PAN) structure is proposed for the efficiency of this solid electrolyte.

For comparative purposes cis-di(thiocyanate)bis(4,4'-dicarboxy-2,2'-bipyridyl)ruthenium(II) (RuL₂(NCS)₂) was investigated. Bis((4,4'-dimethoxy-2,2'-bipyridyl)- 4,4'-dicarboxy-2,2'-bipyridyl)ruthenium(II) (RuL'₂L) dye was also prepared as a possible sensitizer. The short-circuit current, open-circuit voltage and efficiencies of the latter dye were very low compared to (RuL₂(NCS)₂). From action spectra, the maximum incident photon conversion efficiencies of 5 and 0.5% were obtained at 530 nm for RuL₂(NCS)₂ and 470 nm for RuL'₂L respectively.

Charge recombination between dye-sensitized nanocrystalline TiO₂ electrodes and I₃⁻/I⁻ couple in nanoaqueous and quasi-solid electrolyte is described. The sensitizer was RuL₂(NCS)₂. Treating the dye-coated TiO₂ electrodes with 4-tertiary butylpyridine and 8-hydroxyquinoline improves significantly both the open-circuit voltage V_{oc} (from 650 to 750 mV) and the efficiency (from 4 to 6%) at 1000 Wm⁻² with respect to untreated electrode. The use of 8-hydroxyquinoline for this purpose has been successfully demonstrated.

Double dye systems using RuL₂(NCS)₂ and methyl violet thiocyanate simultaneously adsorbed on titanium dioxide film give enhanced photocurrents and quantum efficiencies. The results show that this is not a simple additive effect. This can be explained by the interaction of the two dyes via chemical interactions where charge recombination is suppressed due to charge separation.

2.49

Dye Sensitization of Nanoporous TiO₂ with Solid Polymer Electrolyte for Solar Energy Conversion.

Weeraman, Tharangika Thushari Karunarathne

141p.

M.Phil. Degree, 2000.

Location No. 129

Abstract

Colloidal nanostructured titanium di-oxide (TiO₂) with thinly covered dye molecule combinations are seriously discussed today as promising solar energy conversion system. In this work TiO₂ is the most widely investigated material because of its thermal and photoelectrochemical stability. Consequently the light absorption cross section is increased

while maintaining a large effective surface area. So the dye sensitized TiO₂ solar cells based on nanostructured films with several dyes have been reported. Ruthenium bipyridine complexes have been widely employed as dyes owing to their stability and high life times of their excited state. However these dyes are very expensive and relatively time consuming to synthesize.

In dye sensitized photoelectrochemical cells made from nanoporous TiO₂, the liquid electrolyte leads to several technological problems such as dye desorption, solvent evaporation and degradation, seal imperfection, hence less working life. Therefore the ideal dye sensitized solar cell is a fully solid state device in which the liquid is replaced by a solid conductor. In that case a solid polymer electrolyte offers a means of eliminating all these problems mentioned above.

We have chosen several dyes isolated from plants which are stable towards photo degradation for the dye sensitization of TiO₂ semiconductors. They are Cu-chlorophyllin and cyanidin. In addition attempts were made to attach inorganic dyes, such as nickel-phthalocyanine (NiPc) and tungstosilicic acid (H₄ [SiW₁₂O₄₀]). The solid state solar cells of the type of CTO/n-TiO₂/Dye/Solid polymer electrolyte/counter electrode were fabricated using two solid polymer electrolytes: poly(ethylene)oxide (PEO) and polyacrylonitrile (PAN) with plasticizers, propylene carbonate (PC) and ethylene carbonate (EC).

Each and every time the stability and efficiency of the solid cell is well comparable by matching the absorption spectra of dyes in their soluble medium and photocurrent action spectra in appropriate electrolytes.

All four dyes show their dye sensitization effects on TiO₂ semiconductor surface clearly giving peaks at 450 nm ($1.6 \times 10^{-2} \mu\text{A cm}^{-2}$), 560 nm ($1.7 \times 10^{-2} \mu\text{A cm}^{-2}$), and 625 nm ($1.8 \times 10^{-2} \mu\text{A cm}^{-2}$), for Cu-chlorophyllin, 410 nm ($3.25 \times 10^{-1} \mu\text{A cm}^{-2}$) and 530 nm ($1.35 \times 10^{-1} \mu\text{A cm}^{-2}$) for cyanidin, 666 nm ($2.45 \times 10^{-4} \mu\text{A cm}^{-2}$) for NiPc and 485 nm ($2.75 \times 10^{-1} \mu\text{A cm}^{-2}$) for tungsto silicic acid on their photocurrent action spectra.

The photocurrent action spectrum of the CTO/ TiO₂/ Cu-chlorophyllin/PEO, PC, EC, KI, I₂/CTO solid state cell shows peaks at 340 nm (for TiO₂), 420 nm and 565 nm (for Cu-chlorophyllin) with corresponding photocurrent densities of $0.058 \mu\text{A cm}^{-2}$, $0.033 \mu\text{A cm}^{-2}$ (Q%=0.378) and $0.0125 \mu\text{A cm}^{-2}$ (Q%=0.046) respectively. Under illumination of 100 W tungsten filament lamp, this cell gives a cell efficiency of 0.36%. The conductivity of the polymer electrolyte PEO, KI, I₂, PC, EC is of the order of 10^{-5} S/cm . The conductivity of the solid cell (CTO/ TiO₂/ Cu-chlorophyllin/PEO, PC, EC, KI, I₂/CTO) is $3.59 \times 10^{-7} \text{ S/cm}$.

The photocurrent action spectrum of solid state cell (CTO/ TiO₂/ Cu-chlorophyllin/PAN, PC, EC, KI, I₂/CTO) shows peaks at 310 nm (for TiO₂) and 680 nm (for Cu-chlorophyllin) with corresponding photocurrent densities of $7.5 \mu\text{A cm}^{-2}$ and $0.725 \mu\text{A cm}^{-2}$ (Q=3%) respectively indicating that there is dye sensitization. This cell gives a cell efficiency of 0.49% under the illumination through a 100W tungsten filament lamp. The conductivity of solid polymer electrolyte PAN, PC, EC, KI, I₂ is of the order of 10^{-7} S/cm and the conductivity of the solid cell (CTO/ TiO₂/ Cu-chlorophyllin/PAN, PC, EC, KI, I₂/CTO) is $4.26 \times 10^{-5} \text{ S/cm}$.

The photocurrent action spectrum of the CTO/ TiO₂/ cyanidin/PAN, PC, EC, KI, I₂/CTO gives photocurrent densities of $9.75 \mu\text{A cm}^{-2}$ at 330 nm and $0.575 \mu\text{A cm}^{-2}$ at 680 nm. The cell efficiency is calculated to be 0.5%. The conductivity of the cell CTO/ TiO₂/ cyanidine/PAN, PC, EC, KI, I₂/CTO is of the same order as observed for the cell CTO/ TiO₂/ chlorophyllin, PAN, PC, EC, KI, I₂/CTO.

The cell fabricated with poly (ethylene) oxide as a solid polymer electrolyte and cyaniding as the dye, i. e. CTO/ TiO₂/ cyanidin/PEO, PC, EC, KI, I₂/CTO gives an open circuit voltage of 700 mV and a short circuit photocurrent density of $5.8 \mu\text{A cm}^{-2}$. The cell efficiency is calculated to

be 1.0% under illumination through 100W tungsten filament lamp ($110\text{mW}/\text{cm}^2$). The conductivity of the solid electrolyte in the cell (PEO, PC, EC, KI, I_2) is $4.10 \times 10^{-4} \text{ S}/\text{cm}$.

NiPc attached titanium dioxide semiconductor has peaks in photocurrent action spectrum at 372 nm and 666 nm with the corresponding photocurrent densities of $2.9 \times 10^{-4} \mu\text{A cm}^{-2}$ and $2.45 \times 10^{-4} \mu\text{A cm}^{-2}$ respectively. Peak at 666 nm is due to dye. It clearly shows that nickel-phthalocynine has dye sensitization effect on the TiO_2 semiconductor. The solid state cell fabricated with PAN polymer and a gold plate as a counter electrode gives the open circuit voltage of 415 mV with a short circuit photocurrent of $48 \mu\text{A cm}^{-2}$. The calculated fill factor is 0.33 with a cell efficiency of 5.9×10^{-6} . The completed cell, in its photocurrent action spectrum gives peaks at 380 nm (for TiO_2) and 710 nm (for NiPc sensitization) with the corresponding photocurrent densities of $1.84 \times 10^{-3} \mu\text{A cm}^{-2}$ and $2.64 \times 10^{-3} \mu\text{A cm}^{-2}$ respectively. The carrier concentrations calculated from the slope of the Mott-Schottky plots, taking the dielectric constant of NiPc to be 11 ($\epsilon=11$) is $7.3 \times 10^{19} \text{ cm}^{-3}$.

The completed cell CTO/ TiO_2 , NiPc, PEO, PC, EC, KI, I_2 /Gold gives the V_{oc} of 380 mV and I_{sc} of $14.5 \mu\text{A cm}^{-2}$ with fill factor of 0.10 under illumination through 100W tungsten filament lamp. The calculated cell efficiency is 5.11×10^{-6} . I-V behavior observed by varying resistance and illumination through 100W tungsten filament lamp for the solid state cell consisting of CTO/ TiO_2 , NiPc, PC, EC, KI, I_2 /Au gives $V_{oc} = 220 \text{ mV}$ and $I_{sc} = 325 \mu\text{A cm}^{-2}$. The high value of I_{sc} for solid state cell prepared using two plasticizers is due to high conductivity of propylene carbonate (PC) or ethylene carbonate (EC). The cell efficiency is calculated to be 3.24×10^{-6} .

Under illumination through sunlight with an intensity of 835 Lux, the cell, CTO/ TiO_2 , NiPc, CuI, Platinum gives I_{sc} of $16.9 \mu\text{A cm}^{-2}$ and V_{oc} of 3.4 mV. Hall effect studies on NiPc shows that resistivity of NiPc is $5.306 \times 10^{-7} \Omega\text{m}$ at the room temperature of 30°C and in the presence of magnetic field hole resistivity, ρ_H is calculated as $9.32 \times 10^{-4} \Omega\text{m}$.

2.50

Dye-Sensitized Photoelectrochemical Cells Based on TiO_2 Films with Polymer Electrolytes for Solar Energy Conversion.

Somasundaram, Sashikala

87p.

M.Phil. Degree, 2001.

Location No. 173

Abstract

Dye-sensitized photoelectro-chemical cells based on porous nanocrystalline films of TiO_2 (nanocells) are gaining much attention as promising solar energy conversion systems. The performance of these devices depends largely on the dye used as the sensitizer. The spectral response of the cell, photocurrent quantum efficiency, and stability depend on the nature of the dye. The important physical characteristics of the dye, which determine the above properties of the cell, are the absorption spectrum of the dye, the redox properties of the ground state and the excited state of the dye molecule in relation to the band position of TiO_2 and the anchoring ability of the dye molecules to the surface of the TiO_2 crystallites. Ruthenium complexes are good sensitizers for the nanocell. Carboxylate ligands anchor the dye molecules to the TiO_2 surface and promote electron injection from the photoexcited level to the conduction band of TiO_2 . The search for alternative sensitizers is essential for the further development of the nanocell and other dye-sensitized molecular electronic devices. Hence as part of this study attempts were made to search for relatively inexpensive organic dyes isolated from plants which are stable toward photodegradation. Brazilin dye from *Caesalpinia sappan* and Munjistin from *Rubia cordifolia* were extracted and purified and I-V characteristics

of the cell using these dyes were studied and compared to the cells made, using the standard ruthenium bipyridyl dye. The fill factor of the cells fabricated using these dyes were comparable to that of the cell fabricated using the standard ruthenium bipyridyl dye. But the short circuit current and the overall cell efficiency values were very low compared to those of the standard ruthenium bipyridyl dye. Moreover, cell fabricated using brazilin dye give higher short circuit current and the overall cell efficiency values compared to the cells fabricated using mungin dye.

In dye-sensitized photoelectrochemical cells made from nanoporous TiO_2 , the liquid electrolyte leads to several technological problems such as dye desorption, solvent evaporation and degradation, seal imperfection, hence less working life. One way to overcome this problem is to replace the liquid electrolyte by a polymer electrolyte membrane.

Studies were done to replace the liquid electrolyte with polyacrylonitrile (PAN) based plasticized polymer electrolyte. For that novel all solid state dye-sensitized photoelectrochemical solar cells of the type, FTO/ TiO_2 /dye/PAN, EC, PC, $\text{Pr}_4\text{N}^+\text{I}^-$, $\text{I}_2/\text{Pt}/\text{FTO}$ were fabricated and characterized using current-voltage characteristics and action spectra. Liquid electrolyte generally used for such solar cells has been successfully replaced by a quasi solid electrolyte comprised of polyacrylonitrile (PAN) with ethylene carbonate (EC) and propylene carbonate (PC) as plasticizers and $\text{Pr}_4\text{N}^+\text{I}^-$ redox couple without a significant loss of quantum efficiency. For the polymer electrolyte, the optimum conductivity of $2.95 \times 10^{-3} \text{ S cm}^{-1}$ was obtained for the electrolyte composition PAN: EC: PC = 15:35:50 (weight %). The short circuit current and the open circuit voltage obtained for an incident light intensity of 600 W m^{-2} were 3.726 mA/cm^2 and 693 mV respectively. This corresponds to an overall efficiency of 2.993%. From the action spectrum, IPCE value of 32% was obtained for incident light of wavelength 480 nm.

Attempts were also made with a mixture of ruthenium bipyridyl dye and ruthenium terpyridyl dye (Black dye) to optimise the PEC cell. The short circuit current and the overall efficiency of the cell increased when the dye mixture was used. The short circuit current and the open circuit voltage obtained for an incident light intensity of 600 W m^{-2} for the cell with the mixture of dyes were 4.06 mA/cm^2 , and 697 mV , respectively, for the PAN polymer electrolyte. This corresponds to an overall efficiency of 3.5%. From the action spectrum, the maximum IPCE value of 44% was obtained for incident light of wavelength 540 nm. When Black dye was used alone, the short circuit current and the open circuit voltage were 3.13 mA/cm^2 and 693 mV , respectively, for an incident light intensity of 600 W m^{-2} . This corresponds to an overall efficiency of 2.5%. From the action spectrum, the maximum IPCE value of 29% was obtained for incident light of wavelength 550 nm.

2.51

Electrochemical, Gas Chromatographic and Spectroscopic Methods for Investigation of the Fate of some Commonly used Pesticides in Sri Lanka.

Rodrigo, Udaya Indike

115p.

M.Phil. Degree, 2004.

Location No. 383

Abstract

Pollution of our environment due to heavy use of pesticides is of significant concern. Therefore, electrochemical, gas chromatographic and spectroscopic methods were used to investigate the fate of some commonly used pesticides in Sri Lanka. Among these analytical methods, electrochemical methods are generally inexpensive and easy to perform although

some skills are necessary. Consequently, electroanalytical methods have been attractive in recent years for quantitative and qualitative analysis and for mechanistic studies due to their unique advantages over traditional methods.

Propanil is a common and widely applicable herbicide that is extensively used in Sri Lanka on rice and potatoes. Gas chromatography and colorimetry are able to quantitatively determine its presence at 10^{-3} mol dm⁻³ concentration levels in soil, plant and water. Residual analysis of propanil in the form of its principal degraded product, 3,4-dichloroaniline has been successfully conducted using gas chromatography with the electron capture detector.

Propanil is fairly stable in mixed water/ ethanol medium between pH = 4 and pH = 7 for a period of ten weeks. However, in strong acid medium (pH = 1), it undergoes slow degradation of pseudo first order with an apparent rate constant of 9.2×10^{-8} s⁻¹ while in strong basic medium (pH = 13), its degradation is very fast. Adsorption of propanil onto glassy carbon surfaces is pH dependent and is irreversible in basic medium. Fresh solutions of 3,4-dichloroaniline mimic the behaviour of propanil after degradation.

Comparison of the electrochemical behaviour of propanil and that of fresh solutions of 3,4-dichloroaniline prepared at different time periods and the variation of the voltammetric features of these two analytes at different pHs suggest that the principal degraded product of propanil is 3,4-dichloroaniline. Although this degradation process is very rapid at pH = 13, it would probably undergo slow degradation under environmental conditions. Appearance of new peaks in gas Chromatographic and spectroscopic analysis confirmed the degradation of propanil in the environmental and laboratory prepared samples.

Copper oxychloride is a commonly used protective fungicide used to control Anthracnose and Cercospora leaf spot on vegetables, chilies, tobacco and cloves: coffee rust: late blight and early blight on tomato and potatoes: blister blights on tea. It is available with the trade name of Recop, Helmoxy, Cobox, Cuprative and Fernacot. Electroanalytical methods provide an alternative approach for the determination of copper oxychloride in environmental samples as they are often sensitive and selective with relatively lower cost instrumentation.

Cyclic voltammetric studies of the Cobox fungicide (main constituent is copper oxychloride) showed two oxidation and two reduction peaks at 0.29V, +0.02 V - 0.12 V and -0.38 V respectively at bare glassy carbon (GC) electrodes. These scan rate dependence of the peak current of the Cu(II)/Cu(I) couple suggests that the transfer of Cu(II) species toward the electrode surfaces is mainly due to diffusion. Further, amperometric experiments indicate that optimum potential of operation is -0.15 V vs. SCE. Amperometric calibration curves constructed at this potential produced a linear dynamic range from 5.0×10^{-5} mol dm⁻³ to 1.0×10^{-4} mol dm⁻³.

Phosphate derivatives constitute an important class of pesticides. Among those acephate, chlopyrifos and glyphosate are the most common pesticides in Sri Lanka. Although organophosphates are subjected to a transformation in soil, with a half-life of over two months, persistence of its degraded products could be found even after three months. As a result, such degradation products may be distributed in the natural water and other natural resources. Therefore, the detection and characterization of such compounds are of environmental interest. As these pesticides are not active at bare electrodes, a typical situation for many commonly used pesticides, chemical modification of bare surfaces was conducted, Chemically modified electrodes often find applications where a substance of interest is not active is not active at bare surfaces. Electrochemical techniques give a characteristic voltammogram for a $5.0 \mu\text{mol dm}^{-3}$ glyphosate solution and an amperogram for a $0.175 \text{ mol dm}^{-3}$ stock solution indicating that the method serves as a versatile tool for the

detection of this compound at low concentrations.

During this research, attempts were also made to identify and characterize organophosphate pesticides in soil by using FT-IR and chromatographic techniques.

FT-IR spectra show significant variations in the bands in the OH-bending region and the OH-stretching region along with the Si-OH and Al-OH stretching modes, while the features appear in the chromatograms resemble the spectroscopic evidence except in the case of copper oxychloride.

Thus GC-FTIR techniques can be further developed for the identification and prediction of the degradation patterns of pesticides in soil in combination with other techniques.

2.52

Electrochemical Studies of Electronically Conducting Polymers and their Possible Applications.

Lankeswara, Lankeswarage Palitha Perakum

128p.

M.Phil Degree, 1997.

Location No. 26

Abstract

Electrochemical synthesis, characterisation and electrochromic properties of polyaniline and some of its derivatives will be discussed in this thesis. In addition, the applications of polyaniline in electrocatalysis and liquid crystal display devices will also be described.

Aniline was polymerized to yield polyaniline by potentiostatic and potential cycling methods. Potentiostatic polymerization required at least +0.06 V with respect to a Saturated Calomel Electrode (SCE) and in the latter case the potential was cycled between -0.10 V and +0.80 V with respect to the SCE. Polyaniline films were prepared from solutions having pH value greater than 3 were insulators, but those prepared in strong acidic media (pH<3) had potential dependent conductivity. These films can be switched reversibly from a conducting state to a non-conducting state by cycling the potential within the range of solvent limits. The background electrolyte had a decisive effect on the conductivity of the material. The change in applied potential of polyaniline resulted in the change in colour as is well known. i.e. polyaniline exhibits electrochromic properties. The colour of the polymer depends on various factors such as potential, pH, type of the background electrolyte etc. Among the various polymers studied, N-alkyl derivatives of polyaniline exhibited intense colours and fast switching times.

Small organic molecules such as methanol and ethanol are adsorbed on to platinum (Pt) electrodes and oxidation products of these molecules usually poison the electrode surface leading to complete suppression of electrode activity. It has been found that Pt electrodes modified by the deposition of a thin layer of polyaniline are resistant to such deactivation, and can be used repeatedly as working electrodes.

Alignment of nematic (7CB) and ferroelectric (CS1013) liquid crystals on rubbed polyaniline films has also been investigated. It was found that polyaniline serves as an excellent template for the alignment of both nematic and ferroelectric liquid crystal molecules. Polyaniline also acts as a conducting surface under the conditions of preparation.

2.53

Equilibrium Studies on Toxic Metal Ion-Mixed Ligand Systems under Physiological Conditions.

Chandrathilaka, A.M.D.S.

142p.

M.Phil. Degree, 2012.

Location No. 1239

Abstract

The research on toxic metal complexes has become a worldwide interest and they have been studied extensively related to various aspects such as, investigation of effective toxic metal chelators for chelation therapy, removal of toxic metals from water reservoirs, and biological models to understand metalloenzyme activity, etc. However, the studies done on interactions between toxic metals and mixed ligand systems are very rare, especially with ligands entering to our body more frequently. Thus, the main focus of the study was on the investigation of the interactions between toxic metals and biologically and medicinally important ligands in mixed ligand complexes to find out the bioavailability of ligands and to discover less harmful ligand combinations for chelation therapy. The current study explored the equilibrium study of single and mixed ligand systems of four toxic metal ions; Pb^{2+} , Cd^{2+} , Al^{3+} and Cu^{2+} with ten ligands ascorbic acid, paracetamol, salicylic acid, citric acid, uracil, aspirin, vitamin B₁, vitamin B₃, caffeine and disodium salt of ethylenediaminetetraacetic acid (Na_2EDTA), using pH titrations and UV - Visible absorption spectra recorded under the physiological conditions of 37.0 ± 0.2 °C temperature and 0.15 mol dm^{-3} ionic strength. Mixed complex formation was further confirmed theoretically with composite curves plotted for mixed complex systems. Stability of the ternary systems over the corresponding binary systems was compared calculating $\Delta \log K$ values.

The analysis revealed that all four metal ions have significant interactions with each ligand alone and with ligand mixtures. Though, Na_2EDTA was the strongest ligand bound to four metal ions in binary complex formation, there were several mixed complexes for each metal, which were more stable having several hundred times larger stability constants than M-EDTA complexes. Specially, mixed complexes consisting of (Na_2EDTA)(Vitamin B₁), (Na_2EDTA)(Ascorbic acid) and (Na_2EDTA)(Citric acid) ligand combinations had remarkably high stability with four metals. As most mixed ligand complexes had logarithmic values of stability constants greater than 6, they were all good for chelation therapy with fewer side effects, especially ligand pairs without EDTA. Mixed complex formation ability of toxic metals with ligands considered was in the order of $Pb > Cd > Al > Cu$. Further, the work revealed that, the bioavailability of paracetamol, ascorbic acid and vitamin B₁ will be significantly lower for a metal intoxicated person.

2.54

High-Speed Counter-Current Chromatographic Separation and Antibacterial Activity of Proanthocyanidins from Tea Leaves.

Hettihewa, S.K.

102p.

M. Phil. Degree, 2009.

Location No. 920

Abstract

The thesis consists of two parts, Part I and Part II. Part I deals with the extraction, purification, and separation of proanthocyanidins from blister blight infected tea flush caused by

Exobacidium vexans using Sephadex LH-20 and High Speed Counter Current Chromatography (HSCCC) as an increase of galloylated proanthocyanidins after the infection has been reported.

The freeze dried acetone extract of the leaves from tea cultivar TRI 2025 was partially purified on Sephadex LH-20. Two methanolic extract fractions (F_1 , F_2) and two acetone extract fractions (F_3 , F_4) were obtained. F_4 fraction was subjected to further separation using HSCCC as it was the most active fraction, which had the highest yield of proanthocyanidins.

HSCCC resulted in five fractions PA_1 - PA_5 with the solvent system hexane: ethyl acetate: methanol: water (1:5:1:5). Thin layer chromatography (TLC) was performed on these fractions, developed with the solvent system, ethyl acetate: water: formic acid (90: 05: 05) and visualized under dimethylaminocinnamaldehyde (DMACA) spray reagent. Retention factor values (R_f) of PA_1 - PA_5 were recorded as 0.26, 0.35, 0.51, 0.69, 0.76 and 0.79.

The purity of each proanthocyanidin fraction was evaluated by high-performance liquid chromatography (HPLC). Only PA_1 - PA_3 and PA_5 were homogeneous fractions. Comparison of 1H NMR spectral data of the proanthocyanidins isolated with those previously reported indicated highly complicated structures. ESI-MS suggested that PA_1 could be a trimeric digallate or a tetrameric flavan-3-ol. ESI-MS suggested that PA_2 may be a trimeric or dimeric proanthocyanidin while PA_3 was a dimeric digallate proanthocyanidins. These results indicate that galloylated proanthocyanidins are present in blister blight infected tea leaves.

Part II deals with the screening of the proanthocyanidins isolated from blister blight infected tea flush against selected human pathogens as i) the antibacterial activity of the catechins free proanthocyanidins from tea flush against selected human pathogens has not yet been reported and ii) the antibacterial properties would be increased due to the galloylation of the compounds has also been reported.

Methanolic fractions (F_1 and F_2) and acetone fractions (F_3 and F_4) obtained from Sephadex LH-20 column were screened against NCTC and ATCC reference strains of *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*. Susceptibility tests were performed by the Muller Hinton Agar (MHA) well diffusion method and minimum inhibitory concentrations (MIC) of homogeneous proanthocyanidin fractions PA_1 - PA_3 were carried out by an agar double dilution method.

Pseudomonas aeruginosa and *Escherichia coli* were inhibited by neither of fractions F_1 and F_4 at any of the concentrations between 1-10 mg/ml. Acetone extract fractions F_3 and F_4 showed antibacterial activity against *Staphylococcus aureus* while F_4 demonstrated promising antibacterial activity even at lower concentrations. MICs of the purified fractions of poanthocyanidins were found to vary between 512 ppm-1024 ppm. 13 out of 25 *Staphylococcus aureus* strains showed that MIC value of PA_1 was at 1024 ppm while 19 out of 25 *Staphylococcus aureus* strains showed that MIC value of PA_3 was at 512 ppm. It can be concluded that those results suggest strong antibacterial activity of galloylated proanthocyanidins from tea leaves.

2.55

Investigation of Environmental Fate of Some Selected Pesticides Using Electrochemical Methods.

Ekanayake, C.B.

83p.

M. Phil. Degree, 2008.

Location No. 790

Abstract

Extensive use of pesticides has significantly affected the ecosystems. Degradation of pesticides, however, may prevent the accumulation or contamination of pesticides. Their impact on human health and the environment largely depends on the quantity applied, the toxicological and ecotoxicological properties, and the persistence in the environment, especially in soil and water. Consequently, accurate determination of the levels of pesticides, and their fate in the environment have become major issues. It is very necessary to monitor the fate of pesticides in the environment. These challenges can be successfully overcome by the use of low cost and environmentally friendly, quantitative analytical methods.

In this context, this project involves the use of electroanalytical methods, in particular, amperometric methods, for some commonly used pesticides, such as propanil, thiram and glyphosate. If the pesticide is not active at bare electrodes, they are modified with suitable catalysts. Analytical characteristics required for quantification such as sensitivity, detection limits and linear dynamic range are determined for each pesticide.

In order to determine the fate of different pesticides in the Sri Lankan environment, different environmental conditions are stimulated in the laboratory, and the levels of pesticides and their residues and degraded products are analyzed using electroanalytical methods. However, spectroscopic methods are used whenever necessary. After addressing these issues under laboratory conditions, pesticides are introduced on plants grown under controlled conditions (i.e., in a soil bed prepared in a poly-tunnel). Different environmental conditions are simulated during the introduction of different pesticides. Quantitative determination of active ingredients and their degraded products in leachates of soil beds collected at different time intervals are used to investigate the fate of pesticides in the environment.

The herbicide Paraquat (1,1-dimethyl 1-4,4'- bipyridinium dichloride) has been widely used in agriculture as a nonsystemic contact herbicide for many crops. In this study, systematic, quantitative laboratory scale experiments have been carried out to obtain preliminary data of fate studies of Paraquat using three different soil types used on rice cultivation in Sri Lanka. Furthermore, this study has been extended to simulate rice field environment maintained in a poly tunnel.

A desorption model for Paraquat under dynamic conditions is formulated based on three experimental variables: time of sampling, concentration of adsorbed Paraquat on soil and flow rate. These variables are related to important aspects of kinetics, equilibrium and diffusion, respectively. Dynamic conditions are specially selected in this investigation to simulate real environmental conditions where desorption of paraquat followed by leaching through soil occurs, provided sufficiently long time periods despite the high partition coefficient of Paraquat.

3,4-dichloroaniline (3,4-DCA), the major degraded product of the weedicide, propanil is detected at stearic acid-modified electrodes, using steady-state amperometry, which provides a satisfactory minimum detection limit. This methodology is successfully extended for the detection of 3,4-DCA at ppm levels in water of a model rice bed after application of the recommended dose propanil.

Interaction of glyphosate with platinum surfaces is also investigated. Cyclic voltammetric experiments of polycrystalline Pt electrodes in glyphosate solutions indicate the appearance of reduction and oxidation peaks. Sequential additions of glyphosate initiates a gradual decrease in the current of the peak associated with the reduction of surface platinum oxide, with concomitant appearance of a new peak at a more positive potential. The latter peak, associated with the reduction of a Pt(IV)-glyphosate complex, which occurs at a less negative

potential due to electron donation groups of glyphosate. Further, a new concentration-dependent, diffusion-controlled redox couple centered beyond the H-adsorption/ desorption region appears during cyclic voltammetric scans. Steady-state amperometric experiments of glyphosate result in a linear calibration curve with favourable analytical characteristics.

Detection of thiram is performed using both amperometric and spectroscopic methods. The spectroscopic method is extended for the determination of the partition coefficient (K_D) of thiram between CHCl_3 and H_2O phases, which is used to determine the apparent partition coefficient (K_D') of thiram between sieved soil and water through a solvent extraction step. The K_D' values determined for an initial thiram concentration range of 3.00 ppm to 10.00 ppm. show a decreasing trend, which levels off at high concentrations, indicating the strong irreversible adsorption behaviour of thiram on soil at low concentrations.

2.56

Investigation of Green Catalytic Properties of Clay Nanocomposites.

Wijeratne, S.

176p.

M.Phil. Degree, 2010.

Location No. 1215

Abstract

Clays are layered aluminosilicates. Some of these clay minerals have negatively charged layers due to isomorphous substitution of Al and Si by lower-valent cations. These layer charges are balanced by the uptake of cations into the interlayer spaces. Such cations are easily exchangeable and thereby various cation-exchanged clays can be prepared. Of these, Fe^{3+} , Al^{3+} -exchanged clays show high Brønsted acidity and Cu^{2+} , Ni^{2+} -exchanged clays show high Lewis acidity. In this study, such modified clays were used as acid catalysts to effect organic reactions, particularly, carbon-carbon, carbon-oxygen and carbon-nitrogen bond formations.

A range of cation-exchanged montmorillonite clays (M^{n+} -MMT, $\text{M}^{n+} = \text{H}^+$, ZrO^{2+} , Al^{3+} , Fe^{3+} , Cr^{3+} , Ce^{3+} , Ce^{4+} , Cu^{2+} , Zn^{2+} , Co^{2+} , Ni^{2+} and Cd^{2+}) were prepared and characterized by X-ray diffraction (XRD), X-ray Fluorescence (XRF), Fourier-Transform Infrared (FTIR), Thermal Gravimetry (TG), and Differential Scanning Calorimetric (DSC) methods. Diffusion Reflectance Infrared (DRIFT) analysis of pyridine-adsorbed M^{n+} -MMT showed that the clays dried at room temperature have Brønsted acidity sites (M^{n+} -MMT, $\text{M}^{n+} = \text{H}^+$, ZrO^{2+} , Al^{3+} , Fe^{3+} , Cr^{3+} , Ce^{3+} and Ce^{4+}) and some Lewis acidity sites (M^{n+} -MMT, $\text{M}^{n+} = \text{Cu}^{2+}$, Zn^{2+} , Co^{2+} , Ni^{2+} and Cd^{2+}).

Friedel-Crafts alkylation of benzene with 2-propanol in the presence of M^{n+} -MMT ($\text{M}^{n+} = \text{Al}^{3+}$, Fe^{3+} or H^+) and *para*-toluenesulfonic acid or 10-camphorsulfonic acid gave cumene, the precursor for the industrial preparation of phenol, in 60-65% yield under optimised conditions. The removal of 2-propanol from the reaction mixture as azeotropes with benzene and water restricted further enhancement of the yield of cumene. Al^{3+} -MMT-catalysed isopropylation of toluene with 2-propanol gave *para*-cymene (1-isopropyl-4-methyl benzene) as the only product in 40% yield regioselectively, demonstrating the shape selectivity of the interlamellar space of Al^{3+} -MMT. However, under similar conditions anisole and bromobenzene gave 1: 1 mixtures of *ortho* and *para* isopropylated derivatives in 50 and 32% yields, respectively.

As an example of carbon-oxygen bond formation in an environmentally friendly manner, the reaction of salicylic acid and acetic anhydride both at room temperature and at 50-60°C using M^{n+} -MMT ($\text{M}^{n+} = \text{Cu}^{2+}$, Fe^{3+} , Al^{3+} or H^+) gave aspirin (acetylsalicylic acid) in 70-75% yield. Furthermore, Cu^{2+} -MMT catalyzed the reaction of a range of alcohols with acetic anhydride at room temperature to give high yields (>90%) of the corresponding esters in reaction times

varying from 0.25 to 8 h. With ZrO^{2+} -MMT, carboxylic acids also gave the corresponding esters in good yields (70-75%) at room temperature.

The formation of carbon-nitrogen bonds catalyzed by M^{n+} -MMT, was exemplified by the reaction of phenylacetic acid and aromatic amines to give the corresponding amides in high yield (85-94%). The ZrO^{2+} -MMT catalyzed the reaction of acetic anhydride and aromatic amines to give the corresponding amides in almost quantitative yield (>90%). Employing similar reaction conditions, acetaminophen, an analgesic and an antipyretic, was prepared from acetic anhydride and 4-aminophenol in 85% yield.

The efficiency of the M^{n+} -MMT catalyst in the above organic reactions, was unchanged even after recycling several times. Further, many of the above reactions required no organic solvent and the other reactions required only a minimum amount of solvent.

Our results indicate that clay minerals of the montmorillonite type modified by cation-exchange make up a group of green catalysts, which can be used in a range of organic reactions involved in the synthesis of commercially important compounds.

2.57

Investigation of the Extent of Acid Precipitation in Sri Lanka.

Nissanka, N.M.J.

70p.

M.Phil. Degree, 2005.

Location No. 532

Abstract

The research describes here reports on the occurrence of acid rain in Sri Lanka and to correlate acidic precipitation to air pollution from both local as well as transboundary sources. In this study, rainwater was collected from several meteorological stations throughout Sri Lanka, except north and the east representing different pollution level areas such as rural, industrial and urban areas. A locally designed rainwater collector was used to collect rainwater. Collected samples were brought to the laboratory at University of Peradeniya after preservation and subjected to chemical analysis. The parameters measured were; pH, conductivity, sulphate, nitrate, ammonium, chloride, potassium, sodium, magnesium and calcium.

During the initial phase of the project, classical methods were employed for the analysis. Nitrate was analyzed by the azo dye method using sulphanilamide and N - (1-naphthyl)ethylene diamine hydrochloride after cadmium reduction. Sulphate was determined turbidimetrically using barium sulphate. Ammonium was determined by indophenols blue method. Other parameters such as sodium, magnesium, calcium and potassium were analyzed using flame photometry and atomic absorption methods. Later ion-chromatograph was used for the analysis of rainwater samples.

It was found that acid rain occurs in Sri Lanka, specially in Colombo and in the hill country. The percentage of samples having acid rain was found to increase during the period of study. There was also acid rain in the north central province during the North East monsoon period of October to February indicating transboundary pollution in this area. Hill country and the Sabaragamuwa province also had acid rain but less than Colombo and North Central province. The main contributing factors for acid rain are automobile exhaust and diesel power stations in Sri Lanka. Because the acid gases can get transported over long distance, pollutants from the Indian subcontinent may also be responsible for acid rain in Sri Lanka, specially in the North Central province.

2.58

Isolation of Endophytic Fungi of Sea Weeds from the Coastal Areas of Sri Lanka: A Study on their Chemistry and Biological Activities.

Premaratne, S.R.

135p.

M. Phil. Degree, 2009.

Location No. 918

Abstract

Endophytic fungi are capable of colonizing internal tissues without causing apparent harm to their host plants. The biological associations they develop between their host plants lead to produce diverse groups of molecules with interesting biological activities. Thus, they arouse the interest of scientists as a novel source of biologically active metabolites. Many research findings indicate that the marine environment in particular has provided a number of new, biologically active compounds resulted from different building blocks and enzymatic reactions unique to the terrestrial environment. Overall rationale in the present study is an attempt to isolate and discover bioactive compounds from novel resources like endophytic microorganisms from seaweeds, as this is an unexplored area of biochemical diversity especially in Sri Lanka.

Seaweed samples which consisted of green algae (n = 24), brown algae (n = 19) and red algae (n = 29) were collected from four different locations in Sri Lanka (Arugam Bay, Tangalle, Kirinda and Kalutara) and were investigated. The specimens were preserved and kept in the Natural Products Laboratory at the Institute of Fundamental Studies, Kandy. All the species except coralline forms i.e. *Amphiroa* spp., *Jania* spp. and *Cheilosporum* spp. were tested for the presence of endophytic fungi and only 17 seaweeds were detected with endophytic fungi.

To isolate bioactive metabolites, four fungal strains isolated from *Sargassum wightii* Greville (*Aspergillus fonsaceus*), *Codium geppiporum*, O.C. Schmidt (*Botrytis* sp.), *Halimeda discoidea* Decaisne (*Aspergillus niger*) and *Udotea flabellum* (*Aspergillus* sp.) were specifically selected. To check the feasibility studies of the isolation of endophytic fungi under the laboratory conditions, a preliminary experiment was carried out by using a terrestrial endophytic fungus, *Aspergillus niger* isolated from *Murraya koenigii*.

Subjected upon repeated column chromatography using various techniques, four compounds, Adenine, Uridine, Phenylacetic acid and Aurasperone A were isolated from *Aspergillus fonsaceus* isolated from *S. wightii* and their structures were elucidated using spectroscopic methods. Genistein and (-)-Prolylleucyldiketopiperazine were isolated from the *Botrytis* spp. isolated from *C. geppiporum*.

The crude extracts of fungal strains isolated from *S. wightii*, *C. geppiporum*, *H. discoidea* and *U. flabellum* and all the pure compounds except Genistein were tested for biological activity. The isolated quantity Genistein (1.2 mg) was inadequate for biological activity testing. When screened for antioxidant capacities using DPPH (2,2'-diphenyl-1-picrylhydrazyl) radical scavenging assay, none of the crude extracts showed radical scavenging activities. However, Uridine (EC₅₀ 563.00 ppm), Phenylacetic acid (EC₅₀ 656.19 ppm) and Aurasperone A (EC₅₀ 593.55 ppm) had comparatively higher antioxidant activities compared to the positive control, Vitamin C (EC₅₀ 80.2 ppm).

The results of the allelopathic activity study revealed that the crude extract of *Aspergillus niger* isolated from *H. discoidea*, Adenine and Phenylacetic acid showed lower germination percentage values compared to the positive control, Tween 20 on lettuce seed germination. Thus they act as allelopathic positive treatment while crude extract of *Botrytis* sp. and (-)-

Prolylleucyldiketopiperazine act as allelopathic negative treatments with comparable percentage seed germination and seed vigor values of the positive control. They have shown higher average root to shoot ratios on lettuce seeds, higher weight of seedlings, higher values for differences in chlorophyll content.

Cytotoxicity activity of crude extracts and pure compounds were tested using Brine shrimp (*Artemia salina*) micro-well cytotoxicity assay and only crude extract of *Botrytis sp.* showed high toxicity (LC_{50} 7.3 ± 0.35 ppm) when compared to positive control, Quinoline (LC_{50} 160 ± 1.4 ppm).

When subjected to oxidative burst study for analysis of immunomodulators, Aurasperone A showed that it has a potential suppressive effect on Polymorpho nuclear cells (PMNs) assay. Aurasperone A also interestingly showed a significantly stronger antiproliferative effect when subjected to T-cell proliferation inhibition assay. T-cell proliferation is an important *in vitro* parameter of *in vivo* immune function hence Aurasperone A may be useful in immunomodulating therapies.

2.59

Low-Cost and Environmentally-Friendly Methodologies for Treatment of Water and Wastewater.

Perera, Sujeewa

181p.

M.Phil. Degree, 2001.

Location No. 176

Abstract

The increase in population and new developments in industrial technology are constantly intensifying environmental pollution problems. Environmental scientists are forever seeking more economical methods of preserving the environment. Consequently, research needs to be continuously conducted to find answers to pollution problems, in particular pollution due to metal ions, coloured substances and anions.

Dolomite, Feldspar, Laetrile, aquatic plants such as *Ipomea aquatica* and *Pisitia stratiotes* and aqueous extracts of *Caesalpinia bonduc* seeds exhibit excellent removal ability to decrease the magnitude of many pollution parameters. The possibility of using natural substances in this regard introduces numerous advantages over conventional chemical methods. Low maintenance cost, low toxicity and small amount of sludge are some of them.

Among many natural substances investigated dolomite offers the highest efficiency for phosphate removal. Optimization of experimental parameters such as solution pH, flow rate, column length, initial concentration, particle size and adsorption capacity reveals that the present removal by dolomite is high for laboratory prepared solutions and more importantly for polluted water and industrial effluents. X-ray diffraction and adsorption isotherm studies provide mechanistic information of the removal process.

Feldspar, a readily available mineral, is a good adsorbent for sulfate, phosphate and coloured substances under optimized experimental conditions. The maximum efficiency for the removal of sulfate, phosphate and coloured substances is about 42%, 52% and 73% respectively. Studies on X-ray diffraction patterns, adsorption isotherms, desorption patterns and recovery methods suggest that the removal occurs via ion exchange in conjunction with surface adsorption.

Laterite, another readily available mineral is also a good alternative for the removal of heavy metals, coloured substances and some anions from polluted water and waste water. The efficiency of the removal process strongly depends on experimental parameters such as solution pH, amount of absorbent, particle size of laetrile, etc. More importantly, the laetrile based laboratory scale filter is useful to obtain high quality drinking water.

Another attractive treatment methodology used in the area of waste water treatment is the use of aquatic plants, *Ipomea aquatica* and *Pistia stratiotes*. These plants are able to remove ions and nutrients from polluted water such as Mg^{2+} , Ca^{2+} , Mn^{2+} , Fe^{2+} , Co^{2+} , Zn^{2+} , Cu^{2+} , Pb^{2+} , PO_4^{3-} and NO_3^- showing the bioaccumulation of such species in the selected plants. During the treatment, decrease in electrical conductivity, pH and chemical oxygen demand is also observed.

The research on the use of aqueous extracts of shell-removed *Caesalpinia bonduie* seeds, develops another low cost procedure for effective removal of turbidity and coloured substances from laboratory prepared solutions and industrial effluents. According to respective measurements, significant reduction in turbidity and colour of effluents collected from many industries is observed during treatment.

2.60

Low Cost Methods for Colour and Metal Ion Removal from Industrial Effluents and Polluted Water.

Keerthiratne, K.W.M.S.

128p.

M.Phil. Degree, 2005.

Location No. 535

Abstract

Industrial development, urbanisation and uncontrolled agricultural practices have resulted in severe environmental problems in Sri Lanka. Many rivers, water streams and lakes in the country are already polluted with organic and inorganic pollutants. Thus, it is of great importance to monitor levels of pollution, and to introduce preventive measures by treating polluted waters using suitable methods. Investigation of the potential ability of economical and readily available naturally occurring substances such as Brick-clay, ball-clay, Kaolin, dolomite and saw-dust for the treatment of polluted water is of great significance for a developing country.

Colour removal of industrial effluents by brick-clay, sawdust, dolomite and ball-clay packed columns has been studied and is found to be efficient as well as economical. Cations of Ca, Mg, Cr, Mn, Fe, Co, Cu, Zn, Cd and Pb can also be effectively removed using brick-clay, Kaolin, sawdust and ball-clay packed columns. The efficiency of removal has been further enhanced by optimization of experimental parameters such as particle size, length of packing and flow rate. Systematic investigation of standard solutions and mixtures of these metals within the working concentration range shows that brick-clay is highly efficient in removing Co, Cd and Pb (>90%) indicating the preferential adsorption of these ions over the other cations. Although about 90% removal is achieved for Cr, Mn, Fe, Cu and Zn, main group cations (Ca and Mg) are removed with an efficiency of less than 50%.

The brick-clay packed column has a good potential as an adsorbent of lead from polluted water. It is a dangerous and hazardous chemical, which causes several abnormal diseases such as cancer, abortions, low birth etc. While the treatment method depends on physico-chemical forms of removal, effectiveness of the removal process depends on experimental parameters

of the treatment procedure. Mechanistic studies of the process under optimized conditions are thus desirable for a better understanding.

The pH of lead ion solution after treatment always lies in the vicinity of the neutral value regardless of the initial pH. The relationship between the amount of lead absorbed on to brick particles and the bulk concentration of the lead ion solution between pH 4 and pH 6 shows the applicability of the Freundlich isotherm for most cases, while the Langmuir model seems to fit in certain cases. A fraction of lead removed may be available as exchangeable ions, because concentrations of Ca^{+2} , Mg^{2+} and K^{+} in the eluent are very low. Such columns exhibit a reasonably high capacity toward the lead removal process.

This study shows that brick-clay is appropriate for the removal of colour and metal ions from polluted water. Further, the proposed method is economical and environmental friendly. Such methodology would offer unique advantages in the treatment of polluted water in developing countries.

2.61

Mechanistic Investigation of Interaction of Chromium Species and Thermally-Treated Brick Clay.

Bandaranayake, A.M. Anushka

102p.

M.Phil. Degree, 2012.

Location No. 1198

Abstract

Brick clay, being a natural substance having a variable composition, reflects many difficulties in both qualitative and quantitative analysis. Comparison of the d-values of XRD patterns with the standard data base suggests that unfired brick clay under investigation consist of many clay minerals, such as vermiculite, kaolinite, hornblend, magnetite and quartz. XRF is useful in obtaining the composition of metallic elements, while FTIR provides information on functional groups. In addition to the main elements present in brick clay, such as Fe, Al and Si, trace elements, such as Mn and Ti, are present according to the XRF patterns. Brick clay particles are negatively charged according to surface titrations conducted with brick clay suspensions.

The extent of removal of Cr(VI) species from aqueous solution by brick particles highly depends on the temperature of firing of brick clay, owing to many physical and chemical changes that occur during firing. The highest removal of Cr(VI) species by brick clay is obtained with clay fired at 200°C, and the amount of suspended matter is low with brick clay fired at temperatures ranging from 200°C to 600 °C based on turbidity measurements. Optimization of more experimental parameters, such as stirring time and settling time, leads to 60 % removal of Cr(VI) by brick particles fired at 200 °C in batch experiments, without pH control. Dynamic experiments conducted in packed columns also effectively removes Cr(VI). The extent of removal does not significantly depend on solution pH up to pH = 11 and on common interferences.

Fired brick clay, which bears a negative charge according to surface titration measurements, shows affinity towards Cr(VI) species despite the negative charge of $\text{Cr}_2\text{O}_7^{2-}$, the source of Cr(VI). The Cr(VI) - brick clay heterogeneous system, which shows the, strongest interaction with brick clay fired at 200°C, obeys both the Langmuir and the Freundlich adsorption isotherms with high regression coefficients, indicating strong adsorption capacity of fired brick clay on chromium species. Investigation on surface charge, constituents of brick clay, acid treatment of clay particles and the effect of firing temperature suggests that the reduction of

Cr(VI) to Cr(III) by reducing agents present in brick clay make a significant contribution for adsorption of chromium species followed by subsequent removal. Many metal ions are released as a result of Cr(VI) - brick clay interaction according to X-ray fluorescence studies.

This study is on the investigation of the interaction of aluminium species with brick clay under different experimental and environmental conditions. The extent of leaching of aluminium from brick clay is found to depend on the medium pH, ionic strength of the medium, contact time and firing temperature of brick clay. It is conclusively demonstrated that burnt brick clay does not leach aluminium when it is exposed to a medium of high ionic strength. Further it is shown that, under optimized conditions, brick clay can be used for efficient sorption of aluminium ion from water, owing to its ion-exchange nature.

The interaction between Cr(VI), available as $\text{Cr}_2\text{O}_7^{2-}$, and brick clay particles fired at temperatures between 200°C and 600 °C follows pseudo second order kinetics, and the method of initial rates provides average rate of the interaction process. Kinetics modeling further suggests that the mass transfer of the interaction be mainly, controlled by time dependent intraparticle diffusion, and immobilization of Cr(VI) species within interlayer structure of the brick clay matrix and interparticle diffusion, both of which are time independent.

2.62

Metalloporphyrin Coated Electrodes as Sensors for Pesticides.

Malavipathirana, Sarath

89p.

M.Phil Degree, 2001.

Location No. 177

Abstract

Glassy carbon (GC) electrodes coated with 5, 10, 15, 20-tetraphenylporphyrinatoiron(III)chloride [Fe(III) TPPC1] shows the electrochemistry of the Fe(III)/Fe(II) couple in aqueous medium between the potentials of +0.25 V and -0.50 V vs. saturated calomel electrode (SCE). The reduction peak current of the Fe(III)/Fe(II) couple is significantly enhanced when small amounts of polar organo - halides, such as chloroacetic acid and endosulfan are introduced into the electrochemical cell. The peak shape and the peak location suggest that the reduction of such pesticides proceeds through a series of reactions that comprise an electrochemical reaction, then a chemical reaction followed by another electrochemical reaction (ECE mechanism), where the reduction product of Fe(III), i.e. Fe(II), forms an electroactive adduct with the pesticide, which then undergoes electrochemical reduction. The current generated during this electrochemical process is thus proportional to the bulk concentration of the respective pesticide, indicating the analytical utility of Fe(III) TPPC1 modified GC electrodes as sensors for the pesticides stated earlier. In the absence of Fe(III)TPPC1 coatings on the electrode, pesticides show sluggish electrode kinetics resulting in little or no activity. Electrocatalytic ability of Fe(III)TPPC1 towards organo-halide pesticides is thus demonstrated.

Although the analytical utility of Fe(III)TPPC1 coated electrodes is demonstrated during cyclic voltammetric experiments, sensitivity of detection is not high enough to apply such sensors for real applications. However, steady - state amperometry overcomes this limitation by decreasing the lower detection limit by at least an order of magnitude. Optimization of analytical parameters, such as solvent composition, potential of operation, type and concentration of electrolyte, method of coating, and concentration of the coating solution, is performed whenever possible, as this process is necessary to obtain an adequate response.

Under optimized conditions, the detection limit of chloroacetic acid is found to be 5×10^{-6} mol dm^{-3} based on the signal-to-noise ratio of three.

Electrochemical activity of copperoxychloride is monitored for comparative purposes between organochlorine pesticides and those containing inorganic chloride. Cyclic voltammetry of this analyte results in Cu(II)/Cu(I) and Cu(I)/Cu(0) processes at moderate potentials at the bare GC electrode, in both acidic and basic media, and consequently, chemical modification of the electrode is not necessary.

More importantly, the bare GC electrode produces a selective response for copperoxychloride in the presence of other common interferant species with the exception of Fe(III). Steady-state amperometry of this analyte at the bare electrode in 0.1 mol dm^{-3} HCl electrolyte medium, in which more pronounced response is given than in basic medium, results in a lower detection limit of 3×10^{-8} mol dm^{-3} under optimized conditions.

This is a significant finding of this area of research, as such low levels may not be accessible by other analytical methods available at present.

2.63

Modeling Interactions of Pyrite and Monochlorophenols.

Makehekwala, Madhubhashini

90p.

M.Phil. Degree, 2013.

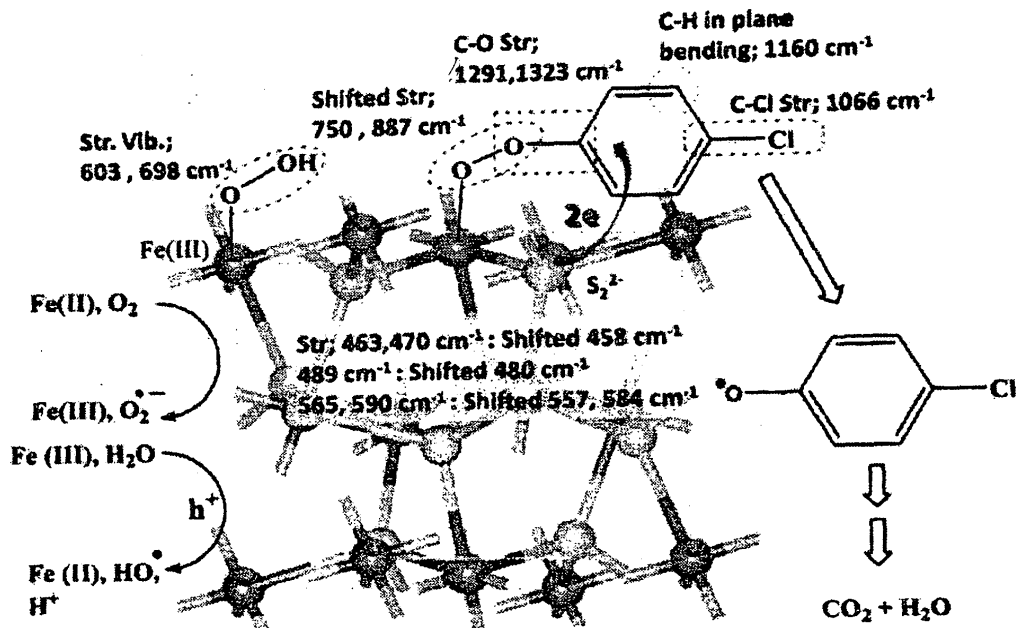
Location No. 1356

Abstract

The overall aims of this research were to examine the ability of pyrite in the destruction of selected chloro-phenols found in drinking water and the interfacial properties of pyrite-water suspensions. The selected monochlorophenol (MCP) isomers were 2-chlorophenol (2-CP), 3-chlorophenol (3-CP), and 4-chlorophenol (4-CP). The adsorption density values on pyrite increased in the order, $2\text{-CP} < 3\text{-CP} < 4\text{-CP}$ at 298 K. The MCP adsorption data were always in accordance with the Langmuir model. According to the calculated thermodynamic parameters, in most cases, $\Delta H^\ddagger < -T \Delta S^\ddagger$, indicating that the adsorption step was largely entropy-controlled. The optimal pH of the MCP adsorption onto pyrite was ranged pH between 5 and 6.

The mechanism of adsorption of 4-CP onto pyrite was identified by IR spectroscopic data. The pyrite oxidation had occurred both at $\equiv\text{Fe(II)}$ and $\equiv\text{S}_2$ sites forming FeOOH and $\text{S}_2\text{O}_3^{2-}$ on pyrite surface. The $\equiv\text{Fe(III)}$ at sulfur-deficient defect sites can split adsorbed water molecules into hydroxyl radicals ($\text{OH}^\bullet_{\text{ads}}$), $\equiv\text{Fe(II)}$ and surface bound H^+ . The spectroscopic evidence showed the formation of $\equiv\text{FeOOH}$ on pyrite surface by confirming the formation of $\text{OH}^\bullet_{\text{ads}}$ and H_2O_2 . The 4-chlorophenolate anionic intermediate was formed at the production of inner-sphere surface complexes with $\equiv\text{FeOOH}$ on pyrite surface. The $\equiv\text{SS-H}$ groups on pyrite produced weak physical bonding with 4-CP. The IR bands observed at 1170, 1203 and 1145 cm^{-1} evidenced for the presence of HSO_4^- and FeSO_4^0 species in the vicinity. The most dominant sulfur oxy-anions are SO_3^{2-} and HSO_4^- .

The mechanistic pathway of the adsorptive degradation of 4-CP on pyrite was postulated as:



2.64

Natural Dissolution Mechanisms of Serpentinite Soils from Sri Lanka: Leaching of Chromium, Nickel and Manganese to the Environment.

Rajapaksha, R.M.A.U.

78p.

M.Phil. Degree, 2012.

Location No. 1216

Abstract

Ultramafic rocks and their related soils are non-anthropogenic sources of metal contaminants. The toxic metal release from these soils into the surrounding areas and groundwater is an ecological, agricultural and human health concern. The main objective of this dissertation is to evaluate the releasing mechanisms and environmental conditions affecting the release of Ni, Mn and total Cr and the possibility of Cr(VI) formation from serpentinite soils in different ultramafic complexes in Sri Lanka by coupling interpretations garnered from chemical extractions and model experiments. Also, Ni and clay mineral surface interactions were also investigated using, batch sorption experiments along with computational modeling.

Sequential extraction experiments, utilized to identify 'elemental pools,' indicated that Mn is mainly associated with oxides/(oxy)hydroxides, whereas, Ni and Cr is bound in silicates and spinels. Both Ni and Mn demonstrate rapid release rates in water in Ussangoda soil (2.4 and 2.0 mol m⁻² s⁻¹, respectively) and release rates increase with increasing ionic strengths. Soils from Ussangoda, evaluated from 0.05 to 10 mM with organic (citric, acetic and oxalic) and inorganic (H₂SO₄, HNO₃ and HCl) acids, show that the maximum rate of Ni and Mn release occurs with oxalic acid (10 mM) at 7.11 and 3.56 mol m⁻² s⁻¹, respectively. Summarizing chemical extractions, Ni and Mn release rates increase in the order of HNO₃ ~ HCl acetic < H₂SO₄ < citric < oxalic acids and results indicate that both protons (H⁺) and ligands corroborate to accelerate metal release. Despite multiple phases capable of releasing Ni and Mn, the reaction kinetics demonstrate that antigorite (i.e., the silicate fraction) is responsible for a majority of the Ni and Mn release. Overall, our results support that serpentinite soils offer a highly labile and chemically modifiable source of Mn and Ni than Cr.

Since the serpentinite soil is rich in Cr, its oxidation to Cr(VI) is an environmental hazard in sediments, soils and groundwater related to ultramafic rocks and their metamorphic derivatives. Oxidative formation of Cr(VI) related to serpentinite soils were investigated in detail using model experiments with fuchsite (Cr(III)-muscovite), birnessite and in the presence and absence of humic matter. The rate of Cr(VI) in solution increases with increasing fuchsite and birnessite suspension densities and decreasing pH and humic matter at 25°C. The overall rate expression of Cr(VI) released and oxidized in solution from fuchsite can be expressed as

$$d[\text{Cr(VI)}]/dt = k\{\text{fuchsite}\}^{0.86} * \{\text{birnessite}\}^{0.25}$$

Where k is a function of pH equal to $7.316 * 10^{-5} \text{pH}^2 - 9.607 * 10^{-5} \text{pH} + 3.126 * 10^{-4} \mu\text{M L m}^{-2} \text{h}^{-1}$.

Since Ni release from serpentinite soils was high, Ni adsorption on various single and dual site clays (gibbsite, goethite, natural red earth and laterite) was determined using batch experiments as a function of pH, background electrolyte concentration, and adsorbate loading. The experimental data was quantified by 2-pK surface complexation modeling using monodentate and bidentate surface reactions. Gibbsite and laterite showed higher retention of Ni compared to natural red earth (NRE) and goethite indicating high affinity to AlOH surface sites of all clays. The maximum adsorption density of $9.0 \times 10^{-5} \text{ mol m}^{-2}$ was reported for gibbsite. All four sorbents showed a negligible variation with ionic strength. However, the introduction of both monodentate and bidentate sites, i.e., $\equiv\text{AlOH}$ was required to characterize Ni-adsorbent interface. The Ni adsorption capacity, i.e., Γ_{Ni} , varied with the type of sorbents used in accordance with the following order: $\Gamma_{\text{Gibbsite Ni}} > \Gamma_{\text{Laterite Ni}} > \Gamma_{\text{NRE}} > \Gamma_{\text{Goethite Ni}}$. In all cases, the estimated Gibb's free energy parameter showed that the Ni(II) adsorption was spontaneous.

2.65

Nematicidal Compounds from some Sri Lankan Plants.

Bandara, Balasuri Muhandiramalegedara Champani Anuruddhika

127p.

M.Phil. Degree, 2001.

Location No. 174

Abstract

This thesis consists of two parts. Part one of the thesis describes the nematicidal activity of some Sri Lankan plants against *Pratylenchus loosi* (Tylenchida: Pratylenchidae), *Radopholus similis* (Tylenchida: Pratylenchidae) and *Helicotylenchus* species (Tylenchida: Hoplolaimidae). Out of 454 extracts from 173 plant species screened for nematicidal activity, nine extracts were found to be active against *P. loosi* and *Helicotylenchus* species. The LC₅₀ values suggested that *Ocimum gratissimum* (Leaves and twigs, dichloromethane extract), *Gliricidia sepium* (leaves, hexane and dichloromethane extracts), *Cyperus rotundus* (Rhizome, dichloromethane extract) and *Hortonia floribunda* (leaves, dichloromethane extract) showed good nematicidal activity against both *P. loosi* and *Helicotylenchus* sp. Comparisons were made with known nematicidal compounds and with a commercially available nematicide, ethyl 3-methylthiophenyl-N-isopropylphosphoramidate (Nemacur[®], phenamiphos), in order to calculate effective levels of nematicidal activity and to make standard concentrations for bioassay directed fractionation.

Of the known nematicidal compounds, catechol, guaiacol, pyrogallol and geraniol showed similar levels of nematicidal activity at 1,000 ppm against *P. loosi* and *Helicotylenchus* sp. while linalool and sitosterol were found to be inactive. The inactivity of the latter suggested that there were differences in susceptibility among species of nematodes.

The dichloromethane extract of *Ocimum gratissimum* showed LC₅₀ (LC = Lethal concentration) of 5839, 6337 and 6697 ppm and MC₅₀ (Moribund concentration) of 5458, 5180 and 6411 ppm, 24 hours after treatment (HAT) against *Helicotylenchus* sp, *P. loosi* and *R. similis* respectively. The active constituent with LC₅₀ of 465, 482 and 507 ppm and MC₅₀ of 456, 457 and 478 ppm 24 HAT against *Helicotylenchus* sp, *P. Loosi* and *R. similis* was identified as eugenol, (2-methoxy-4-(2-propenyl) phenol, 1-(3'-methoxy-4'-hydroxyphenyl) prop-2-ene.

The dichloromethane extract of *Cyperus rotundus* showed LC₅₀ of 8625, 10,000 and 11,782 ppm after 24 h against *Helicotylenchus* sp, *P. Loosi* and *R. similis*. Five moderately active compounds were isolated but their structures could not be elucidated. They were C/45/1 with LC₅₀ after 24 h of 700, 707 and 747 ppm, C/37/1 (LC₅₀ 612, 681 and 818 ppm, C/36/1 (LC₅₀ 752, 513 and 752 ppm), C/41/1 (LC₅₀ 912, 941 and 979 ppm) and C/41/2 (LC₅₀ 846, 893 and 908 ppm) against *Helicotylenchus* sp, *P. Loosi* and *R. similis*.

Part two of the thesis describes the structure-nematicidal activity relationship of aryl alkenes related to eugenol. All the phenyl ethenes screened for activity were found to be inactive except ethenes with a 4'-OMe group present. As the length of the side chain increased i.e. from ethene to propene and butene, activity was found to increase. The highest activity was shown by the 3'-OH, 4'-OMe substituted butadiene, with conjugated double bonds in its side chain. The 4'-OMe substituted butadiene showed less activity, while the 2', 4'-dimethoxy substituted butadiene was weakly active.

Although the 1-(3'-hydroxy-4'-methoxyphenyl) buta-1,3-diene was the most nematicidal aryl alkene against *Helicotylenchus* sp., aryl alkenes with a diene side chain are photolabile and unstable. Therefore 1-(3'-hydroxy-4'-methoxy phenyl) but -1-ene (LC₅₀=169 ppm) can be considered as the most useful nematicidal compound among the aryl alkenes screened.

The conclusions were that nematicidal activity

- was enhanced with increasing length of the side chain and with conjugation,
- required a 4-methoxy substituent and was enhanced by a 3-hydroxy substituent and
- was increased by a 2-methoxy substituent and decreased by hydroxy groups ortho- and para-to the side chain and methoxy groups meta-to the side chain.

2.66

Separation of Tea Flavan-3-OLS by High-Speed Counter-Current Chromatography and Antioxidant and Antifungal Activity Studies.

Wijekoon, W.M.A.M.B.

113p.

M. Phil. Degree, 2009.

Location No. 916

Abstract

Theaflavins (TFs) in black tea and proanthocyanidins (PAs) found in fresh tea leaves are oligomeric and polymeric flavan-3-ols. Theaflavins (TFs) are orange coloured pigments found in black tea and are important compounds that determine the quality of black tea.

Theaflavin (TF), theaflavin-3-gallate (TF3MG), theaflavin-3'-gallate (TF3'MG) and theaflavin-3-3'-digallate (TFDG) are the four major TFs found in black tea. The present study was carried out to determine whether high-speed counter-current chromatography (HSCCC) could be used to obtain pure reference samples of the four major TFs, Theaflavin (TF), theaflavin-3-gallate (TF3MG), theaflavin-3'-gallate (TF3'MG) and theaflavin-3-3'-digallate (TFDG). An *iso-butyl* methyl ketone (IMBK) extract of theaflavins prepared from black tea TRI dust no. 1 sample was

fractionated by HSCCC, without a preliminary clean-up step. The use of different combinations of n-hexane-EtOAc-MeOH water only was investigated as the solvent system for HSCCC. The solvent systems n-hexane-EtOAc-MeOH-water (1:4:1:4 and 1:5:1:5) were selected as these were observed to be the most effective for separation of TFs. It was found that the two theaflavin monogallates, theaflavin-3-gallate, theaflavin-3'-gallate were not separated while theaflavin and theaflavin-3-3'-digallate were obtained in high purity after a single HSCCC run. Previous workers had achieved these same results after either using a preliminary clean up procedure or by separating standard samples of TFs.

Comparative studies of antioxidant activity performed with the IBMK theaflavin extract of black tea and the extract from one cup of black tea suggested that TFs in black tea contribute to the high antioxidant properties of black tea.

PAs found in tea flush have been implicated in the resistance of tea cultivars to infection by the fungus *Exobacidium vexans*, an obligatory biotrophic fungus which causes blister blight leaf disease of tea. An aqueous acetone extract of proanthocyanidins prepared from healthy tea leaves was partially purified using Sephadex LH-20 chromatography. The crude proanthocyanidin extract obtained was fractionated with high-speed counter-current chromatography (HSCCC) using the solvent system n-hexane-EtAc-MeOH-water (1:5:1:5) which was found to result in the best separation. Five proanthocyanidins and two other flavanoids were separated in high purity by a single HSCCC run. NMR spectroscopy and comparison of data with those reported in the literature were used to establish their structures. The proanthocyanidins were found to be epigallocatechingallate-(4 β \rightarrow 6)-epicatechingallate (46), epicatechingallate-(4 β \rightarrow 6)-epigallocatechingallate (47), epigallocatechingallate-(4 β \rightarrow 6)-epicatechingallate (48), epifazelechin-(4 β \rightarrow 6)-epigallocatechin gallate (49) and epicatechingallate-(4 β \rightarrow 6)-epicatechingallate (50). The two flavanoids were epigallocatechindigallate (45) and epicatechin digallate (51).

Pure proanthocyanidin and catechins isolated were used to determine their fungitoxicity against *E. vexans*. The spore fall technique showed that PAs and catechins from tea leaves inhibited spore germination of *E.vaxans* on laboratory culture media. The crude proanthocyanidin and catechin extracts showed 100% inhibition of spore germination at 250 ppm. More than 95% inhibition was shown by the pure proanthocyanidin samples (PA1-PA4) that were isolated, while the pure catechin samples epigallocatechin gallate (EGCG) and epigallocatechin digallate (EGCDG) showed 100% inhibition at 128 ppm. Fungitoxic activity of pure catechin and proanthocyanidins against *E. vexans* has not been reported previously.

2.67

Structural Studies of the Capsular Polysaccharide from *Streptococcus pneumoniae* Type 25F and Studies on Green Tea Constituents.

Rajapaksha, K.T.P.M.P.

94p.

M.Phil. Degree, 2004.

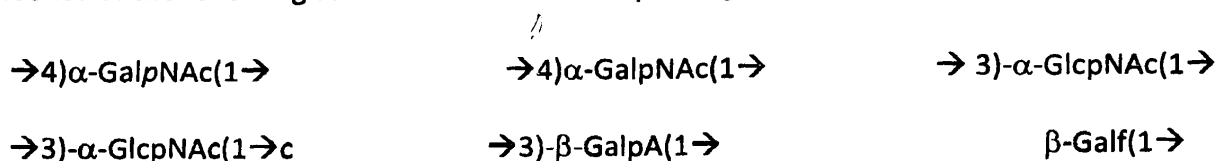
Location No. 334

Abstract

The thesis consists of two parts, Part I and Part II. Part I deals with the structural studies of the capsular polysaccharide isolated from *Streptococcus pneumoniae* type 25F.

The composition and the mode of linkage of the glycosyl constituents present in the polysaccharide, and in a degraded polysaccharide obtained after treatment with 48% aqueous hydrogen fluoride, were determined using sugar and methylation analysis. Nuclear Magnetic

Resonance (NMR) Spectroscopy of the degraded polysaccharide was employed to establish the presence of the following structural units in the repeating units of the polysaccharide.



The sequence of the sugar residues in the repeating unit, however, could not be established using these methods. Attempts to cleave the polysaccharide using Smith degradation and triflic acid hydrolysis were not successful.

Part II of the thesis describes the extraction and separation of tea constituents in fresh tender tea shoots, using High Speed Countercurrent chromatography (HSCCC). The ethyl acetate extracts from the tea clones TRI 2023, TRI 2025, TRI 2043, TRI 3079 and TRI 4006 were used for HSCCC separation, and the fractions obtained were analyzed by High Performance Liquid Chromatography (HPLC). Catechins present were identified by comparing the HPLC retention times with those of standard reference samples. It was found that the catechins epigallocatechin gallate (EGCG), epicatechin gallate (ECG), epigallocatechin (EGC), epicatechin (EG), two other catechins FLA1 and FLA2, and theobromine, were extracted with high purity after a single HSCCC run. The structure of the two catechins FLA1 and FLA2 were elucidated using NMR and Electron Impact Mass Spectroscopy (EI-MS) data. FLA1 was found to be catechin gallate (CG) and FLA2 was identified as epigallocatechin-3-5-di-O-gallate.

The antioxidant activity (AOA) of the catechins and some catechin extracts was compared with that of the antioxidants α -tocopherol (Vitamin E) and Butylated Hydroxyanisole (BHA). The β -carotene bleaching method and the DPPH radical scavenging method were used for this determination. The AOA of EGCG, CG, epigallocatechin-3-5-di-O-gallate and catechin extracts containing a high proportion of EGCG was found to be comparable to that of Vitamin E and BHA. The high AOA of epigallocatechin-3-5-di-O-gallate has not been reported previously.

2.68

Studies on some Medicinal and Related Plants of Sri Lanka.

Liyanage, Chandani Samarawickrama

133p.

M.Phil. Degree, 2002.

Location No. 219

Abstract

This thesis describes the chemical investigation of some medicinal and related plants of Sri Lanka. The preliminary studies on certain biological activities of some constituents/extracts/fractions are also discussed.

Two Annonaceous plants, *Cananga odorata* (Sin. Wana-sapu) and *Enicosanthum acuminata* (Sin. Wal-waraka, Mal-lawulu), two Rutaceous plants *Acronychia pedunculata* (Sin. Ankenda) and *Euodia lunuankenda* (Sin. Lunu-ankenda) and the Labiatae plant *Leucas zeylanica* (Sin. Geta-thumba) were investigated in this study.

Alkaloidal fraction of the stem bark of *Cananga odorata* yielded six alkaloids, oxopukateine, cleistopholine, onychine, eupolauridine and liriodenine and CO-H-1, whose structure was not confirmed. This alkaloidal fraction was shown to possess very weak cytotoxicity to Brine shrimps.

The methanol extract of *Encosanthum acuminata* stem bark yielded a clerodane diterpenoid and the aporphine alkaloid liriodenine. This clerodane diterpenoid showed weak mosquito larvicidal and weak cytotoxic (Brine shrimp) activities.

The petroleum ether extract, of the fruits of *Acronychia pedunculata* yielded a new arylketone dimer, demethylacrovestone.

The dichloromethane extract of the fruit shells of *Euodia lunuankenda* yielded a new acetophenone, 1-[4'-(3''-methyl-2''-butenyloxy)-3'-(3''-methyl-2''-butenyl)-2',6'-dihydroxyphenyl]-2-hydroxyethanone, which showed strong antifungal activity against *Cladosporium cladosporioides*.

The root extract of *Leucas zeylanica* yielded β -sitosterol, ursolic acid and its methyl ester acetate while the extractives of aerial parts yielded the flavonoid – tricetin, β -sitosterol glucoside, oleanolic and ursolic acids. These extracts have not shown any significant biological activity.

2.69

Synthesis of Aggregation Pheromone of Black Beetle and Studies on 1,6 Germacradien-5-OL.

Sothyruvan, Thiruchittampalam

93p.

M.Phil. Degree, 2002.

Location No. 218

Abstract

This thesis consists of two parts.

The first part describes the total synthesis of the aggregation pheromone of the coconut rhinoceros beetle, *Oryctes rhinoceros*. Although the pheromone has been identified as S-ethyl 4-methyloctanoate, the racemic mixture has been shown to be effective in attracting the beetle. Three methods of syntheses were derived from a retrosynthetic analysis of the molecule. Of the three methods selected, the cheapest starting material and the shortest route was found to be that starting from cane sugar. The first step in this sequence involved the acid degradation of cane sugar by hydrochloric acid giving levulinic acid. Levulinic acid was converted into its ethyl ester by Fischer esterification. Wittig olefination of ethyl levulinate followed by catalytic hydrogenation resulted in the target molecule, ethyl 4-methyloctanoate being synthesized in its racemic form.

The second part of this thesis describes synthetic studies on a semiochemical, 1,6-germacradien-5-ol present in the defense effluent of pine sawfly. The stereochemistry of this germacrane and its role in the defense mechanism of pine sawfly are unknown. The molecule has two chiral centers and two transgenic double bonds. A method to synthesize all four stereoisomers by the same common route was developed on the basis of retrosynthetic analysis. The proposed method involved joining together of two key fragments, an aldehyde and phosphonium salt or arylalkyl sulfone using stereoselective olefination methods (Wittig reaction and Julia olefination) in order to synthesize an open chain diene, which is the precursor for ring closure. The final ring closure could be accomplished by a ring closing metathesis. The Wittig reaction approach was abandoned as an attempt for ring closing metathesis using a Wittig salt and an aldehyde with a hydroxyl group protected as methyl ether, which had previously been attempted had failed for what was suggested to be stereochemical reasons. The present work was an attempt to synthesize the open chain diene using Julia olefination with the hydroxyl group in the aldehyde fragment protected with a bulky

group. However, all attempts to introduce bulky ether failed and the only protection possible are in the form of an acetate ester. Although both fragments for the Julia olefination were synthesized, time constraints prevented the synthesis of open chain diene and the ring closing methasis being carried out.

2.70

Synthesis of Glycolipids for use as Liquid Crystals and Surfactants.

Abeyrathne, A.R.N.M.

137p.

M.Phil. Degree, 2012.

Location No. 1217

Abstract

The study of liquid crystalline behavior of new amphiphilic carbohydrate derived liquid crystals has become a world wide interest since these glycolipids have technical and biological applications in a wide area such as thermotropic and lyotropic liquid crystals, surfactants, lubricants, solubilization and crystallization of membrane enzymes and etc. Novel glycosides have been synthesized by linking D-glucose to four different nonpolar parts; cinnamyl alcohol, chloroxylenol, 3-pentadecylphenol and 3 β -epiandrosterone. The structures of both acetylated and deacetylated compounds were elucidated by means of ^1H and ^{13}C nuclear magnetic resonance spectroscopy, fourier transform infrared spectroscopy and gas chromatography-mass spectroscopy. The effect of alkyl and aryl stability of liquid, crystal phases upon inclusion of a rigid spacer in between hydrophilic and hydrophobic parts was investigated.

The anisotropic shape of the molecules is important to exhibit liquid crystallinity. The study of liquid crystal behavior of the compounds synthesized were carried out using optical polarized light microscopy, differential scanning calorimetry, and thermo microscopy. Further the identification of the mesophases of the compounds was done by X-ray diffractometry. Both acetylated and deactylated compounds exhibit thermotropic as well as lyotropic liquid crystal behavior, hence they are amphotropic liquid crystals. The thermotropic liquid crystal phases were confirmed as smectic A (Sm A), smectic B (Sm B), hexagonal columnar and discotic by X-ray studies and both lamellar and hexagonal type lyotropic phases were exhibited. Further, these thermotropic liquid crystals formed by the compounds are monotropic liquid crystals since they are formed only in the cooling mode due to supercooling of the liquid phase.

Glycolipids are natural surfactants based on a hydrophilic sugar (carbohydrate) part and a hydrophobic hydrocarbon domain. Another target of this research is the rationalization of the surfactant behavior of above glycolipids on basis of Critical Micelle Concentration (CMC). The nonionic surfactants treated with iodine form donor -acceptor complexes in aqueous medium. Thus the CMC is determined by the spectral absorption and the shift in the absorbance maximum (λ_{max}) of I_2 upon complexation with surfactant. For a better, comparison of results, turbidity measurements are exploited to determine CMC. In accordance with the results of both methods, the CMC of all the acetylated compounds, lie within the typical CMC for nonionic surfactants; 10^{-5} - 10^{-4} mol dm $^{-3}$.

2.71

Synthesis of N,N'-Ethylenebis (Acetylacetonimine) and Dithiooxamido Transition Metal Complexes and Investigation of their Potential for Binding Anion, Cation and Small Molecules.

Adhikari, A.M.S.K.P.

59p.

M.Phil. Degree, 2011.

Location No. 1115

Abstract

Macrocyclic ligand complexes play a significant chemical role in many systems. Such complexes are typically very stable and show unusual structural, electronic and electrochemical properties. Recently, a novel dinickel macrocyclic complex synthesized has shown a significant affinity towards trapping halide ions. Extension of such a study to synthesize a new simple metal macrocyclic systems capable of trapping simple hazardous molecules and ions present in the environment was the major concern of this research project. In this regard, a few macrocyclic metal complexes of copper(II), nickel(II) and iron(III) were synthesized by the metal template synthesis method and characterized by using UV-visible, FTIR, NMR, XRD and CV techniques. Their binding ability with anions such as SCN^- , Br^- , Cl^- and I^- and cations such as Ag(I) , Pb(II) , Cd(II) , Zn(II) and Ni(II) were studied.

The nano-structured blackish complex of copper(II) synthesized with dithiooxamide (rubeanic acid) and acetylacetonimine (acac) shows significant affinity towards silver(I) ions. Therefore, this complex is suitable for trapping silver ions in water. The X-ray structure of the copper(II) and nickel(II) complexes synthesized with ethylenediamine (en) and acetylacetonimine (acac) were determined with the support of Wayne State University, USA. The copper(II) complex with en and acac shows the ability of binding with anions such as SCN^- , Br^- , Cl^- and I^- . Carbon dioxide (CO_2) trapping capability of the complex was studied using a CO_2 sensor probe and it was observed that the complex is capable of trapping CO_2 up to 50 % at room temperature in methanolic medium.

A similar iron(III) complex (Fe-en-acac-R) synthesized also shows the anion binding capability and similar type of acid-base properties. Although the structures were not determined, a few attempts were made to synthesize two dimeric metal complexes of copper(II) and nickel(II) using dibromo-ortho-xylene for bridging ligand of the two monomers.

2.72

Synthesis of Essential Oil Derivatives for Development of Insecticidal Products against Mosquitoes and Houseflies.

Kalhari, K. Susitha

189p.

M.Phil. Degree, 2005.

Location No. 512

Abstract

Public health pest control is a major priority to minimize the infections and transmission of vector-borne diseases in the tropical region. Increased public concern regarding the potential adverse effects of chemical insecticides has prompted the search for alternative methods of pest control. Plant essential oils having a rich source of bioactive chemicals have been considered potent alternatives to conventional insecticides as a natural means of pest control.

The objective of the present study are to synthesise derivatives of essential oil compounds,

menthol, thymol, α -terpineol, geraniol, eugenol, citronellol, cinnamyl alcohol and cinnamic acid and to evaluate their activity against mosquitoes and houseflies. The second is to establish the Structure Activity Relationship (SAR) of compounds with the aim of identifying structural features that are necessary for activity and the third to develop insecticidal products.

Insecticidal properties of oils of *Cinnamomum zeylanicum*, *Cymbopogon nardus*, *Cymbopogon citratus*, *Ocimum gratissimum*, *Ocimum canum*, *Toona ciliata* and *Mentha piperita* have been recognized and the principal active compounds were identified. Acyl, halo acyl, ether, cyclic acetal, epoxide and hybrid derivatives with structures based on insecticidal menthol, thymol, α -terpineol, geraniol, citronellol, eugenol, cinnamyl alcohol and cinnamic acid have been synthesized by using standard reaction conditions. Synthetic derivatives were purified by Dry Column Flash Chromatography and structures were elucidated by ^1H and ^{13}C NMR spectral data. Bioassay followed the WHO standard protocol for *Culex quinquefasciatus*, *Anopheles tessellatus* and *Aedes aegypti* and topical application method for *Musca domestica*. Anti-mosquito creams/ lotions, mosquito coils, repellent candles and housefly baits and liquid sprays were prepared incorporating active compounds and oils and the bio-efficacy was tested in the laboratory and field.

Synthetic derivatives showed enhanced insecticidal activity with relative to the parent compounds. SAR of the compounds identified that lipophilicity of the molecule as one of the key activity enhancing factors. This was highlighted by the increased activity in the ester derivatives of menthol, geraniol, cinnamyl alcohol and cinnamic acid with relative to their analogues containing hydroxyl, ether and carbonyl functionalities. The majority of compounds with aliphatic ester groups, which are less bulky, showed increased activity than its chlorinated and fluorinated compounds. The presence of a nitrogen atom in the esterifying group has retained the insecticidal activity and the replacement of hydroxyl functionality for example with glycerin acetal moiety has increased the activity significantly. Aromaticity is another key factor, which contribute to enhance the activity as seen in thymol. Degree of unsaturation is also contributed to either retain or enhance the activity of α -terpineol and geraniol derivatives. The structurally related analogues have either comparable or higher activity indicating that structural variations contribute positively towards the insecticidal activity. SAR data also indicated that cinnamic acid ester derivatives are less toxic than their parent alcohol moieties.

Field study data of anti-mosquito creams revealed that five formulations showed 100% protection and ten formulations greater than 90% protection in the field with relative to the commercial formulations. It was also found that both citronella and neem oil function as a synergists in above formulations. Bioassay data of housefly baits indicated that seven baits showed good KT_{50} values with comparison to the reference bait.

2.73

Synthesis of Potent Bio-Active Acridone Alkaloids.

Diyabalanage, H.V.K.

123p.

M.Phil. Degree, 2001.

Location No. 172

Abstract

This thesis discusses total synthesis of seventeen acridone alkaloids eight of which are new (compounds, **126**, **127**, **128**, **129**, **58**, **135**, **136** and **137**), three coumarin derivatives and four new acridone-coumarin dimmers (arimarines).

1,3,5-Trihydroxy-9-acridone (**126**) was synthesised from 2-amino-3-hydroxybenzoic acid and phloroglucinol. Methylation of compound **126** under different conditions gave 3,5-dimethoxy-1-hydroxy-9-acridone (**59**), 3,5-dimethoxy-1-hydroxy-10-methyl-9-acridone (**127**), 3,5-dimethoxy-1-hydroxy-4-methyl-9-acridone (**128**), 1,3,5-trimethoxy-10-methyl-9-acridone (**57**) and 1,3,5-trimethoxy-4,10-dimethyl-9-acridone (**129**). Demethylation of compound (**57**) afforded 1,3,5-trihydroxy-10-methyl-9-acridone (**58**). 1,3-Dihydroxy-5-methoxy-9-acridone (**130**) was obtained upon condensation of 2-amino-3-methoxybenzoic acid with phloroglucinol.

Reaction of anthranilic acid with phloroglucinol yielded 1,3-dihydroxy-9-acridone (**131**). Methylation of compound **131** furnished 1-hydroxy-3-methoxy-10-methyl-9-acridone (**132**) which upon demethylation gave 1,3-dihydroxy-10-methyl-9-acridone (**133**).

Iodination of compound **131** afforded 1,3-dihydroxy-2,4-diiodo-9-acridone (**134**) whereas compound **59** gave 3,5-dimethoxy-1-hydroxy-2/4-iodo-9-acridone (**135**). The palladium catalysed Heck condensation reaction of **135** with 2-methyl-3-butene-2-ol yielded 1-hydroxy-3,5-dimethoxy-2-(3'-hydroxy-3'-methyl-1'-butenyl)-9-acridone (**136**) and (**59**). Prenylation of compound **59** with 4-bromo-2-methyl-2-butene gave 3,5-dimethoxy-1-hydroxy-10-(3'-methyl-2'-butenyl)-9-acridone (**137**) while prenylation of compound **131** with methylcrotonaldehyde gave des-*N*-methylnoracronycine (**138**).

Total synthesis of coumarin derivatives 6-bromo-7-hydroxycoumarin (**139**), 6-bromo-7-methoxycoumarin (**85**) and 6-[(*E*)-3-Hydroxy-3-methyl-1-butenyl]-7-methoxycoumarin [(*E*)-Suberenol] (**82**) from 4-bromoresorcinol and malic acid has been reported in this thesis.

Preparation of four new acridone-coumarin dimers (acrimarines), 1,3,5-trihydroxy-2-[1''-(7'-methoxy-2'-oxo-2H-chromen-6-yl)-3''-methyl-2''-butenyl]-9-acridone (**103**), 1,3-dihydroxy-5-methoxy-2-[1''-(7'-methoxy-2'-oxo-2H-chromen-6-yl)-3''-methyl-2''-butenyl]-9-acridone (**104**), 3,5-dimethoxy-1-hydroxy-2-[1''-(7-methoxy-2'-oxo-2H-chromen-6-yl)-3''-methyl-2''-butenyl]-9-acridone (**105**) and 3,5-dimethoxy-10-methyl-2-[1''-(7'-methoxy-2'-oxo-2H-chromen-6-yl)-3''-methyl-2''-butenyl]-9-acridone (**106**) from (*E*)-suberenol (**82**) and relevant acridones has been described in this thesis. Methylation of compound **103** furnished acrimarines 105 and 106.

2.74

Synthesis, Properties and Applications of Nano Gibbsite Crystals: A Substrate for Arsenate Remediation.

Kumara, I.G.C.K.

111p.

M.Phil. Degree, 2009.

Location No. 919

Abstract

Gibbsite (α -Al(OH)₃, monoclinic, P21/n) structure consists of double layers of close packed OH groups. The primary aim of the present research is the synthesis and characterization of nano gibbsite crystals. Subsequently its potential use for arsenate removal from drinking water is examined. Nano gibbsite crystals were synthesized by the titration between AlCl₃ and NaOH under suitable experimental conditions. The particles were characterized by TEM, EDS, XRD and FTIR spectroscopic methods. The initial product of Al(OH)₃ is amorphous and as dialysis proceeds, it gradually transformed into crystalline structure. A10 days of dialysis are sufficient for initiation of gibbsite crystal formation. Synthesized gibbsite crystals were hexagonal in shape and around 90 ± 25 nm in diameter. XRD and FTIR further reveal the formation of gibbsite crystals.

Synthesize Al(OH)₃ particles at pH 9 shows somewhat a different IR spectrum. The OH

stretching and bending vibrations correspond to bayerite. Thus, pH plays a critical role in the selection of aluminum hydroxide morphology. Gibbsite surface bears positive charge below pH 9.3. The DTA and TGA experiments indicate formation of a new phase upon dehydroxylation of gibbsite. FTIR spectroscopy data coupled with XRD analysis suggests that dehydration sequence of nano gibbsite was via chi-alumina.

Arsenate adsorption on gibbsite nano particles is pH dependent and sorption favor at acidic medium. Affinity of gibbsite for arsenate at pH 5 is nearly 4 fold greater than that of at pH 9. Monolayer coverage of arsenate on gibbsite nano crystals surface at pH 5 found to be $3.12 \times 10^{-6} \text{ mol m}^{-2}$ while that of in pH 9 to be $2.36 \times 10^{-6} \text{ mol m}^{-2}$. Model calculations imply significant lowering of active surface sites for arsenate adsorption as pH increases. A 98% of arsenate removal observed at the pH range 4 to 8.5. Arsenate exhibit negligible changes with ionic strength variation indicating possible inner-sphere surface complex mechanism. Adsorption process causes a significant change in the OH stretching modes of gibbsite. Molecular modeling calculations using DFT, predict the bond lengths of As-Al, Al-O, As-O to be 3.15Å, 1.90Å, 1.74Å and bond angles of O-As-O, Al-O-As to be 106° and 122° respectively for possible binuclear-bidentate surface complexation.

2.75

Tea Catechins: Antibacterial Activity against Methicillin-resistant *Staphylococcus aureus* (MRSA) and Enhancement of Sensitivity of MRSA to Oxacillin.

Kumbukgolla, W.W.

93p.

M.Phil. Degree, 2012.

Location No. 1242

Abstract

Tea (*Camellia sinensis*, L.), an economic crop in Sri Lanka, is a popular beverage globally. Tea is known to have a range of physiological properties. Catechins which are abundantly found in tea are responsible for most of the beneficial effects of tea. Although catechins have shown antimicrobial properties, the potential of catechins from Sri Lankan tea in the control of drug-resistant bacteria has not been explored previously.

Methicillin resistant *Staphylococcus aureus* (MRSA) strains (100) were isolated from over 700 clinical isolates, obtained from Teaching Hospital, Peradeniya, by following standard experimental procedures. The MRSA strains were characterized by microscopic examination, coagulase test, DNase test and sensitivity assays against oxacillin. The MRSA strains were screened, using agar plate dilution assay, for antibacterial activity of crude catechin fractions (CCF), isolated by solvent fractionation of aqueous methanol extracts from tea flush of two cultivars, TRI 2023 and TRI 2025; the cultivar TRI 2023 was selected as it is known to be more resistant to insect attack than TRI 2025. Minimum inhibitory concentration (MIC) values of CCF were found to be in the following ranges: 32 mg/l (4 MRSA strains for CCF from each cultivar), 64 mg/l (7 MRSA strains for CCF from TRI 2023 and 14 strains for CCF from TRI 2025), 128 mg/l (62 MRSA strains for TRI 2023 and 63 strains for TRI 2025) > 128 mg/l (27 MRSA strains for TRI 2023 and 19 strains from TRI 2025).

The yield of CCF can be increased from 1.42% (w/w, fresh weight) to 2.08% by two additional solvent extractions of tea flush. Although the yield of CCF from tea flush is about five times higher than that from mature tea leaves, the antibacterial activity against MRSA was comparable for both the CCFs obtained from tea flush and mature leaves.

The CCF was fractionated using high-speed counter-current chromatography (HSCCC) to obtain (-)-epigallocatechin gallate (EGCg), (-)-epicatechin gallate (ECg) and (-)-epigallocatechin digallate (EGCDg). EGCg and ECg were characterized by ¹H NMR and comparison with authentic samples on HPLC. EGCDg was identified by NMR analysis. The antibacterial activity of EGCg and EGCDg was assayed against 25 MRSA strains and that of ECg against 10 MRSA strains; both EGCg and EGCDg had MIC values of 32-128 mg/l for 23 strains and > 128 mg/l for 2 strains while ECg had MIC values > 128 mg/l for all the 10 strains examined.

The antibacterial activity of oxacillin against MRSA was considerably enhanced by pre-incubation of MRSA strains with CCF or EGCg in a dose- and time-dependent manner. When 25 MRSA strains were pre-incubated with CCF (100 mg/l) for 4 h, the MIC values of oxacillin against MRSA decreased from ≥ 128 mg/l to 8 mg/l. Pre-incubation of MRSA strains with EGCg (1 mg/l) for 4 h also reduced the MIC values of oxacillin against MRSA from ≥ 128 mg/l to 8 mg/l.

M.Sc. Research Project Reports

ANALYTICAL CHEMISTRY

2.76

Adsorption and Desorption Behavior of Phosphate on Kaolinite.

Gunaseena, Dilani Nilushika

30p.

M.Sc. Degree, 2005.

Location No. 411

2.77

Adsorption of Cadmium (II) by Kaolinite.

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Location No.407

2.78

Adsorption of Mercury (II) by Kaolinite.

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Location No. 412

2.79

Adsorption of Thiram by Soil.

Attanayake, A.M.T. Samanthika

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2.80

Adsorption of Zinc on Kaolinite in the Presence of Calcium and Magnesium.

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2.81

Alizarin Red S Impregnated Conducting Polymer as a Potential Ionic Sensor.

Fernando, M.S.A.

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2.82

Analysis and Recovery of Iodine from Brine in Solar Salt Manufacturing.

Warnasooriya, W.M.P.B.K.

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M.Sc. Degree, 2004.

Location No. 344

2.83

Analysis of Cadmium in Drinking Water in Padavi Sripura Area and Modification of Diphenyl Thiocarbazon.

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M.Sc. Degree, 2004.

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2.84

Analysis of Market "Chinese Roll" Samples in Kandy Municipality Area for Acrylamide: A Probable Carcinogen.

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Location No. 873

2.85

Analysis of Organochlorine and Organophosphorus Pesticide Residues in Sri Lankan Agricultural Export Commodities with Special Emphasis on Tea.

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Location No. 131

2.86

Analysis of Pesticide Residues in Chilli (*Capsicum annum*).

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Location No. 102

2.87

Analysis of Proteins in Infant Milk Formulae.

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2.88

The Analysis of Sludge, Soil, and Plants for Lead Contamination and Investigation of Suitable Methods for Removal of Lead.

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2.89

Analysis of the Quality of Water at School Level.

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2.90

Anion Association and CO₂ Reduction Capacity of Some Selected Transition Metal Macrocyclic Complexes.

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2.91

Anti-Oxidant and Anti-Tyrosinase Natural Products of *Nymphaea stellata*.

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Antimicrobial Natural Products against Oral Pathogens.

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Arsenic Determination and Removal from Drinking Water.

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Assessing Salinity Level of Soils in Area near the Batticaloa Lagoon.

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2.95

An Assessment of Heavy Metal Contamination in the Marine Sediments of Galle Harbour.

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Characterization of Acid Proteinases of Porcine Ovaries and Analysis of their Expression.

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Characterization of Deoxyribonucleases from Pitcher Juice of *Nepenthes distillatoria*.

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2.98

Chemical and Biological Activity of Selected Varieties of Spring Canola (*Brassica napus*) and Mustard (*Brassica juncea*) and Introduction of a High Content of Favourable Fatty Acids to Mustard.

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Chemical Characteristics of Industrial Effluents after Treatment with Brick Particles.

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Chemical Substances Produced by Selected Microorganisms and their Biofilms.

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Comparative Antioxident Activity and Quantification of Gymnemic Acid from Sri Lankan *Gymnema* sp.

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2.102

A Comparative Survey of Bioaccumulation of Some Metallic Ions Such as CU(II), CR(VI)O₄²⁻ by the Aquatic Fern - *Azolla pinnata*.

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2.103

Comparison of Ripening Methods for "Kolikuttu" (*Musa sapientum* L. AAB Group) Banana.

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Copper Kaolinite Interactions: An Application of Diffuse Layer Surface Complexation Model.

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Current Pollution Status of Valaichenai Lagoon.

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Decontamination of Cadmium Containing Aqueous Solutions using Feldspar.

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Defluoridation of Water.

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2.108

Determination of Mercury Content in Marine Fish Marketed in Sri Lanka.

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2.109

Development of a Sensor to Detect Lead (II) in Water Using Ammonium Salt of Di Ethanoldithiocarbamate.

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2.110

Development of an Electrochemical Sensor for Copper (II) Analysis.

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2.111

Development of an Opto-Chemical Sensor for the Detection of Metal Ions in Aqueous Solution.

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2.112

Development of an Opto-Chemical Sensor for the Investigation of Metal Cations.

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Development of Environmentally Friendly Methodologies for Control of Industrial Pollution.

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Development of Low Cost Method for the Monitoring of Ambient Air Quality.

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2.115

Development of Novel Methods to Prepare Montmorillonite-Polyaniline Nanocomposites.

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Development of Self-Cleaning Textiles by Incorporating Photo Chemically Active TiO₂ Nano-Particles.

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2.117

Effect of Incorporating Sulphate of Potash Magnesia (SPM) and Kieserite to a Recommended NPK Mature Tea Fertiliser Mixture (U709) on Soil Nitrogen Availability.

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Efficiency of Removing Arsenic from Drinking Water Using Aluminum Oxide and Ferric Oxide.

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2.119

***Elaeocarpus serratus*: Anti-Oxidant Activity and Cosmetic Applications.**

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Electrochemical Detection of Chromium (VI).

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Evaluation of Chemical Properties of Tea in Different Regions of Sri Lanka.

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Evaluation of Ion Removal Capacity of Low Cost Naturally Available Murunkan Clay for Desalination of Water.

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An Evaluation of the Presence of some Selected Metals in Commercial Bottled Drinking Water in Sri Lanka.

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Evaluation of Water Quality of Girandurukotte where Chronic Kidney Disease is Prevalent.

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Evaluation of Water Quality of Kelani River with Emphasis on Chrome Leather Tanning Industrial Effluents.

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Evaluation of Water Quality of Maa Oya with Emphasis on Total Organic Carbon and Carbofuran Residues.

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Feldspar-Fluoride Interactions: Examination of Interfacial Processes by Potentiometry.

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Ground Water Pollution in Batticaloa.

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Hydrogen Peroxide in Milk: Its Estimation and Possible Effects on the Quality of Milk.

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Impurities Adulterants and Diluents of Illicit Heroin in Sri Lanka.

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Interaction of Phosphates with Brick Clay Particles for Water and Wastewater Treatment.

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Investigating the Effect of Selected Macro and Micronutrients on Biological Treatment Systems Adopted by Sri Lankan Textile Industry.

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2.135

Investigation of Corrosion Inhibition of Aluminium Surfaces using *Neolitsea cassia* (L) (Wild Cinnamon) Extracts.

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M.Sc. Degree, 2013.

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2.136

Investigation of Lead Pollution in Pinga-Oya and Comparison of Analytical Results of Lead Content Using Atomic Absorption and UV/ Visible Spectrophotometers.

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Investigation of Sorption of Methylene Blue (MB) Dye on Thermally Treated Brick Clay Particles.

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2.138

Investigation of the Interaction of Glyphosate and Paraquat (Gramoxone) at Platinum and Glassy Carbon Electrode Surfaces through Electroanalytical Methods.

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Investigation of the Solid State Photochemical Reactivity and Polymorphism of Three Common Drugs.

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2.140

The Investigation of the use of Laterite for the Removal of Ag⁺ from Aqueous Medium.

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Investigation on the Extent of Pollution of the Kallar Lake.

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Investigation on the Natural Water Coagulant *Strychnos potatorum* ("Ingini") Seed Powder for Drinking Water Treatment.

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Isolation and Characterisation of the Factor, Present in Ginger, which Reduces Cow Milk Allergy.

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Isolation and Characterization of a Trypsin Inhibitor from seeds of *Tamarindus indica*.

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2.145

Low Cost Approach on Chlorpyrifos Residue Analysis in Vegetables.

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Measurement of Fluoride Ions in Drinking Water.

Ashraff, Aboobucker

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2.147
Monitoring of Selected Nutrients in Mango during the Processing for Manufacturing of Mango Jam.

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2.148
Mosquito Larvicidal Activity of Plant Essential Oils and Essential Oil Compounds.

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Location No. 872

2.149
Mosquito Larvicidal Biological Control Agent from Sri Lankan Isolate of *Metarhizium anisopliae*.

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2.150
Mosquitocidal Studies of Mugetanol Derivatives and Herbal-Based Mosquito Coils.

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2.151
Multi Technique Approach for the Determination of the amount of Active Ingredient in Amoxicillin Capsules.

Peiris, Theresa
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Location No. 132

2.152
Pesticide Residue Analysis in Sri Lankan Made Tea.

Wimalasena, C.R.
75p.
M.Sc. Degree, 2011.
Location No. 1147

2.153 **Pesticide Residue Analysis of Drinking Water in Girandurukotte Area where Chronic Kidney Disease is Prevalent.**

Devasurendra, A.M.
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Location No. 947

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Location No. 236

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Location No. 779

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M.Sc. Degree, 2010.
Location No. 969

2.159

Qualitative and Quantitative Estimation of (a) Glycyrrhetic Acid In Liquorice (b) Methimazole in Carbimazole by Using Plasma Desorption Mass Spectrometry (PDMS) and High Performance Liquid Chromatography (HPLC).

Jerard, D. M. Sirimal

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M.Sc. Degree, 2002.

Location No. 251

2.160

Quantification of Anionic Surfactants in Effluent of Effluent Treatment Plant of Garment Washing Industries.

Siriwardana, Pamodya Nilanthi

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Location No. 238

2.161

Quantitative Analysis of Rainwater for Investigation of Air Pollution at Peradeniya.

Kotabewatta, P. A.

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2.162

Quantitative and Qualitative Assessment of Pesticide Residues in Large-Scale Vegetable Plots Surrounding the Tea Plantation.

Abeyasinghe, J.M. Damayanthi

74p.

M.Sc. Degree, 2005.

Location No. 465

2.163

Quantitative X-Ray Diffraction Analysis of Polymorphs of Mebendazole Drugs Available in the Sri Lankan Market.

Jayakody, J.K.P.M.

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Location Nos. 951 and 963

2.164

Removal of 2-Chlorophenol in Water Using Montmorillonite Clay and Montmorillonite-Polyaniline Nanocomposites.

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M.Sc. Degree, 2004.

Location No. 343

2.165

Removal of Arsenate and Arsenite by Fullers Earth.

Wanasinghe, W.M.S.C.

31p.

M.Sc. Degree, 2004.

Location No. 345

2.166

Removal of Cadmium by Thermally and Chemically Modified Peat.

Bandara, B.W.M.G.C.

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Location No. 1211

2.167

Solvent Effect for Extraction of Aflatoxin B₁ from Animal Feed.

Rathnayake, R.M.D.N.

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M.Sc. Degree, 2011.

Location No. 1195

2.168

Studies of Plant Extracts as Natural Antioxidants.

Peiris, Thusith

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M.Sc. Degree, 2004.

Location No. 322

2.169

The Study of Change in Atmospheric Lead (Pb) Levels in Colombo with the Phasing Out of Leaded Petrol in Sri Lanka.

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2.170

A Study of the Solasodine Content in Different Species of *Solanum* in Sri Lanka.

Kanagarathnam, Uma

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2.171

Synthesis and Characterization of Photochromic 5-Chloro-4,6-Dimethyl-2-Hydroxybenzaldehyde.

Wijewardena, K. Buddika

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Location No. 408

2.172

Synthesis and Characterization of Poly (3,4-Ethylenedioxythiophene) Intercalated in Bentonite Clay.

Fernando, T.S.B.

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Location No. 513

2.173

Synthesis of Transition Metal Macrocyclic Complexes for the Utilization of CO₂.

Navarathne, W.D.T.J.

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M.Sc. Degree, 2013.

Location No. 1379

2.174

Understanding Light Emitting Properties of 8-Hydroxyquinoline-Resorcinol-Formaldehyde Polymer Metal Chelates.

Nayanananda, S.B.

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2.175

Utilization of Conducting Polymers as Sensitizers in Solid-State Photocells.

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2.176

Utilization of Rice Husk to Remove Metal Ions in Solution.

Rajakaruna, D.J.A.S.De S.

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Location No. 194

2.177

Variation of Groundwater Quality Trends: A Case Study from Sammanthurai Well, Sri Lanka.

Sharifdeen, M.M.

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CHEMICAL ECOLOGY AND PESTICIDE CHEMISTRY

2.178

Chemical Investigation of *Litsea ovalifolia*.

Goonesekera, Iranga Wimala

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2.179

Chemistry and Bioactivity of *Diploclisia glaucescens* and *Elaeocarpus serratus*.

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2.180

Determination of Neutral Sugar Composition of Tea Clones TRI-3015, TRI-3019 and TRI-4078.

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2.181

Effect of Root Polyphenols and Amino Acids on Nematodes in Tea.

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2.182

Effect of Sunlight, Soil Nutrient Status and Original Establishment on the Chemical Composition of *P. longum*.

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M.Sc. Degree, 2002.

Location No. 231

2.183

Insecticide Tolerance in the Bruchid *Callosobruchus maculatus*.

Bogamuwa, M. M. Samantha

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M.Sc. Degree, 2002.

Location No. 230

INDUSTRIAL CHEMISTRY

2.184

Analysis of a Commercial Fertilizer.

Widurusinghe, U.M. Ratnakumari

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M.Sc. Degree, 2002.

Location No. 253

2.185

Application of Hydrocyclone in Industrial Wastewater Treatment.

Egodawatta, E.A.I.N.

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M.Sc. Degree, 2012.

Location No. 1202

2.186

Controlling Odour in Tobacco Processing.

Bandaranayake, B.M.S.H.

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Location No. 1232

2.187

Effect of Sunlight and Rain on the Colour of Coloured Asbestos Sheet.

Karunaharan, Arunasalam

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Location No. 526

2.188

Effect of Using Microwave Energy for Withering on Quality of Made Tea.

Imthyas, S.

154p.

M.Sc. Degree, 2000.

Location No. 130

2.189

Extraction and Characterization of Bixin from the Annatto Seeds and its possible use in the Colour Enhancement of Gold Fish.

Dananjaya, S.H.S.

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M.Sc. Degree, 2013.

Location No. 1325

2.190

Feasibility Study of Bio Diesel Production from Locally available Non Edible Oils.
Gnanarathna, P.M.G.M.
73p.
M.Sc. Degree, 2011.
Location No. 1096

2.191

Improving the Quality of Cement Manufacturing Process by using Statistical Techniques.
Hettiarachchi, H.A.J.R.
65p.
M.Sc. Degree, 2011.
Location No. 1095

2.192

Manufacture of Precipitated Calcium Carbonate from Dolomitic Quick Lime.
Pathmanathan, Kandiah
38p.
M.Sc. Degree, 2000.
Location No. 112

2.193

Mosquito Larvicidal Activity of Selected Plant Extracts and Isolation of Active Ingredient from *Pagianta dichotama*.
Sooriyage, R.S.
53p.
M. Sc. Degree, 2010.
Location No. 946

2.194

Optimization of Activated Sludge Process for a Brewery Waste Water Treatment under Local Conditions: Plant Process Control and Managment by a Quality System.
Perera, D. S. C.
84p.
M.Sc. Degree, 2004.
Location No. 336

2.195

Preparation of an Adherent Hydroxyapatite Layer on Stainless Steel for Orthopedic Applications.
Wijayarathna, E.D.B.P.
24p.
M.Sc. Degree, 2012.
Location No. 1201

2.196

Quality Improvement of Fertilizers by using Control Charts for Variables.

Welagedara, Anuradha

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M.Sc. Degree, 2002.

Location No. 195

2.197

Quality of Generic and Branded Drugs in Sri Lanka.

Rixan, Fathima Ifthiya

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Location No. 335

2.198

Removal of Dye Colour from Aqueous Solutions by Adsorption on Mineral Surfaces.

Jeyaruban, Kanagarajah

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Location No. 291

2.199

Removal of Iron from Rubber Factory Effluent using Dried Salvinia Plant Material.

Fazeel, U.M.

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M.Sc. Degree, 2004.

Location No. 378

2.200

Removal of Phosphate and Phenol in Wastewater using naturally available Materials.

Silva, S.A.N.C.

59p.

M.Sc. Degree, 2008.

Location No. 723

2.201

Some Formulation Studies of Toothpaste using Eugenol Rich Flavour and Calcium Carbonate.

Kumara, N.M.N.I.U.

74p.

M.Sc. Degree, 2009.

Location No. 903

2.202

Stream Water Blackening by Effluent Discharge of a Yarn Dyeing Industry.

Fernando, Priyantha Lakshmen

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M.Sc. Degree, 2002.

Location No. 196

2.203

Study of Print Intensity Variation of Cigarettes.

Pathiraja, Chandana Mahesh Sadagiri

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M.Sc. Degree, 2003.

Location No. 337

2.204

Survey on Occupational Health and Safety Management Systems Applications in Sri Lankan Industries.

Ossan, T.K. Sahid

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M.Sc. Degree, 2004.

Location No. 377

2.205

Use of Diluted Natural Rubber Centrifuged Latex for Pillow Manufacture.

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M.Sc. Degree, 2003.

Location No. 290

2.206

Waste Human Hair as an Oil Recovery Material.

Samoon, Mohamed Meerasahibu

189p.

M.Sc. Degree, 2002.

Location No. 250

NANOSCIENCE AND NANOTECHNOLOGY

2.207

Antimicrobial Efficacy of Nano-Zinc Oxide-Coated Cross-Linked Cotton.

Karmegam, Vasanthi

48p.

M.Sc. Degree, 2013.

Location No. 1342

2.208

Copolymerization of 8-Hydroxyquinoline with Aniline and Intercalation of 8-Hydroxyquinoline into Montmorillonite Clay.

Jayasekara, I.U.

55p.

M.Sc. Degree, 2013.

Location No. 1376

2.209

Design, Manufacture and Implantation of Custom-Made Orthopedic Bioprotheses for Needy Patients: Nano-Range Hydroxyapatite Coating on Roughened Stainless Steel Surfaces.

Mahavithana, A.P.

105p.

M.Sc. Degree, 2010.

Location No. 1100

2.210

Dye Sensitized Solar Cell Based on Hydrothermally Synthesized TiO₂ Nanotubes.

Akilavasan, J.

39p.

M.Sc. Degree, 2010.

Location No. 1101

2.211

Fabrication of Dye-Sensitized Solid-State Solar Cells: use of Triethylamine Hydrothiocyanate as Crystal Growth Inhibitor.

Bandara, H.M.U.G.A.

41p.

M.Sc. Degree, 2011.

Location No. 1144

2.212

Fabrication of ZnO Based Dye-Sensitized Solar Cells Using Screen Printing Technique.

Ratnayake, I.S.

38p.

M.Sc. Degree, 2013.

Location No. 1343

2.213

Influence of the Particle Size of CaCO₃ Coating Layer on the Efficiency Enhancement of SnO₂-Based Dye Sensitized Solar Cells.

Siriwardena, E.K.D.H.D.

33p.

M.Sc. Degree, 2013.

Location No. 1377

2.214

Instrument and Software Development for Measuring Size of Nanoparticles Using Dynamic Light Scattering.

Ariyasinghe, D.M.B.P.

26p.

M.Sc. Degree, 2010.

Location No. 1037

- 2.215
Mixed Cation Effect in Enhancing the Efficiency of Dye Sensitized Solar Cells Based on Poly(Methyl Methacrylate) (PMMA) and Nanoporous Titanium Dioxide (TiO₂).
Jayathissa, Rasanjali
55p.
M.Sc. Degree, 2012
Location No. 1237
- 2.216
Modeling of Arsenic Adsorption on Gibbsite Nanoparticles.
Abeywardana, S.B.Y.
49p.
M.Sc. Degree, 2012.
Location No. 1180
- 2.217
Photocatalytic Degradation of Methylene Blue on FeTiO₃/ TiO₂/ PbS Hetero-Junctions.
Sivayoganathan, Sivayini
48p.
M.Sc. Degree, 2013.
Location No. 1341
- 2.218
Preparation and Characterization of Ferrite Nanoparticles.
Ranasinghe, S.K.
56p.
M.Sc. Degree, 2012.
Location No. 1199
- 2.219
Preparation, Characterization and In-Vitro Release Study of Ascorbic Acid-Encapsulated Liquid Crystal Liposomes.
Hewawarawita, L.S.
45p.
M.Sc. Degree, 2011.
Location No. 1145
- 2.220
Self-Cleaning Cellulose Fabric with TiO₂ Nano Particles.
Akramus, Z.
45p.
M.Sc. Degree, 2011.
Location No. 1099

2.221

Study of Ionic Conductivity of (Polyethylene Oxide) (PEO) Based Polymer Electrolytes with Fillers.

Athukorala, E.A.D.M.

45p.

M.Sc. Degree, 2012.

Location No. 1200

2.222

Surface Modification of Iron Oxide Nanoparticles by Casein.

Weerasekara, W.M.P.M.B.

38p.

M.Sc. Degree, 2011.

Location No. 1181

2.223

Thermal Degradation Behavior of Clay Polymer Nanocomposites.

Wijeratne, K.T.

89p.

M.Sc. Degree, 2011.

Location No. 1098

2.224

Transparent Nano-Composite Electrodes for Dye-Sensitized Solar Cells.

Wickramaarachchi, W.A.P.N.

35p.

M.Sc. Degree, 2013.

Location No. 1303

2.225

Zinc Oxide-Based Dye-Sensitized Solar Cells.

Karunaratne, S.M.M.L.

31p.

M.Sc. Degree, 2012.

Location No. 1231

2.226

Zinc Oxide Thin Films for Dye-Sensitized Solar Cell Applications

Liyanage, D.S.K.

41p.

M.Sc. Degree, 2010.

Location No. 1036

3 - EARTH SCIENCES

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Research Project Reports

Ph.D. Dissertations

3.1

A Classification Method for Optical Phenomena of Cat's-Eyes and Stars in Minerals.

Kumaratilake, W.L.D.R.A.

128p.

Ph.D. Degree, 2011.

Location No.1117

Abstract

In gemstones, needle-like inclusions originate by crystallization of exsolved impurities which occupy structurally favourable specific crystallographic directions in the host mineral during cooling. Countless sub-microscopic needle inclusions near the surface of a cabochon-cut gemstone scatters and reflects light and forms an image that can be described as an optical-loop called a Cat's-eye. Two or more optical-loops cross each other and form a star effect or a network of stars in gemstones. Cat's-eyes and formation of stars and star networks are phenomena that are least explored areas in gemmology. Objective of this study is to develop a *classification method* of cat's-eye and star phenomena applicable to all gem minerals, revealing the effects in profound detail.

The study introduces quantitative and qualitative classifications to aid systematic study of cat's-eyes and stars. The quantitative approach (a) reduced the gamut of least explored cat's-eyes and stars into mere eighty nine types, a stereogram and a code visually illustrating complex star-networks analytically and the stereogram enabling the decoding of codes, (b) surfaced many missing links of cat's-eyes and stars laying a platform for new discoveries like sinhalite cat's-eye. The qualitative comparison scale portrays the quality of a cat's-eye/star from a commercial standpoint and determines the subjective value addition of the stone.

Both quantitative and qualitative research methodology was utilised to devise the classifications. Hypothesis test was carried out from observational study of needle inclusions including those given in previous literature. The result is significant that needles orient *parallel to each other* and *parallel to symmetry-axes-of-rotation of the host crystal* and form the optical-loops perpendicular to those even in rough gemstones. In a fashioned cabochon (sphere) an optical-loop moulds into a circular loop-plane, and hovers above the surface of the stone at a specific distance. This *hovering-distance* (d) is determined by the Wuthrich's equation $d = r/2(n-1)$ mm which relates to the radius of the sphere (r) and the host refractive index (n). Several symmetry-axes-of-rotation produce angled loop-planes which crisscross to form a star-network. To better understand the effect, the study utilized the relation of cat's-eye and star phenomena to the host crystal symmetry. The quantitative model developed here used this relation and incorporated the loop-plane as an *extra symmetry element* in the host *stereogram*. Model's *parameter* is the *formation of loop-planes perpendicular to symmetry-axes-of-rotation* and the *variable* is the *component symmetry-axes-of-rotation*, one hundred and six in total within the *thirty two symmetry classes*. The symmetry-axes-of-rotation are categorized into *stand-alones* (e.g. A_6), *sets* (e.g. $6A_2$), and *combinations* (e.g. A_42A_2 , $6A_24A_33A_4$). The stand-alones produce *twenty seven* cat's-eyes, and both the sets and combinations yield *sixty two* star-networks, which is an exhaustive number for entire range of minerals. The total of eighty nine cat's-eye and star effects has been uniquely identified and a code has been developed to document and classify each one of those on the basis of

component symmetry-axes-of-rotation producing the effect. Thus, a four-level and four/eight/twelve-digit code has been proposed in the classification.

Many gemstone examples were fitted into the coded classification and this included speculations. However, Sri Lankan star sapphire showed some inconsistency and additional data had to be gathered to improve it. Certain twin crystals display symmetries which deviate from their simple crystals and the new classification scheme is consistent with such compound crystals too. New scheme was also applied to star sapphires showing *polyasterism* to uncover the details of displaced sections of those crystals produced by deformation. The classification was finally applied on man-made fibre-optic cat's-eye material (amorphous) to learn the commercial manufacture of the star stones. A qualitative-model was developed to *compare* qualities of cat's-eye/star phenomena. The *parameter* is the hovering distance d of the phenomena whilst keeping constant the radius (r) of the stones under comparison. *Subjective variables* were the three quality factors of the comparing phenomena - *intensity, definition* and *colour*. To represent qualities of entire range of known phenomena a sample of twenty eight cat's-eye/star species were selected with radius $r = 5\text{mm}$. The quality factors of seven commercially accepted species were benchmarked and the benchmarks were utilized to develop a *comparison scale*. Comparison scale demonstrates relative position of a given cat's-eye/star with respect to a benchmark.

M.Phil. Theses

3.2

Applications of Red Clays of Sri Lanka for High Quality Ceramic Products.

Hettiarachchi, P.

99p.

M.Phil. Degree, 2011.

Location No.1116

Abstract

Demand for raw materials such as ball clay and china clay has been extremely increased in recent past with the application of ceramic materials for building and construction purposes such as floor and wall tiles. Consequently, available ball clay and china clay deposits are rapidly being exhausted. Red clay-based ceramics such as bricks, roof tiles, pottery and ornamental ware are being manufactured in Sri Lanka for a long time. Poor understanding on red clay and its product has resulted in manufacturing low quality products. The diversification of the product range has not happened throughout the last few decades due to lack of research and development on red clay-based ceramics. Present study was focused to identify the potential of red clay in the production of high quality low cost ceramic products.

The mineralogical composition and textural variation of red clays collected from two main climatic zones of Sri Lanka were identified. The effect of mineralogical composition and textural variation of red clays on the quality of the products was investigated. The potential of incorporation of commonly available granite as a fluxing raw material for red clay ceramics was then studied. Also the feasibility of incorporation of a high alkali-borax frit for reducing the vitrification temperature of red clay-based products was determined. For diversifying the range of products, the feasibility of developing an efficient casting slip using red clays and fabricating of compatible glazes for these products were studied.

The results showed that clay samples of dry zone are rich in illite group clay with a high amount of alkaline oxides (Na_2O and K_2O) and Fe_2O_3 . Samples from the wet zone were rich in the

kaolinite group clays with a low amount of alkaline oxides and Fe_2O_3 . The dry zone clays showed a lower refractoriness compared to the wet zone clays that are characterized by good vitrification and higher strength even at low firing temperatures. When the amount of Na_2O , K_2O and Fe_2O_3 in the clay-silt fraction is about 21 wt.%, a best quality product (flexural strength up to 26.82 MPa and water absorption <6.51 %) can be obtained. The composition raw materials such as clay-silt and sand are 80 wt. % and 20 wt.% respectively and the burning temperature was at 1000 °C. If the amount of Na_2O , K_2O and Fe_2O_3 is low, a 90 wt.% of clay-silt fraction must be added to obtain the optimum quality at 1000 °C.

The results showed that microcline, anorthite, biotite and hornblende of granite act as fluxing mineral-materials for the body composition of red clay products. A product having higher flexural strength (72.48 MPa) and bulk density (2.59 g/cm^3) and less water absorption (<0.11 %) can be fabricated using granite powder. The body composition of the best product is 60 wt. % of clay-silt, 10 wt. % of quartz and 30 wt.% of granite. The incorporation of 10 wt. % of frit into above composition resulted in reduction of firing temperature from 1100 °C to 1025 °C. However, the strength of the final product was reduced from 72.48 to 49.98 MPa.

A casting slip having a good casting rate and casting properties can be prepared using locally available red clays. However, china clay should be added to improve the casting rate of the slip. Present study revealed that the transparent or stain fritted glazes matured at 1100 °C can be used to enhance the quality of red clay products.

Based on the results obtained from the study, it can be suggested that red clay deposits available in Sri Lanka can be utilized to fabricate high quality ceramic products such as tiles, cookware items and ornamental wares.

3.3

Application of Spatial Data Infrastructure Technology and Mobile GIS for Disaster Management in Sri Lanka.

Koswatte, R.M.K.G.S.P.B.

109p.

M.Phil. Degree, 2011.

Location No. 1143

Abstract

In disaster management, the value of accurate and reliable information together with available resources and facilities on the current situation of the disaster event is crucial. Spatial information plays a key role in case of decision making and action planning. Use of spatial data in disaster management will be a collaborative effort of integrating spatial data from diverse sources. Spatial Data Infrastructures (SDIs) benefited for such collaboration enabling to share information among wider community involved.

Mobile GIS would greatly improve the quality of infield decision making of disaster management. Use of Mobile GIS tools developed based on SDI framework will further improve efficiency and effectiveness in all levels of disaster management related activities. But, the lacking of proper SDI framework suitable for Mobile GIS application development for disaster management blocks the benefits of integrated use of these technological marvels. It urges a new SDI model in bridging this gap.

This research implemented a theoretical approach to identify the additional requirements in SDIs to use for Mobile GIS applications in disaster management domain. For that, current SDI models were evaluated in light of Mobile GIS and Disaster Management. The developed new SDI model is conceptually evaluated and a prototype Mobile GIS is created to empirically test

the validity of identified elements. The entire system is developed using Open Geospatial Consortium (OGC) compliant Free and Open Source Software (FOSS) to make the system low in cost and to be in accordance with geospatial standards. In addition to that, all the spatial data and metadata used in the system were standardized in accordance with Federal Geographic Data Committee (FGDC).

Within the study, the prototype system developed based on the new SDI is successfully applied to manage an assumed real life disaster incident. In here, it could successfully identified several safety locations by analyzing distributed spatial data in real-time while in the field. The conceptual model evaluation and practical test confirms the validity of identified additional elements and demonstrate the possibility of successful implementation of disaster management focused FOSS Mobile GIS applications using an expanded SDI.

3.4

Assessment of the Potential Threat to Ground and Surface Water due to Agricultural Practices in Kala Oya Basin.

Young, Sansfica Marlyn

200p.

M.Phil. Degree, 2007.

Location No. 696

Abstract

The Kala Oya basin of Sri Lanka covers the North central and the Northwestern provinces that are mostly belonging to the dry zone of the country. Understanding the effect of the agricultural practices on water quality of the area, chemical analyses on different waters were studied from May 2005 to March 2007.

Collected samples were analyzed by the Atomic Absorption Spectrophotometer, at the Department of Geology for Na, K, Ca, Mg, Mn and total iron, while nitrate and phosphate have been measured using the spectrophotometer HACH DR 2010. Appropriate standard techniques were followed to minimize the analytical errors.

Compared to the application rate of fertilizer, the average nutrient concentrations in water are relatively low (1.5 ppm nitrate and 0.5 ppm phosphate) and stable. Detailed geochemical investigations of selected groundwater samples revealed a gradual rise of nitrate-N and some solutes towards the flow direction.

However, excess fertilization to the main crops is becoming a threat to some surface and groundwater bodies. Some lakes show high values (21.6 ppm) of phosphate. In contrast, the phosphate values of most waters are in the range of 0 – 2.5 ppm. Nitrates show a clear high level in the agro wells (1.00 – 8.00 ppm), explaining the fact that the excess fertilizer has been seeped to the nearby water bodies. The lakes, streams and canals do not show any significant increase in nitrate, which may be due to the removal of nitrogen by microorganisms in the water. Though the health risk levels of WHO limits for nitrate and phosphate does not exceed in almost all of the waters.

The results show that stream and canal waters are rich in Ca and Mg but the measured other ions are considerably low. In contrast, lake water is characterized by many dissolved ions except Ca and Mg. The highest values of Fe and Mn are found in lake waters but such ions are low in groundwater. Generally, the dissolved ions in groundwaters are comparably high. The pH is more alkaline in the agricultural wells and dug wells while it is more acidic in the tube wells. Na is high in the agricultural wells and has low Ca and Mg. The conductivity is very high in some dug wells (5500 μ S/cm).

Intense agricultural practices increase the nitrate and phosphate concentrations as well as other dissolved ions in the water of the area. The present study revealed that reducing conditions, chemical and mineralogical characteristics of the overburden soil cover and man made canal network control the nutrient accumulation into the groundwater. The riparian zones along the interconnected canal system of the basin show healthy heavy growth of nitrogenous plants resulting low values of nutrients. The natural conditions such as the basement geology and the climatic conditions may also enhance the dissolved cations in waters. Considering all the above facts, it can be concluded that the contamination potential of surface and groundwater of Kala Oya basin is not significant but occurring in minute quantities with a low trend.

3.5

Genesis of Pegmatites and use of Pegmatite Mine Waste as Fertilizer, Matale District, Sri Lanka.

Amaraweera, T.H.N.G.

128p.

M. Phil. Degree, 2009.

Location No. 917

Abstract

Matale district in Sri Lanka is well known for many mineral deposits, most of which contribute to the national economic development. Detailed geological, mineralogical and geochemical studies were carried out on several exposed mineral deposits located in the Matale District in order to understand the genesis of ore bodies and assess the economic potential of them.

Syenitic to granitic pegmatite bodies, which carry several valuable minerals such as quartz, feldspar, mica and topaz are common in the study area. The field setting, petrography of pegmatites and chemical composition of feldspar around Owala area suggest that those have been derived from a single hydro-saline magmatic source generated by crustal anatexis processes. Liquid fractionation of volatile-enriched, silica-undersaturated melt from the parent magma resulted to form syenitic pegmatites. The residual melt, rich in silica had fractionated again slightly and was emplaced as granitic pegmatites in the vicinity of syenitic pegmatites. However, the granitic pegmatites in the northern part of the area may have derived from a different magmatic source. The lower concentrations of trace elements of feldspars in all studied pegmatites imply that they have less potential for economic minerals other than presently available industrial minerals and topaz.

Mafic granulites boudinage bodies intercalated with marble host in the vicinity of pegmatitic bodies imply that crustal rocks have experienced granulite-facies metamorphism at conditions of $854 \pm 33^\circ\text{C}$ at 10.8 ± 0.6 kbars as revealed by mineral assemblages of Grt-Opx-Cpx-Bt-Pl-Qtz. Although pressure-temperature estimates of present study are identical with the pressure-temperature estimates using sapphirine-bearing rocks elsewhere in the Highland Complex, those are considerably higher than the pressure-temperature estimates using other thermobarometers.

Laboratory incubation experiments show that the waste products at mining sites can also be effectively used as mineral fertilizer. The results reveal that mixtures of waste feldspar and apatite can be utilized as a multi-nutrient fertilizer for long term crops growing in acidic soils. Release of K^+ from mica by reaction with organic acid is much greater than that from potassium feldspar. However, mica also releases higher quantities of iron that is toxic for plant and the iron released may form insoluble iron phosphates with available phosphate. As such, mica cannot be used as a fertilizer.

3.6

Geology, Microstructure and Chemistry of some Vein Graphite Deposits of Sri Lanka.

Balasooriya, Nanda Wipula Bandara

130p.

M.Phil. Degree, 2001.

Location No.179

Abstract

Sri Lanka has a widespread distribution of natural graphite of high purity in exclusive areas of the Central Highlands characterized by Precambrian metasedimentary rocks. At present, exploration work continues mainly at Bogala and Kahatagaha/ Kolangaha mines. The present study is based on graphite from these mines.

Successions of charnockite, quartzite, calcgneiss, garnet gneiss and biotite gneiss are seen associated with Bogala graphite deposits. Occurrence of charnockite and quartzite suggests the metasedimentary stratigraphy of the mined graphite contains rocks. These rocks together with biotite gneiss and rare marble characterize the geology of the KahatagahaKolangaha mine. Petrographic evidence shows that plagioclase is closely associated with graphite veins and has altered to perthite.

The graphite veins cut across gneissic rocks and show irregular branching. Width of the graphite veins of the Kahatagaha/ Kolangaha deposits may vary from 2m to 20m. Most of the graphite veins are discontinuous with thickness varying from less than 1 mm to several tens of cms. The most common vein thickness in Bogala graphite mine is less than 2 cm.

The carbon content in graphite was determined using burning method, XRF analysis and Carbon- Sulphurdeterminator. In graphite from Bogala and Kahatagaha/Kolangaha, more than 93.00% of C was noted. This high percentage of C characterizes good quality natural graphite. Major impurity elements were Fe, Cu, Si, Ca and Mg (9.59% - 0.12%). Al, As, Co, Mn, Ni, Pb, Rb, S, Sr, Ti and Zr (<1000ppm), were the minor elements in vein graphite. X-Ray diffractogrammes of different forms of graphite from the three mines clearly show the presence of strong peaks at $d=3.365$ and 1.680 and weak peaks at 2.137 and 2.036 indicating the formation of graphite-carbon. When peak intensities of graphite-carbon have increased, the small peaks of graphite-carbon disappear.

Graphite flakes are formed from very fine-to-fine fibres. Some graphite samples show graphite flakes converted into scaly structures. Well-formed crystals of graphite with distinct faces are rare but well compact equigranular aggregates with partly hexagonal crystal faces having parallel structure are common as seen by the Scanning Electron Microscopy (SEM) study.

After preliminary studies based on structural and physical characteristics, seventeen different forms of graphite were identified from Bogala, Kahatagaha-Kolangaha and Ragedara mines. Together with the common forms, three similar graphite forms were found to occur in Bogala, Kahatagaha-Kolangaha and Ragedara mines. The common forms are *shiny slippery fibrous*, *coarse radially flaky* and *coarse striated flaky*, graphite. Other forms are *platy needles*, *coarse-flaky* graphite forms and their variations. *Fine flaky* and *amorphous* graphite forms occur only in the Bogala mines.

The variations in the impurity content of the different forms of graphite seem to suggest a difference in the composition of the late pegmatitic fluids flowing into the fractures of the country rocks at different stages of the mineralization process. According to the results obtained, the average content of S in both locations is around 0.01%. The main source of sulphur is sulphur bearing minerals and rocks formed in the host rock. Pyrite (FeS_2) and

Chalcopyrite (CuFeS_2) are minerals of the sulphur bearing ores. After weathering, S had appeared as sulphur enrichment materials in the fractures and along the joints of the host rock.

3.7

Gold Mineralization in Sri Lanka with Special Emphasis on Walawe Basin and Ramboda Areas.

Wijeratne, Godapolage Nissanka

177p.

M.Phil. Degree, 2001.

Location No.185

Abstract

Sri Lanka has a long history of using gold in jewellery, coins and other crafts. Mahawamsa, 'the grate lineage', written about 2000 years ago and Thupawamsa (200-600AD) indicate the mining sites of gold and other metals in connection with building of shrines in ancient Sri Lanka. They also describe the nature of gold found in the mines particularly the dendritic form and sizes of pieces that varied from 10 to 15 cm, characteristic of native gold.

The next available records on gold were in the 19th century during the colonial period of Sri Lanka (then Ceylon) when there was great enthusiasm for gold mining in parallel with the world gold rush. This was also known as the "Ceylon gold rush" and as a result of some work carried out in the valley of Rubies in the Horton Plains, some payable amounts of gold had been recovered. The gold was found in the bottom layer of the gem deposits displaying its high specific gravity. The Ceylon administrative reports of 1893 showed that gold was also mined in the Ramboda area. Some analysis of samples have been done even in foreign laboratories. This work, however, had been suspended due to lack of funds.

Gold exploration work in Sri Lanka resumed before the last two decades and has continued in a more scientific manner. Several exploration programmes have been carried out and this work was initiated with the intention of locating potential areas for gold deposits. After studying the available literature, maps and aerial photographs, the work was concentrated mainly to areas covered by the proposed mineralized belt along the microplate margin as shown in a recent plate tectonic model for the development of Sri Lankan rock associations. The study area includes a high grade metamorphic terrain of Sri Lanka which shows a marked difference to the main gold producing areas of the world, the Precambrian greenstone belts. However, there were some similarities such as the presence of wall rock alteration and the structurally controlled nature of mineralization.

Any discovery of gold deposits in Sri Lanka will certainly upgrade the economy of the country and could save a large amount of valuable foreign exchange. Even a low-grade deposit can probably be exploited profitably as labour costs are still comparatively low in the country. Further, the study is expected to contribute to the scientific knowledge on gold mineralization in high-grade metamorphic terrains.

The areas selected include the Walawe Ganga basin and the Kiri-Ibbanwewa areas in the southern part and Ramboda in the central part of the country. Based on the information of aerial photographs, work was concentrated mainly on areas of high structural control. Panned heavy mineral concentrates and raw sediment samples were collected from the streams, flood plains and existing gem pits. Separation of heavy minerals was carried out using the magnetic separator and identification of minerals was carried out using the petrological microscope. Gold grains visible under the microscope were separated in weighed laboratory samples and a

statistical analysis of heavy minerals and gold was performed. Analysis of grain morphology and chemical compositions was carried out using the Electron Probe Micro Analyser and X-Ray Fluorescence Spectrometer (Energy Dispersive). The quantitative chemical data obtained were correlated with the Neutron Activation analytical data. The rock samples collected from locations around gold anomalies in the stream, which included marbles, pegmatites, skarns, pegmatitic gneiss, and veins were digested, the gold was concentrated into organic solvents and analyzed by Atomic Absorption Spectrometer equipped with a Graphite Furnace. Petrological analysis was performed for rock samples from locations that showed gold enrichment.

Heavy sediment analysis revealed that ilmenite and garnet were the major heavy minerals that are associated with gold lying on the decomposed rock layer. The high specific gravities of such minerals as well as gold force them to be distributed at the bottom of the sequence of heavy sediments. The statistical analysis of river sediments shows anomalous increase of gold along the river and the values range from 0.20 to 9.33 g/t. These areas of anomalous gold potential were shown on a map of the Walawe basin.

The composition and the morphology of gold grains show a clear relationship. The morphologies can be divided to main two types;

- (a) The grains with sharp outer contours and
- (b) The grains with worn out outer contours

The results indicate that the sharp edged grains are in the form of Electrum (Au - 65% to 80 and Ag - 35% to 20%). A change of compositions from electrum to pure gold exists and the mechanism behind this transformation is mainly *self-electro-refining*. Mechanical deformation and exposure of fresh surfaces of the grains also promote this process.

The results of rock samples show comparatively high gold concentrations in twelve locations. There are five locations with very high concentrations from 0.005 ppm to 0.161 ppm. Three of them are situated at the upper part of the Walaweriver. The other two are located at one of the major tributaries of Walaweriver, named Mulgamara.

The petrological analyses of rocks from comparatively high gold bearing locations show evidence of influence of fluids in a late stage of peak metamorphism. Crystallization of quartz, presence of secondary non oriented biotite and complete retrogression reactions of altering clinopyroxene to hornblende confirm that fluids had been active in the transportation of gold. However, the presence of calcite in pseudo-sphene shapes and some times also wollastonite in thin sections provides the evidence for the influence of CO₂-bearing fluids.

The results of this study clearly indicate the presence of gold-bearing veins and rocks along the Walaweriver. Further analysis is necessary to identify the distribution pattern of gold below the surface of these rocks and veins. The fluid inclusion studies will be helpful to identify the nature of the fluid and to determine the age relationships. Using this knowledge it may be possible to relate the activity of gold transporting fluids to one particular stage of the peak metamorphic events.

3.8

Quantification of Erosion Rates and Evolution of Geomorphology in the Highlands of Sri Lanka.

Illangasinghe, I.K.M.S.C.K.

174p.

M. Phil. Degree, 2010.

Location No. 1041

Abstract

Erosion is a natural and geomorphological process, which is mainly driven by climate and tectonic forces. However, due to the human activities, the rate of erosion has dramatically increased over the over the natural level especially in agricultural-based tropical countries. Several negative impacts are associated with the erosion. Thus, scientists have been paying more attention to control the elevated erosion through conservation practices. Therefore, identification of erosion hot spots and determination of efficiency of soil conservation measures is vital. Quantification of long-term erosion rate is also an important requirement to compare the short-term erosion rates considering long-term rate as natural benchmark level and useful for quantitatively measurements of geomorphological process. In this research, short-term erosion rate is estimated in plot scale using a novel technique. Further, short-term erosion rate in catchment scale were quantified while introducing an easy, low-cost but reliable river load gauging method. In addition, long-term erosion rates were quantified in the same area based on cosmogenic ^{10}Be nuclide concentrations in river sediments. The entire study was carried out at 8 tributaries of two large river basins (viz Walawe and Kalu river basins) in the tropical highlands of Sri Lanka. Previously measured long-term erosion rates of Upper Mahaweli Catchment were also used to discuss the long-term geomorphological processes in the Central Highland of Sri Lanka.

To quantify short-term erosion rate on plot scale, soil samples were collected randomly from top and sub-surface. The samples were subjected to dry sieve analysis. Then the fine fraction loss was calculated by enumerating the retained percentages of fine fraction in the top soil samples and the sub-soil samples. Finally, the net soil loss was calculated based on area weighted soil loss and deposition rates. To quantify the short-term erosion rates in catchment scale, surface water samples were collected by trained villagers on daily basis throughout a complete hydrological year from the 8 tributaries to estimate the suspended loads. Additionally, depth-integrated water samples were collected on monthly basis. Then a site-specific calibration graph was established between surface and depth-integrated suspended sediment concentrations. In addition, suspended sediment rating curves were constructed. Moreover, chemical erosion rates were measured in these tributaries using dissolved concentrations. To quantify the long-term erosion rates, sediment samples were collected from bed of the rivers of seventeen selected tributaries in the Walawe and Kalu river basins. Concentration of ^{10}Be cosmogenic nuclides were measured in quartz grains of the bed load sediment using AMS facility at the ETH, Zurich.

At plot scale, net sediment generation rate in the plot was calculated as $3304 \text{ t km}^{-2} \text{ y}^{-1}$. Short-term erosion rates estimated in catchment scale using river load gauging range from 180 to $240 \text{ t km}^{-2} \text{ y}^{-1}$ and from 390 to $1250 \text{ t km}^{-2} \text{ y}^{-1}$ in Walawe and Kalu ganga river basins, respectively. Long-term erosion rates in these two basins are in a range of $44 - 190 \text{ t km}^{-2} \text{ y}^{-1}$ and $114 - 130 \text{ t km}^{-2} \text{ y}^{-1}$ for Walawe and Kalu ganga river basins, respectively. The resulted erosion rates in the two basins were analyzed and interpreted with geomorphological parameters and landslide distribution, which were derived using GIS.

This research presents a new method to measure soil erosion and deposition rates on plot scale. Gem mining is prominent in the Kaluganga basin, which yields sediments at a rate higher than $3 - 10$ times over the natural rates of sediment generation in the source regions. However, the short-term sediment yields and the long-term sediment generation rates in the Walaweganga are nearly equal, implying that human interferences in the basin are negligible. It was identified that chemical erosion rate in the catchments are mainly controlled by extent of fresh rocks exposed to the environment via landslides. Tectonically passive tropical Central Highlands of Sri Lanka offer a range of cosmogenic nuclide derived erosion rates for diverse geomorphological settings. The existing morphology of the country has being developed

through escarpment retreat process. The analyses of geomorphological parameters and cosmogenic nuclide derived erosion rates revealed that possible process of retreat is driven at the tip of the encarpment by rock falls and creek incision while base of the encarpment is prominently worn down by mass movements.

3.9 --- Quantification of Proton and Organic-Chlorine Interactions in Pyrite - Water Interface: A Mechanistic Approach.

Liyanagedara, LiyanagedaraMudiyanselageMudithaPremakumara
106p.

M. Phil. Degree, 1997.

Location No.09

Abstract

The overall aim of this project was to test the ability of pyrite in the destruction of chloro-organic compounds found in drinking water. According to the theoretical postulations, pyrite exhibits dual properties, namely, hydrophyllicity and hydrophobicity. Therefore, it may act as a "micella" by protruding into the hydrophobic chloro-organic molecules, that occur in the aqueous phase, to initiate the electron transfer step.

Pyrite was obtained from Huanzala, Peru. The identification was done by X-ray analysis and it was found to be the pure phase of pyrite with a deviation of $+0.068 \text{ \AA}$ of the lattice constant (5.486 \AA) from its normal value (5.418 \AA). The physico-chemical properties of pyrite-solution interface were investigated by potentiometric titrations. After carefully reviewing the available mechanistic models, the modified triple layer model (TLM) was employed to quantify both H^+ and organic-Cl interactions at the solid-solution interface.

The site density of pyrite was calculated from the crystallographic data obtained by X-ray analysis as 7 sites/ nm^2 . The specific surface area (SSA) of pyrite, as determined by the adsorption isotherm of rhodamine-b, was $0.197 \text{ m}^2/\text{g}$. The point of zero charge of the pyrite surface was found at pH 3.25. The double layer thickness of the pyrite-water interface was calculated from the Gouy-Chapman equation as 33 \AA . The acidity constants, $\text{pK}_{\text{a}1}^i$ and $\text{pK}_{\text{a}2}^i$, as determined by graphical method were 0.52 and 4.6 respectively. The same determined by numerical method employing the computer program GRIFT were 2.52 and 6.6 respectively. In addition, the surface complexation constants, $\text{pK}_{\text{a}}^{\text{in}}$ and $\text{pK}_{\text{ClO}_4}^i$ were determined by the same numerical method and they were found as 7.42 and 6.52 respectively. Other than that the behaviour of sulphide and iron when in equilibrium with pyrite was also investigated.

Finally attempts were made to identify the degradation capability of chloro-organics by pyrite surface, using chloroform as a representative of the class. In this study, it was found that pyrite has the ability to adsorb chloroform rapidly. However, the desorption that takes place within 5 min. after adsorption, did not give ample retention time for the chloroform to remain on the surface for degradation. Nevertheless, an equilibrium between the aqueous and surface adsorbed chloroform was observed after 24 hours of equilibration. The evaporation loss, however, prevents the system from reaching a well defined equilibrium. By the same experiment it was found that, under equilibrium conditions $0.92 \mu\text{g CHCl}_3/\text{g}$ of pyrite was adsorbed from a solution having an initial concentration of $9 \mu\text{g CHCl}_3/\text{g}$ of pyrite at pH 9.5.

3.10

The Relationship of Dengue Morbidity with Climatic Factors, Distribution of Vectors and Risk Areas of Dengue in Kandy District.

Wijesinghe, W.M.C.M.

86p.

M.Phil. Degree, 2013.

Location No. 1338

Abstract

Dengue is a mosquito borne infection found in tropical and sub-tropical regions around the world. In recent years, transmission has increased predominantly in urban and semi-urban areas and has become a major international public health problem. South-East Asia and the western pacific regions are the most seriously affected. In Sri Lanka a clinical dengue like illness has been recorded since the beginning of the century, and it was serologically confirmed in 1962. At present, the only method to control or prevent the transmission of the disease is to combat vectors. Climatic factors play a very important role in the transmission of dengue.

This descriptive study was planned to determine the relationship of dengue morbidity with main climatic factors, distribution of dengue vectors and spatial distribution of dengue risk areas in the Kandy District. The study was conducted under three specific objectives. The first one was to determine the relationship between weekly reporting dengue cases and main climatic factors, the second one was to determine the risk areas of dengue transmission by high resolution satellite images and the third was to describe the distribution of immature and adult vectors and man-made breeding sites by dengue cases. The 1st and 2nd objectives used dengue and climatic data of year 2000 - 2009 period. For the 1st objective, weekly average minimum temperature, maximum temperature, relative day time humidity and relative night time humidity were taken. Considering vector, virus, diseases process and notification process, climatic factor of three weeks prior were selected to correlate. Analysis was done in two steps. In the primary analysis, dengue cases were correlated with main climatic factors by Pearson correlation. In the secondary analysis, weekly reporting dengue cases were categorized in to two categories to develop a predictive model. Below 10 cases/week and 11 and above cases/weeks were nominated as (1) (low cases of dengue) and (2) (high cases of dengue) respectively.

Climatic factors with significant relationship in primary analysis were correlated with categorized dengue cases using binary logistic regression. The climatic variable with significant odds was selected and was used to formulate the predictive model. According to the results, there was a significant association between maximum and minimum temperature with dengue cases in the primary analysis. In the secondary analysis, only maximum temperature showed a significant odds ratio [odds ratio = 0.88, 95% CI = (0.79-0.98)]. By that, increasing maximum temperature has a protective effect on dengue in the district of Kandy. Then the predictive model was; Logit (odds of cases of dengue) = 3.305 + (-0.11x weekly average maximum temperature 03 weeks prior).

Risk MOH areas and localities were identified by mapping of dengue cases using GIS and Google Earth. Roads, GramaNiadaradi division boundaries and Google Earth maps were used to identify high risk localities. Those maps clearly showed that risk localities were associated with main roads and densely built areas.

In the 3rd objective randomly selected 423 dengue patients during year 2009-2011 period were examined. Data on immature vectors and breeding places were collected within a 100 meter radius of patients' residences and data on adult vectors were collected inside the residences.

By that *Aedes* and *Aedes* immature stages were found in 65% and 72% of houses respectively. Adult mosquitoes were found in 23% of houses of dengue patients. Most common breeding places in the study area were tanks (32.1%), discarded utensils (15.5%), barrels (12.3%) and plastics and polythene (11.5%). Highly infested breeding places were discarded tyres (24%), discarded utensils (19.3%), clay pots (17.7%) and gutters (16.7%).

In this study rainfall was considered as uniformly distributed. Therefore further studies are recommended considering actual rainfall of local areas within the District. Proper pipe borne water supply should be available in high risk areas. It will help to reduce potential breeding places of the community. Open mouth cemented tanks should be replaced by plastic tanks to prevent vector breeding places. Environmental sanitation programmes are highly recommended to eliminate plastics/ polythene and discarded utensils in dengue spreading areas.

3.11

Sedimentology and Micropaleontology of recent- and Paleo-Tsunami Sediments of Sri Lanka.

Kulasena, W.A.N.L.

97p.

M. Phil. Degree, 2009.

Location No. 907

Abstract

Tsunami waters started inundating many coastal regions of Sri Lanka at different times after the 2004 Sumatra-Andaman earthquake event. The principal study area of Peraliyai in the southern coastal region, maps indicating the extent of tsunami inundation were prepared using satellite imagery, field data and information provided by villagers. After the inundation event, the sediments consisting of discontinuous sheets of differing thickness, heterogeneous compositions and diverse origins were found deposited on coastal depressions as well as in similar low lying inland locations. Most of these tsunami sediments are poorly sorted and contain heterogeneous mixtures of debris of buildings and vehicles, clothes, tree trunks, shells of organisms etc. derived from coastal and deep marine environments. However, there were fine grained tsunami sediments uncontaminated by terrestrial sources occurring as thinly laminated deposits believed and later confirmed to have been deposited from suspensions in temporarily stagnant tsunami waters in particular locations. These fine sediments had got deposited and found preserved in pre-existing topographical depressions, closed houses, containers etc.

The different tsunami sediment types were mechanically separated according to size and grain size distribution curves were drawn. Finer fractions of the sediments were studied for their contents of different microfossils by reflection microscopy. The microfossils were thus separated out and selected samples were studied under the Scanning Electron Microscope (SEM). The cumulative curves for different types of tsunami sediments indicated close affinities. Microfossil contents of the sediment samples from different locations showed the presence of foraminifera, radiolarian and diatoms characteristic of the benthic and planktonic ocean environments. Influenced by references in the ancient historical texts to the occurrences of tsunamis, some topographic depressions where recent tsunami sediments had got deposited were randomly earmarked for hand auger drilling. Some dug pits showed the occurrences of fine grained sediments similar to those from recent tsunami deposits. Grain size distribution curves and SEM studies on the sediments also showed cumulative curves comparable to those drawn for recent sediments. Microfossil contents also manifested remarkable similarities.

Carbon dating studies of the recent as well as paleo-tsunami sediments yielded anomalous and contradictory values. To receive a zero or very low age for the 2004 tsunami sediments from the absolute age determination techniques requires the presence of organic material (foraminifera, radiolarians, diatoms, etc.) transported onshore by the tsunami from the ocean. Given that the sediments settled by suspension contain a mixture of deep ocean microfossils that had been killed at different times, the result would be the average age of the sediment or the age of the particular microfossil that was subjected to radiocarbon dating. To overcome this issue it is required to choose the microfossils that had been killed after the tsunami event. But due to the microscopic size and considerable mixing of tsunami sediments with materials of different ages and the time elapsed from the tsunami event to the commencement of research studies, it is nearly impossible to select the microfossils with certainty about their deaths.

3.12

Spatial and Temporal Changes of Water Quality of Tsunami Affected Areas in the South Western Coast: Sri Lanka.

Welagedara, A.S.

100p.

M. Phil. Degree, 2009.

Location No. 908

Abstract

The December 2004 tsunami made a tremendous damage in the coastal areas of Sri Lanka. Seawater either inundated domestic open dug wells, or entered to aquifers via infiltration of flooded and ponded water. High salinity of groundwater was the immediate effect noted but many contaminants such as heavy metals, nutrients, microbiological pollutants could have contaminated groundwater without any physical indication. Present work therefore aimed at the study and examination of (a) temporal and spatial variations of water quality, (b) mode of occurrences of plumes of saltwater in the subsurface (c) the recovery rate of the groundwater quality and (d) chemical and mineralogical changes of soils in a tsunami affected area in the Southwestern coast of Sri Lanka.

A representative and repetitive sets of water samples were studied during seven occasions from December 2005 to December 2008. Heavy metals, nutrients, pH, electrical conductivity, salinity, total dissolved solids, dissolved oxygen, turbidity and temperature of the water samples were determined. Two dimensional resistivity imaging of subsurface across the tsunami boundary was carried out to observe subsurface. A laboratory experiment was carried out to simulate soil-saline water interaction and XRD analysis was done to identify the mineralogical compositions.

The nutrient levels and heavy metal concentrations in the affected groundwater were low and predominantly below the detection limits, indicating that effect of tsunami inputs with regard to these parameters was not significant. Some wells (with low salinity) showed a predominantly increasing trend of salinity with time and then a decreasing trend. Higher salinity wells on the other hand showed predominantly decreasing salinity trend with time. Electrical conductivity too showed the same behaviour. Other physical parameters did not show systematic geographic or time wise variations.

Resistivity imaging across the tsunami boundary revealed a gradual improvement of groundwater quality with time due to direct infiltration of rain water and flushing by fresh lateral groundwater from unaffected inland areas. This process however, appears to be

extremely slow. Water quality recovery also appears to be hindered by the influence of permanent saline/brackish surface water bodies present in the area.

Soil interacted with saline water appeared to absorb Na^+ , Ca^{2+} , Mg^{2+} and K^+ ions of seawater and release Fe^{2+} , Al^{3+} , and Mn^{2+} into the aqueous phase. The amount of Fe^{2+} and Al^{3+} increases with increasing contact time and the salinity of water. The changes of pH and discolouration of groundwater noted in the affected area can be attributed to releasing of these two ions from salinized soils..

The XRD analysis of affected soils revealed that the smectite group clays can accommodate more dissolved ions from saline water into their structures whereas kaolinite clay mostly rejected them. Lateritic soils comprising smectite clays and the bog soil have absorbed more ions from seawater while releasing Fe^{2+} and Al^{3+} ions. The Cation Exchange Capacities (CEC) of soils increased with the increasing of contact time of saline water and the initial levels of CEC of soil.

3.13

Spatial and Temporal Variations of Hydrogeochemistry in Ancient Tank Cascade Systems in Sri Lanka: Evidence for a Constructed Wetland.

Mahatantila, W.D.K.

150p.

M.Phil. Degree, 2007.

Location No. 697

Abstract

Tank Cascade systems (TCS) are the back bone of the dry zone prosperity in Sri Lanka and supply water throughout the year to agricultural lands since the 2nd century BC. The main aim of this study is to understand the nutrient dynamics of small TCS and find out evidence for the sustainability of the system for thousands of years. Malagane tank cascade in the Deduru Oya Basin was selected for the study and water quality parameters were measured fortnightly throughout a year, followed by monthly measurements for a period of another six months. Daily rainfall was also measured during the study period. Thirteen sediment samples were collected from the tank bed and analysed for basic physicochemical parameters, available metals and total element contents.

In general, all the nutrient contents were increased in the tank water during the dry season and the maximum was reported in August to October, where the rainfall was minimal. Nitrate-nitrogen content varies from 0.62 to 14.9 mg/L while nitrate-nitrogen varies from 0.004 to 2.700 mg/L. Phosphate contents were found in the range of 0.03 to 0.38 mg/L. The other anions and cations also showed a similar seasonal variation. The spatial variation of physicochemical parameters in water is more significant in the dry season than in the wet season. The highest nitrate concentration was recorded in the inflow and decreases after water passing the *Thaulla*. Most of the anionic parameters and heavy metals followed the same pattern. However, the phosphate concentrations showed a decreasing trend from paddy fields (0.26 mg/L) towards *Thaulla*, where the concentration was lowest (0.06 mg/L) and increased thereafter indicating the anthropogenic influences near the tank bund. The composition measurements show that the elemental composition is considerably low in rain water. The lower elemental concentration of the heavy metals in sediments showed that the tank sediment has not been subjected to considerable anthropogenic influence.

In a tank cascade system, *Thaulla* located in the peripheral region of a tank acts as a constructed wetland which removes nutrients and heavy metals effectively from inflow water.

This segment helps to sustain the system for several thousand years without having any adverse environmental effect to the tank water although considerable content of pollutants were added to the system as different kind of fertilizers.

3.14

Stream Sediment Geochemistry of Three River Basins of Sri Lanka with Special Emphasis on Geochemical Ratios and Gem Potential.

Ranasinghe, Pradeep Nalaka

180p.

M.Phil. Degree, 2001.

Location No. 128

Abstract

Recent scientific investigations have revealed that about 25% of the total land area of Sri Lanka is gem bearing (Dissanayake and Rupasinghe 1995). However the gem industry in Sri Lanka is still based on traditional mining methods. Therefore only a few areas are still mined. Developing and application of scientific tools in gem exploration as well as mining and processing is therefore nationally important.

This study was mainly focused on studying some important geochemical aspects such as concentration levels, distribution, behavior of major and trace elements in stream sediments of Sri Lanka and to study the use of geochemical ratios in identifying gem bearing areas.

For this study stream sediments samples were collected mainly from Kotmale Oya and Menik Ganga basin. Samples, collected from Walawe Ganga basin, were used as a reference set and data of previous surveys were also used in statistical analysis. Gem bearing sediment samples and samples from gem source rocks such as skarn and pegmatites were collected mainly from the study areas. Samples were analyzed using the X ray fluorescence technique. International standards were analyzed and repetitions carried out to maintain the accuracy and precision of analysis. The data were treated with the use of statistical software.

The results of the study revealed that different elements are concentrated in different size fractions of sediments. K, Al, Mn, Rb, Ni and Sr concentrate in the $-63\mu\text{m}$ fraction and concentration decreases towards higher grain sizes. Nb and Cr are found in the $+125-177\mu\text{m}$ fraction while the highest concentration of Si was found in the $+177-250\mu\text{m}$ fraction. Zr accumulates in the $+63-125\mu\text{m}$ fraction. The accumulation of clays, and heavy minerals, which contain these elements, in different fractions may be the factor behind this distribution pattern.

When comparing element concentration in the studied basins no major difference in element concentrations were observed except, low Rb and high Fe concentrations in Kotmale basin and high Cu and Zr concentrations of the Walawe basin.

It was also noted that major elements have been depleted with reference to upper crustal levels while trace elements have been enriched. High leaching rates of major elements and accumulation of major elements during sedimentation process may account for this result.

Both factor analysis and correlation coefficients show that major and trace elements behave according to their ionic potential. Elements having high ionic potentials and low ionic potentials show close relations with the other elements of the particular group.

Studying the relationship with element ratios and gem potential reveal that ratios between elements of similar ionic potentials have good relationships with gem potential. Among the

studied ratios $Rb/Sr+Ba/Sr$ ratio can be used in discriminating areas according to their gem potential more effectively. The predicted potentials by this newly identified ratio are comparable with field observations. This new ratio can therefore be applied for gem exploration after field trials.

3.15

Vulnerability Analysis and Risk Assessment of Floods in Ratnapura Municipal Council Area.

Vithanage, N.S.

208p.

M. Phil. Degree, 2009.

Location No. 911

Abstract

Most of the natural disasters in Asia are related to flood causing maximum damage to lives and properties in comparison to other disasters. Many natural hazards affecting Sri Lanka are water related. An effort was made in this study to identify the vulnerability and prepare risk assessment for flood hazard in Ratnapura Municipal Council (MC) using Remote Sensing and Geographic Information System (GIS) techniques. Ratnapura MC is the centre for commercial, trade and administrative activities in Sabaragamuwa Province. Floods are detrimental to Ratnapura MC's vulnerable social and economic development due to loss of lives and destruction of properties. Residential areas and commercial activities are situated along the riverbanks which are highly vulnerable to flooding.

Study area is spread over an extent of 34.5 km². It is located in the *Kalu Ganga* basin. *Kalu Ganga* is the third longest river in Sri Lanka and it discharges the largest volume of water to the sea. Ratnapura town is located in wet zone and high annual rainfall is the main cause of flooding. Ratnapura MC has experienced five critical and, twelve major floods since 1900.

Identification of flood vulnerable areas is very useful for the society to take necessary actions for pre disaster activities such as mitigation and preparedness. The main objectives of the study were to generate flood hazard maps and identify the vulnerability of flood areas.

Generating the flood inundation area map was based on the 1:5,000 digital contour data and previous flood records in the study area. Flood zonation map was prepared by computer based system. Updating and error checking were conducted by a field survey activity using 1:5,000 maps of the study area and a questionnaire survey. Flood frequency analysis was done to identify the pattern of flood inundation in Ratnapura MC area. For vulnerability analysis in this research, the selected social vulnerability variables are population, buildings and public utilities. Risk analysis was based on the hazard and vulnerability analysis. *GramaNildari* Division (GND) wise risk calculations were generated assigning weights for hazard and vulnerability.

GIS technology was used as a risk assessment tool. Land use and land cover, land type, school/college locations, hospital locations and important buildings, road network, population data (GND wise) and digital elevation model (DEM) are found to be very useful to identify various impacts of floods. Field survey data and historical records were also found to be very important for the successful analysis.

3.16

The Wannu- Highland Boundary Shear Zone of Sri Lanka: Field and Structural Evidence.

Ranaweera, L.V.

122p.

M. Phil. Degree, 2008.

Location No. 788

Abstract

Previous petrological, structural, geochronological, geochemical and isotopic data have led to the identification of three lithotectonic units in the Precambrian of Sri Lanka, namely, the Wannu Complex (WC), the Highland Complex (HC) and the Vijayan Complex (VC). The HC is a Palaeoproterozoic belt of rocks flanked on either side by the Mesoproterozoic WC to the West-North West and Mesoproterozoic VC to the East-South East. These lithotectonic units have been juxtaposed during two tectonic events which led to the high-grade metamorphism and polydeformation of those as a consequence of the assembly of Gondwana supercontinent during the Pan-African.

The WC-HC and the HC-VC boundaries resulting from the two collisional orogenies had been a subject of debate. The geology and the geographical position of the HC-VC boundary are fairly well understood and believed to be a tectonic boundary. Whereas the geology of the WC-HC boundary and its geographical position are poorly understood despite the magmatic, sedimentation, isotopic, geochemical and structural differences between the two lithological units have been identified.

The present study deals with unraveling the geology of the WC-HC boundary and its geographical position. Detailed geological and structural analyses were carried out along a part of the boundary which runs over a stretch of 150 km length and 0.1-1 km width between Habarana and Ginigathena within the studied area. In the northern part of the boundary follows nearly a NS, and then a SSE direction before it turns into a SSW direction in the central part and continues in the same direction further South.

The boundary zone consists mainly of charnockitic rocks and metasediments formed under granulite-facies. Among them pelitic gneisses, marble and hornblende-bearing metagranitoids are the predominant rock types. Pelitic gneisses and calcitic to dolomitic marbles occur almost along the entire length of the boundary North of Kandy. South of Kandy, dolomitic to calcitic marble is absent along the boundary and hornblende-bearing metagranitoids are present. However, pelitic gneisses continue to occur and sometimes make conformable layers. The lithological contact between the WC and the HC lies between the pelitic (Grt-Bt) gneiss and the underlain marble (N of Kandy) and Khondalite (S of Kandy).

Most of the rocks along the boundary zone are highly sheared and consists of mylonites and striped gneisses. Mylonites are Khondalitic while striped gneisses are mainly hornblende-bearing metagranitoids. Striped gneisses of graphic granite also occur. These rocks contain shear sense indicators such as mesoscopic and microscopic S-C and S-C' fabrics, asymmetric folds, asymmetric feldspar porphyroclasts, rotated garnet porphyroclasts and "book shelf" model grains and mineral fishes.

The regional distribution of mylonites and striped gneisses and shear sense-indicators demonstrate that this is a tectonic boundary and a crustal-scale ductile shear zone which formed in a convergent type tectonic regime. The plate convergence took place leading to the assembly of Gondwana supercontinent during Pan-African was the tectonic regime where the boundary was formed. It was formed at the juxtaposition of the magmatic arc containing the WC and the HC microplate at ~610-550 Ma. The sense of shear deduced from some of the

above shear sense indicators demonstrates that the WC has moved over the HC from top-to-the SSE, indicating that the latter subducted under the former. The orogeny of this subduction which led the juxtaposition caused the high-grade metamorphism and polydeformation of the boundary zone as in the WC and the HC. The boundary has subjected to six episodes of deformation (D_1 - D_6) and folded by D_4 - D_6 events. The D_5 - D_6 deformation was a consequence of the collision between the already juxtaposed WC-HC unit with the VC. The D_1 deformation during the prograde path followed by D_2 and D_3 deformations during the peak-metamorphism and D_4 - D_6 deformation during the retrograde path characterizes the P-T-t evolution of the boundary zone.

The WC-HC Boundary Shear Zone (WHBSZ) is comparable with Robertson Lake Shear Zone of Ontario, Canada. The two shear zones are comparable in length, metamorphic characteristics of flanking terranes and the tectonic environment. The WHBSZ is a minor shear zone when compared to the large-scale shear zones of Madagascar or India.

Detailed geological and structural mapping along the boundary is essential to understand the structural evolution of the WC-HC boundary and its detailed relationship to the P-T-t evolution of the Sri Lankan Precambrian. Further studies are needed to elaborate the exact nature of the collision between the WC and HC to correlate it with those in the other Gondwana fragments around Sri Lanka.

M.Sc. Research Project Reports

DISASTER MANAGEMENT

3.17

An Assessment of Disaster and Emergency Preparedness Level in the Primary Health Care Centers in IDP Villages, Menik Farm, Vavuniya District, Sri Lanka.

Fonseka, H.F.C.P.

85p.

M.Sc. Degree, 2011.

Location No. 1090

3.18

Assessment of Disaster Management Practices in Sri Lanka : Lessons from 2003 Flood and Landslide.

Hettiarachchi, N.D.

81p.

M. Sc. Degree, 2008.

Location No. 776

3.19

An Assessment of Emergency Preparedness of Secondary and Tertiary Care Institutions of Sri Lanka.

Kumara, K.S.

55p.

M.Sc. Degree, 2008.

Location No. 728

3.20 **Assessment of Land Subsidence Susceptibility within Industrial Estate at Achchuvely in Jaffna.**

Balasoorya, B.M.R.K.

83p.

M.Sc. Degree, 2013.

Location No. 1334

3.21 **Community Disaster Response Teams for Malawenna Village,**

Kumara, L.D.R.S.

57p. (Accompanying CD-ROM available).

M.Sc. Degree, 2010.

Location No. 1092

3.22 **Demining Before Resettlement a Prerequisite: A Case Study - Mannar Sri Lanka.**

Wijeratne, K.M.U.

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Kumara, M.P.N.

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M.Sc. Degree, 2012.

Location No. 1234

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Wettasinghe, R.K.

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Dias, N.K.L.U.A.

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3.26

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3.27

Distribution of Stray Dogs and Their Antirabies Vaccination Status in Hanthana Residence Area in Kandy.

Bandara, A.M.R.

34p.

M.Sc. Degree, 2011.

Location No. 1140

3.28

Distribution of Stray Dogs in Three Selected Locations In Kandy: Possible Outbreak of Rabies.

Sriyani, W.A.C.

75p.

M. Sc. Degree, 2008.

Location No. 772

3.29

Drought Identification and Monitoring in Kurunegala District Using Standardized Precipitation Index.

Kamaradiwela, K.A.D.W.U.K.

47p.

M.Sc. Degree, 2008.

Location No. 740

3.30

Effect of Soil Salinity in the Paddy Cultivation in Vavuniya District.

Charles, P.S.M.

94p.

M.Sc. Degree, 2008.

Location No. 737

3.31

Emergency Response Plan for Teaching Hospital Anuradhapura Sri Lanka.

Karunaratne, A.S.

55p.

M.Sc. Degree, 2008.

Location No. 747

3.32 **Establishment of Health Services for Internally Displaced Persons in Vavuniya, Sri Lanka 2009.**

Wijesekara, N.W.A.N.Y.

108p.

M. Sc. Degree, 2010.

Location No. 1027

3.33 **Establishment of Pre-Hospital Emergency Medical System in the Municipality of Anurdhapura.**

Dassanayake, D.D.M.L.

43p.

M.Sc. Degree, 2011.

Location No. 1318

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Jayalath, P.P.

42p.

M.Sc. Degree, 2011.

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Thilakerathne, H.M.A.G.B.

39p.

M.Sc. Degree, 2012.

Location No. 1236

3.36 **Impact of Seasonal Flooding on Livelihoods in Two Selected Urban Low Income Communities in Colombo District.**

Fahim, A.W.M.

62p.

M.Sc. Degree, 2008.

Location No. 720

3.37 **The Impact of the Internally Displaced Persons from the North and East on the Local Population in Alankuda.**

Samarasinghe, W.

136p.

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Site Identification for Solid Waste Disposal for the City of Colombo Using GIS Techniques.

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Site Selection for Waste Disposal Using GIS.

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Chandana, G.A.D.

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Use of GIS for Indexing Urban Hierarchy.

Piyasiri, B.S.M.

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Use of GIS in Estimating the Potential of Groundwater Availability in Koggala Coastal Aquifer, Sri Lanka.

Kudahetty, Chaminda

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Use of GIS in Habitat Mapping of Two Sri Lankan Hornbill Species.

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Use of Remote Sensing and GIS to Estimate Area Under Paddy Cultivation.

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Dispersion and Water Exchange in Strongly Restricted Inlet Lagoon: A Rekawa Lagoon, South Coast of Sri Lanka.

Thushara, H.K.R.

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Environmental Parameters and Fish Abundance in Negombo Lagoon.

Sanjeewa, J.K.G. Prasad

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3.146

Influence of Seasonal Sea Level Variability on Salt-Water Intrusion in Kelani River Basin.

Ranmadugala, Sajeewa B.H.

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3.147

Numerical Model for Simulating Shoreline Change.

Ariyaratne, H.A.K. Suranjani

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3.148

Ocean Colour Remote Sensing: Bay of Bengal During North East Monsoon.

Lasantha, W.M.M.

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3.149

Seasonal and Spatial Variation of Thermocline and Halocline in the Indian Ocean around Sri Lanka.

Herath, H.M.U. Bandara

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WATER RESOURCE MANAGEMENT

3.150

Assessment of Temporal Variation of Water Quality in Boraesgamuwa Lake.

Nilmini, E.L.S.

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3.151

Availability of Water Resources within the Attanagalla Oya Basin: a Review.

Pitakumbura, D.G.S.W.

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3.152

Development of a Hydrological Model to Predict Kaluganga Flow at Ratnapura.

Gunathilake, G.M.A.K.

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3.153

Groundwater Condition in Monaragala District.

Kularathne, I.G.C.I.

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3.154

Groundwater Resources for Community Water Supply Schemes: A Case Study from Minipe-Muttettutenna in the Kandy District of Sri Lanka.

Dayawansa, E.G.D.

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3.155

Hydrogeochemistry of Groundwater from Two Dry Zone Regions of Sri Lanka.

Herath, H.M.J.M.K.

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Location No. 994

3.156

Impact of Wetland Filling in Urban Area on Flood Detention Capacity: case Study from Muthurajawela Marsh.

Sugathadasa, K.K.

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M.Sc. Degree, 2011.

Location No. 1113

3.157

Potential for Artificial Groundwater Recharge in a Wellfield: a Case Study in the North Western Province.

Kulathunga, L.C.M.K.

74p.

M. Sc. Degree, 2009.

Location No. 905

4 - ENVIRONMENTAL SCIENCES

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Research Project Reports

Ph.D. Dissertations

4.1

Monitoring Air Quality Using Low Cost Techniques and Assessing the Impact of Air Pollution on Vegetative Crops.

Abeyratne, Vilani Deasika Kumari

179p.

Ph.D. Degree, 2005.

Location No. 461

Abstract

Human interference with the atmosphere has created or intensified problems, which are now causing air pollution concerns on a global scale. The cities of Kandy and Anuradhapura are expected to have a higher degree of air pollution owing to its geographic location and due to transboundary pollution respectively. Hence this study aimed to develop low cost, environmentally friendly air quality monitoring methods. Passive & active sampling methods were used to analyze three gaseous pollutants; NO₂, SO₂, and O₃ and PM₁₀ in Kandy. Same gaseous pollutants except PM₁₀ were measured in Anuradhapura using passive sampling method. This study also aims to provide a user friendly AQI, for use by laymen based on both the individual and composite criteria pollutants. Possible consequences of air pollutants for agricultural crops in Sri Lanka or its production have scarcely been explored. In order to fulfill this gap pollutant effects on plants were evaluated using low cost active and passive biomonitoring methods.

In the passive sampler method the pollutant is trapped on a paper filter impregnated with a special developing solution. In the active sampling method the pollutant is trapped into special absorbing media. The trapped pollutants were then analyzed using spectrophotometric and turbidimetric methods. Particulate matter was collected using glass fiber filters and determined gravimetrically. For the sampling period of 15th February 2002 – 31st December 2004, the data reveal that NO₂, SO₂, and O₃ analyzed exceed the recommended air quality standards in Sri Lanka on about 14%, 41% and 28% occasions respectively for Kandy while the corresponding exceedences in Anuradhapura were 0%, 21 %, 27% respectively. PM₁₀ analyzed during the sampling period in Kandy exceeds the recommended US EPA standard on about 80% of the occasions. AQI for the composite criteria pollutants in Kandy and Anuradhapura represent "Good" categories on 57% and 100% occasions respectively. A significant effect on transboundary pollution was recorded from both cities during the sampling period.

In active bio monitoring method, sensitivity of 24 vegetable species to ambient air pollution and ozone was assessed using the open top chamber method. Growth differences of vegetative plants were observed in chambers supplied with filtered and non filtered air during the dry climatic period. The effects of ozone observed on plants above the critical level can be classified in to nine categories. In passive bio monitoring method, attempts were made to observe the stomatal response under different pollutant concentrations using the nail varnish method. A significant effect of SO₂ on stomatal pore opening was observed in the plant *Argyrea populifolia*.

M.Phil. Theses

4.2

Air Quality Trends in the City of Colombo.

Jayaratne, R.N.R.

101p.

M.Phil. Degree, 2005.

Location No. 537

Abstract

Clean air is an essential basic need of all living beings and purity of air we breathe is an important factor of human health. Continuous ambient air quality monitoring in Sri Lanka was started in January 1997 using two fixed ambient air quality monitoring stations, located in front of Colombo Fort Railway Station and in Colombo Meteorological Department premises as information gathered from air quality monitoring is a vital component of air quality management. As comprehensive analysis of air quality monitoring data has not been done up to now, all collected valid data of major air pollutants [one hour average concentrations of nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone and 24 hour average concentration of particulate matter less than 10 microns in aerodynamic diameter (PM₁₀)] was scientifically analyzed in this research using basic statistical parameters (average, 25th & 75th percentiles, minimum, maximum).

Trends over the period from 1997 to 2001 indicated that pollution levels with respect to sulfur dioxide, nitrogen dioxide and PM₁₀ were slowly increasing. Carbon monoxide shows decline trend during over this period. Slightly decreasing trends of sulfur dioxide and nitrogen dioxide with slight increasing trend of carbon monoxide and PM₁₀ was shown over the period from May 2003 to June 2004.

Approximately 95% of concentration values of air pollutants at both monitoring stations are below the National Ambient Air Quality Standards values. However, one hundred and seventy seven occurrences of exceedences from the National Standard value were recorded with respect of sulfur dioxide at Colombo Fort Monitoring Site. Rapid decreasing of sulfur dioxide concentrations can be observed since January 2004 as a result of reducing the Sulfur levels in Sri Lanka auto diesel from 0.5% to 0.3%.

The 24-hour average concentration of PM₁₀ exceeded the USEPA standard at one occasion. However, the annual average of PM₁₀ exceeds the annual standard stipulated by USEPA in all the years during the monitoring period.

Almost same seasonal variation patterns were shown for all measured air pollutants. High concentrations of air pollutants observed during the dry period and low concentrations observed during the wet period. Pollutants concentrations are higher in the North-East monsoon period than in the other periods.

The diurnal pattern of concentrations of air pollutants indicates that mobile sources are the major contributor for air pollution in the Colombo city. In general the concentration of air pollutants are higher during the weekdays than weekends.

4.3

Application of Zero Valent Iron for the Treatment of Landfill Leachate Generated from Gohagoda Municipal Solid Waste Dumpsite.

Wijesekara, S.S.R.M.D.H.R.

87p.

M.Phil. Degree, 2013.

Location No. 1396

Abstract

Landfill leachate is well known as a contaminant source polluting soil, surface and ground water.

The predominant waste disposal method in Sri Lanka is still open dumping which leads to the generation of significant amounts of leachate, mostly to nearby water sources. Gohagoda open dumpsite is one such location at the world heritage city, Kandy, Sri Lanka. This leachate directly flows to the Mahaweli river which is the main water source for the entire province due to the absence of a proper lining system or any treatment mechanism before disposal. Hence, this study was focused on the characterization of the leachate generated from Gohagoda dumpsite, assessment of the spatial and temporal variations, identification of subsurface canals and perched water bodies in the wetland system affected by the leachate flow.

For this purposes, landfill leachate samples were collected monthly throughout the dry and rainy seasons from different points of the leachate drainage channel and tested for quality parameters: pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), alkalinity, hardness, solids, biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), nitrate-nitrogen, nitrite-nitrogen, phosphates, ammonium-nitrogen, chloride, dissolved organic carbon (DOC), total organic carbon (TOC) and heavy metals. Sequential soil extraction procedures were performed in order to characterize the leachate affected local soil. 1-D, 2-D and 3-D modes of resistivity data were collected from Vertical Electrical Sounding (VES) at the abandoned paddy field downstream of the dumpsite, towards the Mahaweli river.

Leachate characteristics confirmed its methanogenic nature and strongly suggested pollution of drinking water sources exceeding many allowable limits of Sri Lankan waste water discharge standards for many parameters including BOD, COD and Ammonia- nitrogen. The local soil seems to have exceeded its maximum capacity to behave as a natural attenuation agent for heavy metal leaching. The resistivity study confirmed that the leachate flow is confined to the near surface and no separate plume movement was observed. The major leachate transporter to the river is identified as a surface channel, without considerable subsurface plume.

This study also focuses on the treatment of landfill leachate with different nanomaterials such as nano-particulate zero valent iron (NZVI), Iron oxide (iONP), Gibbsite (GNP) and Silver (AgNP). Use of NZVI in the treatment of inorganic contaminants in polluted plumes has become the subject of many studies, especially in developed countries. However, NZVI's potential for reduction of COD and treatment of metal ion mixtures has not been explored in detail. Hence, this study investigates the efficiency of NZVI stabilized with starch, mercaptoacetic, mercaptosuccinic or mercaptopropionic acid for the reduction of COD, nutrients and metal ions from landfill leachate in tropical Sri Lanka.

The synthesized nanomaterials were characterized with XRD, TEM, SEM-EDX, TGA, FT-IR and BET. Comparison studies were carried out with four different nanomaterials to determine the efficiency for treating landfill leachate. A series of batch, column and kinetic experiments were performed for the actual leachate from Gohagoda and for the synthetic leachate used for metal removal studies.

Of the samples tested Starch-NZVI and mercaptoacetic-NZVI performed well for both COD and metal mixture. The column experiments showed a ~5-fold lowering of $[Zn^{2+}]$ in the leachate from the Starch- NZ VI-treated silica sand than that from the unamended silica sands. The removal percentages for COD, nitrate and phosphate from Starch-NZVI were 50, 97 and 99% respectively from batch experiments. Heavy metal removal was higher for S-NZVI (>95%) than others. Mercaptopropionic-NZVI and its oxidation products showed the maximum adsorption capacities for Pb(II) ($7 \times 10^5 \text{ molm}^{-2}$) and Cu(II) ($2 \times 10^5 \text{ molm}^{-2}$). Meanwhile, Nitrate-N and phosphate removal densities were 1.654×10^{-5} and $1.952 \times 10^{-7} \text{ molm}^{-2}$ respectively after 4hr of treatment using Starch-NZVI while for other nanomaterials about 40% removal was observed. Hence, it can be concluded that mercapto acids are better stabilizing agents for NZVI and NZVI can be used effectively for tropical landfill leachate treatment.

4.4

Effects of Fertilizer Application in Up-Country Tea Lands on Downstream Pollution.

Wijayawardhana, R.G.A.

137p.

M.Phil. Degree, 2006.

Location No. 529

Abstract

Tea industry in the upcountry of Sri Lanka uses large amount of synthetic fertilizer as tea plants respond to high levels of nutrients. The possible water pollution by chemical fertilizer application in the upcountry tea lands is an issue appealing to the industry. However, the lack of experimental evidence on downstream pollution due to application of fertilizer, an investigation was carried to reveal the potential of pollution threat for upcountry tea lands of Sri Lanka. This study was conducted for two monsoon periods during March 2003 to February 2004.

In order to assess how the water quality varies with the fertilizer application, the study area was categorized into four groups by considering the type of vegetation and magnitude of pollution. In this study, 24 sampling points were selected from Kotmala Oya tributaries and mainstream and 8 sampling points from Belihul Oya mainstream. Firstly, 24 sampling points of Kotmala Oya were statistically analyzed using two approaches to examine the possible trend due to fertilizer application. The 16 sampling points that are located in the tributaries were categorized into four groups; Forest, Tea, Tea with less Anthropogenic Activity and Tea with High Anthropogenic Activity. As the second approach, eight sampling points located in the main stream were analyzed separately and observed the trend in the downstream direction of Kotmala Oya, Finally the two main streams were compared for the measured parameters to observe any possible reasons from the uninhibited areas and the anthropogenic activity in the areas of the tea plantations. The concentration of the Ca^{2+} , Mg^{2+} , Na^+ , K^+ , NO_3^- , PO_4^{3-} , SO_4^{2-} and Cl^- were found to be below the recommended standards set by the World Health Organization (WHO) and Sri Lanka Standards Institution (SLSI) for drinking water. It was found that the concentration of all the parameters in the tributaries of the four vegetation zones showed an increasing trend in the downstream in the order of (Forest) T1 < (Tea) T2 < (Tea + Less Anthropogenic Activity) T3 < (Tea + High Anthropogenic Activity) T4.

The rate of contribution of different cations and anions from various vegetations types to the mainstream were found to be different. As the volume of water increased in the downward direction, it diluted the concentration of the constituents coming from various sources. However, the study showed that the concentration of the ions increased in the downward direction with the increase in the flow volume rate. This observation revealed that the

contribution of cations and anions gradually adding into solution in the downward direction. Forest areas showed the minimum concentration and the highest concentration was found in the final observation point of the mainstream. However, all the parameters were not significantly increasing in the downward direction of Belihul Oya main stream though the flow rate volume increased. This situation revealed that the nutrient addition due to anthropogenic activity was higher compared to the natural biological and geological processes.

4.5

Probable Role of Fluoride and Aluminium in the Incidence of Chronic Renal Failure in Anuradhapura District.

Herath, K.R.P.K.

145p.

M. Phil. Degree, 2008.

Location No. 787

Abstract

While the etiology of the chronic renal failure in the Medawachchiya-Padaviya areas still remains a mystery, some results on the geo-environmental factors of the region reveal some significant findings. A chance discovery made during field studies was that people exclusively use aluminium utensils and some holes were observed in these utensils after continuous use. Water used by these people mostly come from dug wells and they generally have high fluoride content in the range 1.00-4.00 ppm with a median of around 2.0 ppm. Fluoride ions of drinking water and the direct link to chronic renal failure have been reported by many researchers.

In this study, pieces of aluminium from a used aluminium pot were treated with water containing fluoride at different levels of 1.0-6.0 ppm with/ without tomato, tamarind, and tartaric solutions. After 10 minutes of boiling, the amounts of aluminium and lead leached were measured. The amounts of aluminium leached out in the presence of 3.0 ppm of fluoride (simulated food solution) were 4.65 ppm, 28.45 ppm, 157.22 ppm, and 233.18 ppm in deionized water, tomato, tamarind, and tartaric mediums respectively whereas, the amounts of leached Pb were 0.60 ppm, 2.37 ppm, 3.56 ppm, and 9.22 ppm respectively. In an acidic medium, there was more than ten-fold increase in the dissolution of aluminium. This experiment was performed due to the widespread use of acidic ingredients like tomatoes, tamarind, and vinegar which are used for cooking and the use of inferior quality aluminium pots for cooking.

Aluminium leaching under high fluoride stress and acidic spices results in the formation of aluminofluoride complexes which alter the normal metabolic activity of the body. Stable complexes like AlF_3 and AlF_4^- act as phosphate inhibitors, which can potentially lead to dysfunction in biological systems. The presence of elevated levels of both fluoride and aluminium in the blood samples of affected patients gives further credence to the hypothesis that these two species in combination could be a causative factor for the occurrence of occurrence of chronic renal failure in areas with high fluoride content.

M.Sc. Research Project Reports

BIODIVERSITY, ECOTOURISM AND ENVIRONMENTAL MANAGEMENT

4.6

A Comparative Study on Avifauna Associated with Two Selected Seasonal Reservoirs at Kurunegala District.

Wijethunga, M.U.I.

63p.

M.Sc. Degree, 2011.

Location No. 1154

4.7

Conservation Importance of Semi-Evergreen Seasonal Forests of Galamuduna Area in the Knuckles Region.

Abeykoon, A.M.G.G.L.K.B.

134p.

M.Sc. Degree, 2012.

Location No. 1264

4.8

Diversity of Aquatic Plants in Three Selected Tanks and Utilization of Aquatic Plants by the Community in the Anuradhapura District.

Hettiarachchi, D.K.

93p.

M.Sc. Degree, 2013.

Location No. 1383

4.9

Flood Risk Identification and Management in the Horowpathana Urban Environment.

Herath, H.M.I.K.

53p.

M.Sc. Degree, 2013.

Location No. 1381

4.10

Mortality Patterns in Wild Elephants in Sri Lanka.

Dharmakeerthi, W.A.

35p.

M.Sc. Degree, 2011.

Location No. 1255

4.11

Population, Environmental and Climatic Factors on Dengue Distribution in Colombo District.

Wijayalath, W.A.W.P.

69p.

M.Sc. Degree, 2012.

Location No. 1263

4.12

Situation Analysis and Development Strategies for Elephant Orphanage at Pinnawala.

Dayananda, W.G.N.B.P.

45p.

M.Sc. Degree. 2011.

Location No. 1062

4.13

Water Distribution Systems and Diarrheal Disease Transmission: A Case Study in Kegalle District.

Wijesundara, S.R.

60p.

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Location No. 1063

ENVIRONMENTAL SCIENCE

4.14

Abundance and Population Structure of the Paddy Bug in Non-Rice Habitats of a Rice Field.

Jayawickramarachchi, H.K.

73p.

M. Sc. Degree. 1998.

Location No. 19

4.15

Application of Floating Wetlands for Water Quality Improvement.

Fernando, P.V.J.

58p.

M.Sc. Degree, 2011.

Location No. 1156

4.16

Application of Floating Wetlands to Improve Water Quality in Kandy Lake.

Ranaweera, S.P.

66p.

M.Sc. Degree, 2013.

Location No. 1266

4.17

Appraisal of Nitrate Contamination of Groundwater by Intensive Use of Fertilizer around Kandy Area in Maha Season.

Gunatilake, S.K.

47p.

M. Sc. Degree, 1998.

Location No. 13

4.18

Aspects of Diversity and Ecology of Butterflies in Minneriya National Park of Sri Lanka.

Anuradha, E.P.

60p.

M. Sc. Degree, 2008.

Location No. 765

4.19

Assessment of a Risk from Exposed Acid Sulfate Soils in the Southern Highway from Kottawa to Dodangoda.

Jayasinghe, I.M.A.

46p.

M. Sc. Degree, 2009.

Location No. 914

4.20

An Assessment of Drinking Water Quality of Selected Dug- Wells within the Vavuniya Urban Council of Sri Lanka.

Ravi, V.

56p.

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Location No. 923

4.21

Assessment of Nitrate Pollution of Well Water in Relation to Distance of Toilet Pit in Vavuniya.

Thavakiruba, S.P.

45p.

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4.22

Assessment of Pollution Sources of the Vavuniya Tank and Proposing Remedial Measures.

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43p.

M.Sc. Degree, 2010.

Location No. 1059

4.23

Assessment of the Ground Water Quality for Aquaculture, Agriculture and Drinking Purposes in Selected Areas of North Western Province.

Menike, H.M.S. Herath

64p.

M.Sc. Degree, 2000.

Location No. 106

4.24

Behaviour of the Parasitoid *Diglyphus isaea* (Hymenoptera: Eulophidae) of the Potato Leafminer *Iriomyza huidobrensis* (Diptera: Agromyzidae).

Kanagaretnam, Manoranjani

24p.

M.Sc. Degree, 2006.

Location No. 591

4.25

Bioaccumulation of Heavy Metals in Selected Freshwater Macrophytes.

Karunaratne, E.C. D. A.

41p.

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4.26

Biological Aspects of the Development of Some Selected Soil Profiles in the Central Highlands of Sri Lanka.

Yatigamma, T.M.S.S.K

94p.

M. Sc. Degree, 1998.

Location No. 11

4.27

Biological Monitoring of Sulfur Dioxide in Ambient Air Using Bryophytes.

Abeyratne, M.C. Kumari

36p.

M.Sc. Degree, 2005.

Location No. 428

4.28

Biomonitoring of Tropospheric Ozone Pollution in Kandy District Area.

Theivathavapalan, Jamuna

35p.

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Location No. 371

4.29

Bird Diversity in Kumana Marsh in the Kumana National Park, Sri Lanka.

Dewasurendra, P.

62p.

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4.30

Blue Green Algal Populations of Some Irrigation Tanks in Anuradhapura District.

Ranasinghe, R.M.N.P.

54p.

M.Sc. Degree, 2002.

Location No. 206

4.31 **Cadmium Levels of Paddy Field Soils and Drinking Water in Kebithigollewa Area.**

Kooragama, U.P.

40p.

M.Sc. Degree, 2007.

Location No. 657

4.32 **Characterization of Road Dust in the Kandy Urban Area.**

Piyatissa, P.M.J.R.

85p.

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Location No. 761

4.33 **Chemical Characterization of Road Dust in Greater Colombo Area.**

Piyatunga, H.A.N.D.

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4.34 **A Code of Practice for the Shrimp Farmers in Sri Lanka.**

Gamage, B.S.C.

97p.

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4.35 **Comparative Study of Butterfly Fauna in Three Different Habitats of the Knuckles Region, Sri Lanka.**

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4.36 **Comparison of BOD Methodology for Waste Water Samples.**

Dias, M.R.S.

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Rubasinghe, C.

86p.

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Contamination of Menik Ganga in Buttala-Pelwatte Area Due to Anthropological Activities.

Munasinghe, Muditha Hiranthi

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Location No. 208

4.39

Contamination of Shallow Groundwater in the Sinnauppodai Coastal Area, Batticaloa, Sri Lanka.

Sugunathas, Kugathas

53p.

M.Sc. Degree, 2007.

Location No. 663

4.40

Contamination of Stream Water and Sediments of the Kandy Urban Area.

Wanasooriya, W.M.D.I.

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Location No. 766

4.41

Crop Damages by Asian Elephants in Ekgaloya and Dewalahinda Areas in Ampara District, Eastern Province - Sri Lanka.

Karunarathna, M.

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4.42

Design, Development and Evaluation of Experimental Biofilm Leachate Treatment Systems.

Pathirana, K.P.M.N.

47p.

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4.43

Designing the Sanitary Land Fill Site in the Upper Kotmale Hydropower Project Area at Talawakele.

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4.44

Deterioration of Coastal Water Quality from Land Based Activities: Western Province, Sri Lanka.

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4.45

Determination of Allethrin in Mosquito Coils Comparison of Test Methods Specified in Sri Lankan and Indian Standards.

Damayanthi, Asoka

28p.

M. Sc Degree, 1998.

Location No. 15

4.46

Developing a Passive Sampler Method for Monitoring the Air Quality in Kandy.

Abeyratne, Vilani Deasika Kumari

42p.

M.Sc. Degree, 2001.

Location No. 183

4.47

Development of a Video Programme on Dry Zone Forests of Sri Lanka.

Silva, M.A.S. Sankhanath

57p. (Accompanying CD-ROM available in the office).

M.Sc. Degree, 2007.

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4.48

Development of a Water Quality Index to Monitor Stream Water Quality : Case Study of the Mahaoya Basin, Sri Lanka.

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97p.

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4.49

Distribution of Endemic Goitre in Kalutara District.

Liyanage, P.L.C.L.

51p.

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4.50

Diversity and Resource Partitioning of Avifauna in Forest and Agricultural Ecosystems.

Wijesundara, W.M.M.S.

98p.

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4.51

Effect of Different Industrial Effluents on the Water Quality of Valaichchenai Lagoon.

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4.52

Electrochemical Analysis of Pesticides in Water.

Dorabawila, B.M.N.K.

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Location No. 22

4.53

Electrolytic Treatment of Oil-Based Effluent.

Indrasena, Priyadarshinie S.

72p.

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Location No. 372

4.54

**Environment Friendly Options for the Control of Sesame Leaf Webber and Pod Borer:
Antigastra catalaunalis duponchel (LEPIDOPTERA: PYRALIDAE)**

Marasinghe, Jeevani Prasadika

41p.

M.Sc. Degree, 2002.

Location No. 207

4.55

Environmental Problems and their Management in Three Selected Hospitals in the Kurunegala District.

Herath, J.M.M.K.

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4.56

Estimating Fluoride Exposure in Rural Communities in Sri Lanka: A Case Study from Irakamam Village in Ampara District.

Irshad, M.P.M.

53p.

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4.57

Evaluating the Success of Translocating Problem Creating Elephants to Mitigate Human-Elephant Conflict in North-Western Wildlife Region in Sri Lanka.

Jayasinghe, C.A.

87p.

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4.58

Evaluation of Groundwater Quality and Soil Pollution in Urban Solid Waste Dump Site, Kegalle.

Amarasinghe, A.A.I.K.

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M.Sc. Degree, 2012.

Location No. 1246

4.59

Evaluation of Laws Regulating Lakes and Reservoirs of Sri Lanka.

Abewardhana, B.U.G.A.K.

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4.60

Evaluation of Mass and Energy Balances of Landfill Bioreactor "Test Cell" at Peradeniya.

Shripathy, T.

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4.61

Evaluation of Water Quality of Pinga-Oya with Emphasis to Heavy Metal Pollution.

Seneviratne, Neetha Geethanjali

66p.

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4.62

Fluctuations in Physico-Chemical Parameters and Dipteran Larval Density in Household Composting Units.

Abeywardana, K.D.T.N.

78p.

M.Sc. Degree, 2006.

Location No. 522

4.63

Forest Die-Back at Rajawaka Forest Reserve.

Herath, H.M.A.B.

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M.Sc. Degree, 2012.

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4.64

Geochemistry of the Serpentinite Deposit at Ussangoda and Possible Environmental Impacts.

de Silva, K.R.A.

70p.

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Location No. 759

4.65

Geoenvironmental and Engineering Geological Study of Cut Slope Failures in Kandy Area.

Seneviratne, Rohitha Y.M.K.

141p.

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Location No. 373

4.66

Groundwater Quality and Chronic Kidney Disease in the North Western Province of Sri Lanka: A Case Study.

Dissanayake, D.M.M.P.

72p.

M. Sc. Degree, 2008.

Location No. 767

4.67

Heat Treatment of Oil Based Sludge.

de Silva, Poorni

72p.

M.Sc. Degree, 2007.

Location No. 655

4.68

Impacts of Dam Construction of Upper Kotmale Hydropower Project in Kotmale Oya, Talawakelle on Vertebrate Fauna and Possible Mitigation Measures.

Chandrasegaran, Veloo

33p.

M.Sc. Degree, 2006.

Location No. 589

4.69

An Investigation of Chlorpyrifos in Groundwater Under Onion Cultivation in Kalpitiya Peninsula.

Wijekoon, W.M.A.S.R

55p.

M.Sc. Degree, 2003.

Location No.292

4.70

Investigation on Level of Heavy Metals in Ecosystem in the Norochcholai Vicinity Area, Puttalam Lagoon and Coastal Area.

Rubasinghe, C.H.T.

39p.

M.Sc. Degree, 2013.

Location No. 1269

4.71

Leachate Characteristics during the Early Stage of Decomposition of Municipal Solid Waste.

Ponnampalam, Santhana Nangai

79p.

M.Sc. Degree, 1998.

Location No. 21

4.72

Levels of Polyaromatic Hydrocarbons in Kandy City.

Wijayarathna, S.B.A.M.B.Y.

79p.

M. Sc. Degree, 2010.

Location No. 922

4.73

Life Cycle of Automobile Oil in Sri Lanka.

Thalagahagedara, Poornima Manoji

87p.

M.Sc. Degree, 1998.

Location No. 87

4.74

Mechanistic Modeling of Arsenic Retention on Natural Red Earth in Simulated Environmental Systems.

Vithanage, Meththika Suharshini

38p.

M.Sc. Degree, 2004.

Location No. 430

4.75

Methodology to Remove Colour from Textile Waste Water Effluent.

Senevirathne, E.M.D.S.

79p.

M.Sc. Degree, 2011.

Location No. 1162

4.76

A Modeling Approach to Explain the Impact on the Batticaloa Lagoon by the Unnichchai Tank.

Thayananth, Selvarajah

80p.

M.Sc. Degree, 2007.

Location No. 665

4.77

Monitoring Air Quality at Galaha Junction Using Active and Passive Sampling Methods.

Dissanayake, C.D.M.S.

48p.

M.Sc. Degree, 2005.

Location Nos. 429 and 521

4.78

Monitoring the Eutrophication Process in Uranikudha of the Batticaloa Lagoon.

Muralitharan, S.D.

44p.

M.Sc. Degree, 2012

Location No. 1262

4.79

Nutrient and Heavy Metal Removal Capacity of *Pistia Stratiotes* L. from a Freshwater Wetland at Kelaniya.

Surendranathan, Elanganathan

56p.

M.Sc. Degree, 2004.

Location No. 427

4.80

Nutrients and Sources of Pollutants of Maduganga Estuary, Sri Lanka.

Ambanwela, A.S.M.R.N.C.K.

65p.

M.Sc. Degree, 2007.

Location No. 659

4.81

Occurrences and Environmental Impacts of Acid Sulfate Soil in Colombo Suburbs.

Gurusinghe, D.I.C.

57p.

M.Sc. Degree, 2006.

Location No. 628

4.82

The Operational Parameters of a Waste Water Treatment Plant Four Decades after Construction.

Chandrasiri, O.L.N.G.

53p.

M.Sc. Degree, 2007.

Location No. 661

4.83

Performance Evaluation of Clay-Polyethylene-Clay Composite Biofilm Liner for Land Fill in the Dry Zone of Sri Lanka.

Ethayakanthan, S.

52p.

M.Sc. Degree, 2011.

Location No. 1160

4.84

The Performance of Sub Surface Vertical and Horizontal Flow Constructed Wetlands with Special Reference to Sri Lanka.

Bandara, R.S.A.K.

53p.

M.Sc. Degree, 2011.

Location No. 1159

4.85

Photocatalytic Degradation of Remazol Blue Using Ilmenite and Titanium Dioxide.

Ariyadasa, L.A.W.D.

38p.

M.Sc. Degree, 2005.

Location No. 523

4.86

A Population Study of Elephants in the Katagamuwa Sanctuary, Kataragama.

Liyanagama, Saman

30p.

M.Sc. Degree, 2007.

Location No. 660

4.87

Possibility of Cadmium and Fluoride Accumulation in Tea Plants and Soils Fertilized with Eppawala Phosphate Rock.

Thilakasiri, D.B.R.P.

59p.

M.Sc. Degree, 2008.

Location No. 750

4.88

Possible Effects of Some Toxic Elements of Soil and Plants in Forest Dieback Areas of Hakgala Strict Natural Reserve.

Wimalasena, M.D.N. Renuka

66p.

M.Sc. Degree, 2007.

Location No. 658

4.89

Prevalence of Dengue Vector Mosquitoes and Factors Affecting Dengue Transmission in Wellawatta Municipal Council Area.

Thayaseelan, K.

73p.

M.Sc. Degree, 2007.

Location No. 629

4.90

Provenance and Distribution of Silica Sand Deposit at the Sri Lanka Air Force Premises - Ekala, Sri Lanka.

Somapala, K.S.

79p.

M.Sc. Degree, 2011

Location No. 1153

4.91

Quality Assessment of Deep Groundwater in Monaragala District.

Manamperi, A.S.P.

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M.Sc. Degree, 2002.

Location No. 210

4.92

Removal Mechanism of Phosphate Sulfate and Color on Feldspar.

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4.93

Removal of Excess Iron in Ground Water.

Palihapitiya, Chintha Priyanganie

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4.95

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Ariyawardana, P.H.D.A.

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4.96

The Removal of Phosphate in Water by Adsorption on Laterite.

Wijekoon, A.M.N.

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4.97

Removing Metal Ions Present in Electroplating Effluents Using Feldspar, Kaolin and Laterite.

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4.98

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Location No. 1392

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Senanayake, S.M.A.

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Study of Insecticidal Properties of *Euphorbia antiquorum*.

Palugaswewa, I.J.K.

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Location No. 1268

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4.111

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4.114

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Bootawatta, S.G.

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Jayaneththi, P.M.D.

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M.Sc. Degree, 2011

Location No. 1067

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Two Dimensional Multi Electrode Resistivity Survey for Subsurface Mapping: A Case Study from Matale District.

Lekammudiyanse, L.M.M.U.

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M.Sc. Degree, 2013.

Location No. 1267

4.117

Uptake of Cadmium and Nickel by Selected Plant Species under Laboratory Conditions.

Rajaratnam, Shubajini

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M.Sc. Degree, 2007.

Location No. 664

4.118

Utilization of Sargassum to Remove Cadmium in Waste Water.

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Location No. 433

4.119

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Jayasekara, Indra

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Location No. 248

4.120

Water Quality of Maha Oya.

Iman, S.H.M.U.

26p.

M. Sc Degree, 1998.

Location No. 16

4.121

Water Quality Variations of Villages around Serpentinite Bodies at Indikolapelessa, Udawalawa.

Manawadu, U.D.

48p.

M. Sc. Degree, 2010.

Location No. 1057

5 - MATHEMATICS

M.Phil. Theses and M.Sc. Research Project Reports

M.Phil. Theses

5.1

A Binary-Integer Programming Method for Optimal Control of Water Distribution Systems.

Gomez, T.D.A.

73p.

M.Phil. Degree, 2012.

Location No. 1218

Abstract

Modeling and solving a pump scheduling problem focuses on minimizing the electrical energy cost, which is the main element in the operational cost in a water distribution system. The optimal pump-schedule is used to select the best combination of pumps that will be running at each time interval during an optimization period. It also minimizes the maintenance cost of the system while satisfying the hydraulic and system constraints imposed by the distribution system.

A study was undertaken to formulate a pump scheduling model having electric energy cost as the objective function, subject to system constraints: tank water volume, the volume deficit and balancing the hourly water demand with supply. Additionally, the number of pump switches in optimal pump schedule is used as a surrogate measure to minimize the wear-and-tear on pumps, keeping the maintenance cost of the pumps to be minimum.

Since, the decision variables of the scheduling problem are coded with binary-numbers and the objective function and the constraints are linear functions, the formulated model is solved using binary-integer programming. The formulated model and the proposed optimization methodology is implemented in an existing water distribution system and an analysis on post-optimal conditions is performed to discuss the operational and implementation issues which are useful in making decisions to operate a water distribution system. The experimental results have demonstrated that low cost optimal schedule can be obtained by reducing the time duration of switching the water pumps. Additionally, the formulated optimization model and the proposed method of solution can be used to analyze the initial parameters of the water distribution system. It is observed that the significant cost reduction can be achieved by limiting the number of pump switches which results in lower maintenance cost in pumps. Also, the proposed model and the optimization methodology are applicable to the problems with special types of consumer demand patterns.

In this context, the operational cost of the water distribution system can be optimized with the existing infrastructure with the adoption of the proposed pumped scheduling model and therefore, no additional cost is incurred for the implementation.

5.2

A Mixed Type Finite Element Method for Radiation and Scattering Problems in Unbounded Domains.

Sriranganesan, Jeyanthini

60p.

M.Phil. Degree, 2013.

Location No. 1380

Abstract

Scattering problem is concerned with the scattered field of an incident wave by a scattering obstacle. The scattering problem is formulated as a boundary value problem for the scattered field in the unbounded region outside bounded region of the scattering obstacle. The problem consists of the wave equation, a boundary condition on the boundary of the obstacle and Sommerfeld's radiation condition imposed at infinity.

When the incident wave is time harmonic, the wave equation is reduced to the Helmholtz equation. The solution to the scattering problem appearing in the mathematical models is obtained approximately through numerical methods. One of the commonly used methods is the finite element method (FEM).

We consider solving the time harmonic wave scattering problem given by the Helmholtz equation in two dimensions by the finite element method. For numerical considerations, the unbounded exterior domain of interest is truncated to a bounded one by an artificial boundary. Then, a boundary condition is imposed on the artificial boundary to ensure that the scattering waves are transparent and does not generate any spurious reflections. This boundary condition is called Artificial Boundary Condition (ABC) or Radiation Boundary Condition (RBC).

These boundary conditions ensure that the solution inside the bounded domain is the same as that of the solution of the original unbounded problem. Normally, the radiation boundary condition is non-local and is expressed by an infinite Fourier series. Hence, its finite element approximation matrix also involves infinite series. For computations, the series is usually truncated to a finite sum.

In order to avoid this infinite sum and its truncation, many authors have proposed various approximate local radiation boundary conditions. These local radiation boundary conditions introduce some additional truncation error which depends on the radius of the artificial boundary. That is, we have to increase the radius of the artificial boundary for a satisfactory accuracy of the solution. This in turn increase the computational cost as the computational domain increases.

Based on this idea of mixed method, we use a finite element approximation method for the matrix elements which correspond to the exact non-local radiation boundary condition on the artificial boundary. In this approach, there is no term expressed in infinite series in the matrix elements and hence the computational cost is reduced. We choose the artificial boundary as a circle and express the radiation boundary condition as a pseudo-differential operator as a function of the Laplace-Beltrami operator on the unit circle. We construct the mixed type approximation matrix based on this pseudo-differential operator.

We show the convergence of the approximate solution of our method to the exact solution when the exact Dirichlet to Neumann boundary condition is applied on a circular artificial boundary. We use non-uniform partitioning of the artificial boundary by considering some

examples for which analytical solution can be computed.

Based on the idea of the mixed finite element method, we suggest a new approximation method for the pseudo-differential operator which appears in the numerical methods for the Helmholtz equation using the non-uniform partitioning of the artificial boundary.

M.Sc. Research Project Reports

INDUSTRIAL MATHEMATICS

5.3

Applications of Graph Colouring.

Chandrakanth, Somasundaram

60p.

M.Sc. Degree, 2003.

Location No. 289

5.4

Application to Optimization Under Uncertainty.

Suthan, S.

55p.

M.Sc. Degree, 2012

Location No. 1183

5.5

Approximate First Integrals of Perturbed Ordinary Differential Equations.

Ealasukanthan, T.

48p.

M.Sc. Degree, 2011.

Location No. 1122

5.6

Automobile Spare Parts Distribution System Design.

de Mel, Widanalage Raviprasad

89p.

M.Sc. Degree, 2001.

Location No. 171

5.7

Catastrophes and Stabilization Policies in Economic Dynamics.

Sureshkanna, Puvanentheran

59p.

M.Sc. Degree, 2007.

Location No. 666

5.8
Comparison of Minimum Spanning Tree Algorithms for a Telecommunication Network.

Rajakaruna, R.H.M.N.
43p.
M.Sc. Degree, 2012.
Location No. 1182

5.9
Dynamics of Market Models with Inventory.

Ratnayake, R.M.T.
60p.
M.Sc. Degree, 2004.
Location No. 379

5.10
An Efficient Transfer Scheme for School Teachers in Sri Lanka.

Mularachchi, N.S.K.
46p.
M.Sc. Degree, 2002.
Location No. 203

5.11
Implementation of Kruskal's Algorithm.

Wijesekera, W.A.D.H.G.M.
65p.
M.Sc. Degree, 2006.
Location No. 527

5.12
Integro-Differential Inequalities and the Impact of White Noise in Dynamic Market Models.

Baduraliya, Chaminda H.
66p.
M.Sc. Degree, 2007.
Location No. 667

5.13
Low-Cost Laboratory Teaching Kits for Automatic Control Education in Developing Countries.

Ruwanthilaka, J.A.
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M.Sc. Degree, 2006.
Location No. 528

5.14

A Mathematical Model for Blending of Aggregate by Weight.

Athapattu, A.S.

79p.

M.Sc. Degree, 2005.

Location No. 497

5.15

Natural Oscillations in Approximately Linear Second Order Dynamic Models.

Thalagune, E.M.G.W.M.B.

65p.

M.Sc. Degree, 2003.

Location No. 288

5.16

Optimizing the Inventory Cost of Carbon Dust.

Mayuiran, S.

38p.

M.Sc. Degree, 2011.

Location No. 1097

5.17

Optimizing the Ordering of Raw Material for Pharmaceutical Products.

Tharumasoruban, Thamarajah

40p.

M.Sc. Degree, 2002.

Location No. 204

5.18

Statistical Techniques for Soap Production Process in a Local Industry.

Pradeep, B.G.S.A.

68p.

M.Sc. Degree, 2010.

Location No. 989

5.19

Upgrading the Sampling Procedure of Surgical Gloves.

Mallawachchi, M.K.D. Wijaya Sri

96p.

M.Sc. Degree, 2001.

Location No. 202

6 - PHYSICS

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Research Project Reports

Ph.D. Dissertations

6.1

Bilayers and Multilayers of Polypyrrole and Poly(3, 4-Ethylenedioxythiophene) for Conducting Polymer Actuators.

Zainudeen, U.L.

145p.

Ph. D. Degree, 2008.

Location No. 791

Abstract

Polypyrrole (PPy) is a prime candidate for conducting polymer based actuators, but PPy has the disadvantage that the electronic conductivity decreases by two or three orders of magnitude as the polymer is reduced. This causes a decrease in the actuator performance. Thus, there is a need to improve the conductivity of PPy in its reduced state. The present work aims to improve the actuator performance of PPy by using a second, more highly conducting polymer poly(3,4-ethylenedioxythiophene), (PEDOT), as two-component conductive polymeric systems (bilayer and trilayer). In this regard, understanding the electrochemical behavior of individual PPy and PEDOT films, and multilayer films is essential to use these films as a combined system. Systematic studies on the preparation and characterization of PEDOT single layer and PEDOT/PPy multilayer films are reported in this thesis.

PEDOT doped with dodecyl benzene sulfonate (DBS) films were prepared electrochemically with constant currents and characterized using cyclic voltammetry, electrochemical quartz crystal microbalance (EQCM) and optical absorption spectroscopy techniques. Films were prepared at different current densities to choose a suitable preparation current to produce films with optimum properties. With suitable films, influence of ions present in the electrolyte and its concentration on redox process of PEDOT/DBS films were investigated systematically. The investigations show that large DBS⁻ anions are immobile and stay in the polymer matrix during redox cycling and cation movement dominates the charge compensation process. The redox behaviour is found to depend on the type of ions (both cations and anions) present in the electrolyte and the concentration of the electrolyte.

The cyclic voltammetric studies on PEDOT/DBS films show that the main oxidation and reduction peaks assigned to the cation movement shifts gradually towards more negative potentials with the increasing size of the cations. The influence of different anions is more clearly seen in voltammograms. It is found that ions like SO₄²⁻ has a greater difficulty to enter the polymer matrix, whereas the Cl⁻ and Br⁻ ions seem to move in and out of the film easily. The EQCM results also reveal that anion transport becomes more prominent with increasing concentration of the cycling electrolyte in the ionic exchange process. The EQCM responses also show indication of water movement taking place during the redox process, but in a smaller scale compared to water movement occurring in PPy/DBS films under similar conditions.

The UV visible absorption spectral studies have shown that the band gap for a typical PEDOT/DBS film is 2.1 eV. In the oxidized state, absorption spectrum has a peak centred at 1.3 eV, which can be assigned to the bipolaron electronic transition.

Bilayer and trilayer films were prepared electrochemically with PPy and PEDOT conducting polymers, both doped with DBS⁻ anions. In trilayer films, the PEDOT layer is sandwiched between the PPy layers. These multilayer films were characterized using the same techniques used for single layer films. The voltammetric and EQCM results obtained for bilayer films show combined characteristics of individual polymer. Thus, both PPy and PEDOT polymers are active in the redox process in the bilayer films. The redox behaviour is highly dependent on the thickness of each layer. In trilayer films, the reductions of inner and outer PPy layers take place at two different potentials. The results on a pentalayer film confirmed this with the occurrence of three such reduction peaks. The main oxidation peaks in trilayer films appear to occur at one potential only. It is also found that the separation between the two reduction peaks depends on the thickness of the middle PEDOT layer, the scan rate and the concentration of cycling electrolyte. The reduction peak separation becomes smaller and smaller and finally vanishes on repeated cycling. This indicates a gradual enhancement of ion diffusion through the middle PEDOT layer. The optical absorption spectra obtained for multilayer films at different redox potentials show clearly distinguishable peaks belonging to PEDOT and PPy polymers, confirming the independent behaviour of the PEDOT layer in multilayer films.

Electro-chemo-mechanical behaviour of multilayer films was investigated using the force displacement setup. The actuator strain has been found to be large for bilayer and trilayer films compared to that of single PPy layer at faster scan rates. Creep in multilayer and single layer films is found to be rather high during the first few cycles and it gradually disappears after nearly 50 continuous cycles. This indicates that around nearly 50 initial cycles is necessary in cases where actuator operation is required with minimum creep. The force differences between oxidized and reduced states in single and multilayer films are found to vary with scan rates. When the scan rate is increased from 0.01 to 10 Vs⁻¹ force difference increases until it reaches maximum value at about 1.75 V s⁻¹ and then the force difference decreases for higher scan rates. Larger force difference is obtained for trilayer and bilayer films compared to that observed in a PPy single layer. This shows that there is a significant improvement in the force generation when a thin PEDOT layer is added to PPy layers so as to form multilayer films.

Young's moduli of bilayer, trilayer and single layer actuator films are found to depend on the films' redox states. For single and multilayer films, the Young's moduli are found to drop nearly to one fifth of the values in the oxidized state, when the films are reduced.

The main conclusion from these studies can be summarized as follows: The multilayer actuators fabricated with PEDOT and PPy conducting polymers function qualitatively like a single PPy/DBS layer actuator. No negative effects or delamination has been observed. Hence the performance of PPy based actuators can be improved significantly by incorporating a thin layer of PEDOT/DBS. This points the way towards the use of such multilayer film assemblies for fabricating polypyrrole based actuators with better performance.

6.2

Electrical Properties of Zircon (ZrSiO₄) Ceramics Doped with Different Dopants Prepared via Solid State Sintering Route.

Dahanayake, A.D.A.D.J.M.D.S.U.

193p.

Ph.D. Degree, 2006.

Location No. 549

Abstract

Zircon (ZrSiO₄) is an inexpensive natural mineral which is mined in very large quantities

throughout the world including Sri Lanka and is recognized as a potential ceramic material for high temperature applications. It has also been proposed as a waste form for nuclear decommissioning and related applications. Although many studies on the properties of zircon requisite for such applications are reported in literature, electrical properties of zircon have received less attention. The results of a study on electrical properties of doped zircon ceramics prepared via solid state sintering route are reported in the present work. In this study, natural zircon powder was used as the starting material whereas Y_2O_3 , Yb_2O_3 , Eu_2O_3 , Fe_2O_3 , CaO , MgO , Li_2CO_3 and Na_2CO_3 were used as dopants.

Electrical conductivity of sintered samples was measured using *complex impedance spectroscopy* in the temperature range of 100- 500°C. The electrical conductivity of zircon without any dopants sintered at 1300 °C for 5 hours was $2.53 \times 10^{-7} \text{ S cm}^{-1}$ at 500°C whereas it was $8.49 \times 10^{-7} \text{ S cm}^{-1}$ at 500°C for zircon without any dopants sintered at 1450 °C for 5 hours. It was observed that Y_2O_3 , Fe_2O_3 , Li_2CO_3 and Na_2CO_3 doped zircon, with a dopant concentration level of 10 mol %, enhanced the conductivity by one order of magnitude whereas Yb_2O_3 , Eu_2O_3 , CaO and MgO doped zircon did not show any considerable conductivity enhancement, with the same dopant concentration level. The highest conductivity enhancement which was of two orders of magnitude was observed in doubly doped systems; namely (5 mol % Y_2O_3 + 5 mol % Li_2CO_3) doped zircon and (5 mol % Y_2O_3 + 5 mol % Na_2CO_3) doped zircon. It was also observed that the activation energy values for electrical conduction were quite different from system to system indicating that the rate controlling conduction mechanism is not identical in these systems. The most probable conduction mechanism in each system has been suggested with the aid of subsequent *Scanning Electron Microscopic (SEM)* analysis. Fe_2O_3 doped zircon showed some interesting magnetic behaviour and hence magnetic measurements were performed using *Vibrating Sample Magnetometry (VSM)* for curiosity. It was revealed that the presence of ferromagnetic Fe_2O_3 grains in the resulting samples has direct implications with the observed magnetic behaviour.

X-ray Fluorescence (XRF) and *Inductively Coupled Plasma (ICP)* analysis of starting zircon powders confirmed the presence of impurities in different concentration levels. Hence, for a comparative study, zircon was synthesized in the laboratory via solid state sintering of precursor oxides (ZrO_2 and SiO_2). The zircon yield in the resulting samples, calculated using *X-ray diffraction (XRD)* data, was dependent on the dopant and the highest zircon yield (100 %) was observed in 10 mol% Fe_2O_3 doped system whereas doping with Li_2CO_3 or Na_2CO_3 completely hindered the zircon formation. Although it was observed that the most of the laboratory synthesized zircon samples resembled their natural zircon counterparts as far as the electrical conductivity values are concerned, the activation energy values were dependent on the synthesis route.

The electrical conductivity of natural zircon single crystals along crystallographic axes a and c was also investigated. It was observed that the conductivity values measured along c axis (σ_c) were constantly higher than those measured along a axis (σ_a), which is indicative of the conductivity anisotropy of zircon single crystals. However, it was observed that σ_c/σ_a (for a fixed temperature) varies only from 1.50 to 2.77 in the temperature range of interest.

The flexural strength of some selected zircon particulate composites was determined in 4-point

bending mode and it was revealed that the flexural strength of zircon composites were about twofold higher than that of monolithic zircon. The toughening mechanisms in the composites were identified as crack bridging, crack deflection and microcracking by subsequent microstructural analysis performed on the samples.

6.3

Hydrography, Coastal Water Circulation and Classification of Sri Lankan Lagoons.

Arulananthan, K.

307p.

Ph.D. Degree, 2003.

Location No. 311

Abstract

Large daily temperature variations and intermittent hypersalinity are features typical for shallow tropical and subtropical lagoons. We investigate these effects in relation to water exchange, based on data from three lagoons on the west coast of Sri Lanka: Negombo, Puttalam and Chilaw Lagoons.

Negombo Lagoon has an estuarine character with low but variable salinities. The lagoon is strongly choked with respect to the semidiurnal tide, because of a narrow and shallow inlet. Data from Negombo Lagoon includes both a one-year series of monthly hydrographical surveys (salinity and temperature) and a longer campaign, comprising high-resolution salinity, temperature and sea level data from various sites. Simultaneous series of high-resolution meteorological data from a weather mast, covering long and short-wave radiation and data for calculation of turbulent heat fluxes were also obtained. Water exchange with the ocean was studied in relation to heat and freshwater input. The channel flux is a key factor. Salinity stratification, which promotes the exchange of properties, appears regularly. We found a difference in exchange between neap and spring but the difference was smaller than expected. The diurnal tide, which is more prominent during neap, promotes stratification, because of lower tidal velocities. Longer periods of in and outflow, in addition promotes more efficient frontal mixing. The diurnal temperature range is extreme (up to 8°C), but the mean temperature is only 0.5-1°C higher than that of the ocean. Estimates of heat exchange with the ocean and observations of surplus temperature of the lagoon indicate a net heat flux through the sea surface of 10-20 Wm⁻² only, for the period investigated. Observations and calculations based on weather mast data gave higher net flux, probably due to underestimate of the latent heat flux at low winds.

Measurements from the Puttalam Lagoon include monthly hydrographic surveys for a period of 2.5 years and high resolution salinity and sea level data from several sites, including current measurements at the inlet, Kalpity Narrows for a four month period. The Puttalam Lagoon is almost ten times larger and more open than the Negombo Lagoon. Because of poor water exchange and depths of 1-2 m only, the seasonal salinity variations become very large. In its inner parts, the salinities may reach 50-60 because of evaporation whereas the rain periods may lower the salinities to between 20 and 30. The residence times are between 40-100 days for exchange with the ocean but might be even longer. Water exchange within the lagoon takes place primarily during periods of slack water, when tidal mixing is weak and a gravitational circulation can be established. During periods of weak or non-existent horizontal gradients active estuarine circulation is uncommon and water exchange is slower, as indicated in our study. It means that frequent shifts from normal to hypersaline conditions bring down the long-term water exchange. The lagoon seems not to attain a steady state but the salinity continues to increase until the next rain season appears. In fact, it is possible that the salinity

may increase indefinitely. Chilaw Lagoon is smaller than the other lagoons and more restricted. It has two long and narrow entrances, of which one is intermittently closed. It was investigated with tide gauges and salinity-temperature sensors at three sites during 1998. The lagoon is strongly affected by freshwater discharge during floods, when the sea level may rise high above the ocean level.

The salinity of all three lagoons is sensitive to human impact. Changes in freshwater input caused by irrigation or damming, may result in large salinity variations and be crucial to marine life. In Puttalam Lagoon the salinity may have increased by 5-10 psu since the 1960's and it is now well above the oceanic mean, because of a lower river discharge. Also Negombo Lagoon may be affected by reduced discharge. However, all lagoons are also influenced by normal climatic variations, where immediate changes in salinity due to heavy rainfall may reach several psu and the diurnal temperature variability due to sea surface heat flux is 3-5 °C.

6.4

LiFeO₂ and LiCoO₂ Based Ceramics as Alternative Cathode Materials for Molten Carbonate Fuel Cells.

Tennakoon, Tennakoon Mudiyansele Thusitha Nanda

188p.

Ph. D. Degree, 1998.

Location No. 06

Abstract

Lithium ferrite (LiFeO₂) and lithium cobaltite (LiCoO₂) powders have been prepared, using the Pechini method, as alternative cathode materials for Molten Carbonate Fuel Cells. Upon fabrication, the Pycnometry, nitrogen adsorption method (BET), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and optical microscopy were used to characterise the powders. The preliminary electrical conductivities of pelletised and subsequently sintered powders were investigated using four probe method in both air and cathode gas (30% CO₂ and 70 % air) environments. These measurements showed that the prepared undoped LiFeO₂ samples possess a conductivity of 6.0×10^{-3} S/cm (converted to theoretical density) while undoped LiCoO₂ samples prepared using powder calcined at 650°C possess a conductivity higher than 0.57 S/cm at the temperature of interest.

In an attempt to increase the effective electrical conductivity, LiFeO₂ has been doped with magnesium, manganese and cobalt. These doping experiments revealed that cobalt has the highest influence on the conductivity of LiFeO₂ even in the low doping range (<3 mole %). The maximum enhancement of the conductivity up to 0.28 S/cm (at 650°C) was observed for 10 mole % Co-doped LiFeO₂. The iron doping in LiCoO₂ showed no positive influence on the effective conductivity of LiCoO₂.

The undoped LiFeO₂, 10 mole % Co-doped LiFeO₂ and undoped LiCoO₂ were tape cast and sintered at different temperatures to obtain porous-gas-diffusion cathodes. The electrochemical performance of the prepared cathodes were investigated (*in-cell* tests) using a laboratory scale molten carbonate fuel cell (electrode area 3 cm²). The obtained electrochemical performance of these cathodes have been analysed in terms of the effective conductivity, the phase constituents and the microstructural parameters such as particle size, particle morphology and pore size distribution. From these analysis, it was concluded that the LiCoO₂ cathode sintered at 900°C/6h possesses the most favourable (optimum) microstructure for efficient chemical reactions, and hence yields the best performance. The IR-compensated polarisation of this cathode at 650°C corresponding to a current density of 160 mA/cm² was as low as 88 mV which is obviously in the range of lithiated-NiO. The measured IR drop at 650°C

for the best cathode was almost 100 mV larger than the IR drop of lithiated-NiO.

6.5

Physical and Electrochemical Properties of Polyanilines.

Chandrakanthi, R.L.N.

170p.

Ph.D. Degree, 2000.

Location No. 93

Abstract

Polyaniline (PANI) has emerged as one of the most promising conductive polymers for commercial development. The oxidation states of PANI can be varied from fully reduced leucoemeraldine base to the half oxidized emeraldine base and to the fully oxidized pernigraniline base form. In this study emeraldine base form of polyaniline was used as the starting material for the preparation of other oxidation and protonation forms. The fully oxidized form of polyaniline, pernigraniline base (PNB) has been prepared as a pure and stable powder. The protonated form of PNB has been obtained in highly acidic media by controlling the processing conditions such as solvent, temperature, drying procedure, etc. Conductivity measurements showed a metallic behaviour for the partially crystalline PNB salt form.

The thermal characteristics of emeraldine base form of PANI were studied by viscosity measurements, FTIR spectroscopy and thermogravimetric analysis. Thermal aging of PANI results in a decrease in conductivity. The electrochemical behaviour of chemically and electrochemically synthesized polyaniline films have been investigated in aqueous functionalized acid solutions. Cyclic voltammograms of chemically and electrochemically synthesized PANI were found to be almost identical. PANI films obtained by these two processes were compared with respect to their conductivity and stability. The in-situ conductivity experiments enabled the determination of a finite window of conductivity for different functionalized acids.

Nanocomposite materials formed by cadmium sulfide (CdS) and copper sulfide (Cu₂S) with polyaniline were synthesized by chemical methods. CdS/PANI and Cu₂S/PANI nanocomposites were prepared by incorporating Li₂S, Cd(CF₃SO₃)₂ and Cu(CF₃SO₃)₂ in PANI. Particle sizes of CdS and Cu₂S can be varied using this method. These nanocrystal sizes were obtained by TEM and XRD. The nanocomposites show good stability and high absorption in the visible light spectrum. The use of nanocrystals allows great flexibility in controlling the performance of photovoltaic devices by changing the nanocrystal size, concentration, and the material of the nanocrystals.

6.6

Polypyrrole Based Conducting Polymers and their Electrochemomechanical Properties.

Vidanapathirana, Kamal Pushpakumara

230p.

Ph.D. Degree, 2000.

Location No. 95

Abstract

The influence of preparation conditions on the properties of electroactive poly-N-methylpyrrole (PNMP) films were investigated with the view of obtaining highly conductive films. PNMP films were galvanostatically polymerized in aqueous electrolytes by varying the electrolyte concentration, current density, type of doping anion, pH of the electrolyte and the polymerization temperature. The films obtained were characterized using cyclic voltammetry

and impedance spectroscopy. Conductivity of PNMP films was very much affected by the polymerization current density, pH and the polymerization temperature whereas no considerable effect was observed when the concentration of the electrolyte and the size of the anion were changed. Highest conductivity for PNMP films (43 mS cm^{-2}) was obtained with the following conditions: electrolyte concentration = 0.5 M , current density = $62.5 \mu\text{A cm}^{-2}$, anion = ClO_4^- , pH = 1.0 and polymerization temperature = 3°C .

Mass changes occurring in PNMP films during the redox process due to ion exchange were investigated using an Electrochemical Quartz Crystal Microbalance (EQCM). The mass changes and dependence of peak potentials of cyclic voltammograms (CVs) with respect to cycling electrolyte concentration revealed that anions are the moving species during the redox process in PNMP films that were prepared and cycled in aqueous electrolytes containing small anions.

Polypyrrole (PPy) films were prepared with large surfactant anion, dodecyl benzenesulfonate (DBS^-), and their properties were compared with those of PPy films prepared with small anions under similar conditions. It has been observed that the stability of PPy/DBS films made in aqueous electrolytes was same as that of the PPy films made in non aqueous electrolytes.

EQCM studies and dependence of peak potentials of CVs on cycling electrolyte concentration of PPy/DBS films showed a dual step scheme for the redox process in the films when they are cycled in aqueous electrolytes. During oxidation, cation expulsion takes place at lower potentials whereas anion insertion takes place at higher potentials. During reduction, anion expulsion at higher potentials and cation insertion at lower potentials takes place.

Lithium rechargeable cells were fabricated using PPy/DBS as the cathode and polyacrylonitrile (PAN) based electrolyte as the separator. These cells were characterized by cyclic voltammetry, impedance spectroscopy and continuous charge-discharge cycling. Kinetics of these cells seemed to be governed by ion diffusion. Continuous charge-discharge experiments showed that these cells could be cycled more than 1000 times without any appreciable charge decay.

Electrochemomechanical properties of PPy/DBS films were investigated by fabricating bi-layer and dry artificial muscles and obtaining the force exerted by these muscles and the cyclic voltammograms simultaneously. The highest change in the force can always be associated with the main peaks of the cyclic voltammogram. It has been observed that appreciable force change occurred in a rather narrow voltage interval. Muscles fabricated with PPy films prepared using larger anions and higher polymerization current densities gave higher forces. Higher forces can also be obtained by limiting the cycling potential window so that only cation exchange occurs.

6.7

Solid Polymer Electrolytes Based on Polyacrylonitrile (PAN) and Organically Modified Ceramics (Ormocers).

Perera, G.A. Kumudu Sandya

259p.

Ph.D. Degree, 2000

Location No. 94

Abstract

PAN based electrolytes were made by complexing EC and PC with different salts namely, CuCNS, $\text{Cu}(\text{CF}_3\text{SO}_3)_2$, $\text{Mg}(\text{ClO}_4)_2$ and LiCF_3SO_3 . Sample preparation was done using the hot pressed technique. All systems yielded free standing electrolyte films.

System with 21 mol% PAN : 30 mol% EC : 45 mol% PC : 4 mol% CuCNS has a room temperature

conductivity of $3.3 \times 10^{-5} \text{ S cm}^{-1}$ while the system with 20 mol% PAN : 41 mol% EC : 34 mol% PC : 5 mol% $\text{Cu}(\text{CF}_3\text{SO}_3)_2$ has a room temperature conductivity of $4.1 \times 10^{-3} \text{ S cm}^{-1}$. Conductivity variations with temperature of the two systems show Arrhenius and VTF behaviours respectively. Former system seems to be an anionic conductor and the latter system a mixed conductor with cationic and electronic contributions. Electrolytes made with $\text{Cu}(\text{CF}_3\text{SO}_3)_2$ has been used in cells of the form, Cu / PAN: EC : PC : $\text{Cu}(\text{CF}_3\text{SO}_3)_2$ PPy : DBS where DBS stands for polypyrrole polymerized in the presence of DBS. Open circuit voltage was approximately 180 mV. A capacity of about 12 μAh under a load resistor of 50 $\text{k}\Omega$ was obtained.

When $\text{Mg}(\text{ClO}_4)_2$ was incorporated with PAN : EC : PC, a room temperature conductivity of $3.2 \times 10^{-3} \text{ S cm}^{-1}$ can be obtained from the composition 18 mol% PAN: 64 mol% EC : 14 mol% PC : 4 mol% $\text{Mg}(\text{ClO}_4)_2$. Conductivity variation with the temperature takes the form of Arrhenius behaviour. Secondary solid state cells have been fabricated with this electrolyte in the form, Mg / PAN : EC : PC : $\text{Mg}(\text{ClO}_4)_2$ / PPy : DBS. Open circuit voltage lies around 1.5 V. Estimated capacity values are around 0.18 mA h.

System based on LiCF_3SO_3 has a room temperature conductivity of $1.2 \times 10^{-3} \text{ S cm}^{-1}$. Corresponding composition is 15 mol% PAN: 42 mol% EC : 36 mol% PC: 7 mol% LiCF_3SO_3 . Conductivity variation with temperature followed VTF behaviour. Stability of the electrolyte with lithium is somewhat acceptable. Test cells in the configuration, Li / PAN: EC : PC : LiCF_3SO_3 / PPy : X (X : CF_3SO_3^- , DBS⁻, AS⁻) have open circuit voltages around 4 V. It is possible to get more than 800 cycles with an efficiency of 99.95%. Artificial muscles in the form, PPy : X / PAN : EC : PC : LiCF_3SO_3 / PPy : X (x : CF_3SO_3^- , DBS⁻) have been fabricated. Their movements were observed between two voltages. It is seen that the movements are faster when the assembly is thin.

Ormocer electrolytes are having somewhat considerable conductivity values. But, those values should be enhanced further to make them proper candidates for applications. Concept of all solid state cells may be feasible with ormocers.

6.8

Stability, Strain and Speed of Polypyrrole Actuators.

Jafeen, M.

169p.

Ph.D. Degree, 2010.

Location No. 941

Abstract

Polypyrrole doped with large immobile dodecyl benzene sulfonate (PPy/DBS) anions operating in aqueous electrolytes is one of the successful and low cost systems suitable for the use as soft actuators. However, considerable improvement in the performance of the PPy/DBS actuators is still required for successful applications of these actuators. The present work aims to get a better understanding of the processes associated with actuation mechanism of PPy/DBS actuators so as to improve their performance. A second aim has been to use the unique physico-chemical environment of polypyrrole to determine hydration numbers of cations. The PPy/DBS films were prepared electrochemically with constant currents and characterized using cyclic voltammetry (CV), electrochemical quartz crystal microbalance (EQCM), optical absorption spectroscopy, and force-displacement measurement techniques.

The electrochemical processes associated with the actuation of the PPy/DBS films in alkali halide and alkali earth halide chloride aqueous electrolytes having varying concentrations were investigated. The redox behaviour of the films in electrolytes having various concentrations shows that the cathodic peak potentials during the cathodic reduction of the films depend on

the concentration of the cycling electrolytes used. The results also indicate the necessity of water in the right amount in the cycling electrolytes to ease the reduction process. Cyclic voltammetric studies at different sweep rates show that the mobility (diffusion) of counter ions into the PPy/DBS film is larger in concentrated electrolytes having smaller cations.

In highly concentrated alkali halide aqueous electrolytes, the mass of a PPy/DBS film at the end of each redox cycle is found to drift. The change in mass depends on the concentration of the cycling electrolytes used and the number of cycles. The mass drift during cycling can be controlled by interchanging the cycling electrolytes.

The electrochemical stability of PPy/DBS films in aqueous alkali halide electrolytes depends strongly on the concentration of the electrolyte used. While the cycling capacity in dilute electrolytes decreases significantly after about 50 cycles, the capacity remains the same even at the 300th cycle in highly concentrated electrolytes indicating that the films are more stable in highly concentrated alkali halide electrolytes. This is an important result with respect to the usability of this type of actuator.

Very thin nano-sized (nm thick) PPy/DBS films were also prepared using electrochemical polymerization and characterized using EQCM measurements. The results show that ionic motion in nano-sized thin PPy/DBS films during redox cycling in alkali halide aqueous electrolytes has similar characteristics as those of ionic motion in comparatively thicker PPy/DBS films. The results further indicate that the initial layers of a PPy/DBS film are somewhat different in structure from the layers added later in the film.

The hydration numbers of metal cations in aqueous electrolytes were determined using the novel physico-chemical environment of polypyrrole. The primary hydration numbers obtained for alkali, alkali earth and alkali rare earth metal cations in respective chloride aqueous electrolytes having various concentrations (0.02 M - 1 M) are:

Li⁺ : 5.5-5.3; Na⁺ : 4.5-4.3; K⁺ : 2.3-2.5; Rb⁺ : 0.9-0.8 ; Cs⁺ : ~0; Mg²⁺ : 10.4-10.6 ; Ca²⁺: 7.9-8.1; Sr²⁺: 5.7-6.1; Ba²⁺: 3.0-3.1; Y³⁺: 13.6 - 13.8; La³⁺: 9.0-9.1.

The values of the primary hydration numbers of these metal ions are found to remain constant in the above aqueous electrolytes having concentrations up to 1 M. For all cations the primary hydration numbers show an approximate linear variation with the total charge per surface area of each cation, which is a measure of the surface charge density. The model using the surface charge density may well be the best simple model for primary hydration number of a metal ion. Furthermore the primary hydration numbers of metal cations in highly concentrated aqueous electrolytes are smaller than those in dilute electrolytes and the free water in highly concentrated electrolyte is absolutely a 'different kind of water' containing loosely bound water molecules rather than entirely free molecules.

Electro-chemo-mechanical behaviour of PPy/DBS actuators was investigated using the computer automated Force-Displacement setup. Experiments demonstrated that the electrochemical strain of a PPy/DBS actuator in aqueous electrolytes depends on of the actuation frequency and on the type of cations in the cycling electrolytes. At high actuation frequencies, strains depend solely on the cation plus the hydrated water molecules (i.e. on the hydration number) and at low frequencies, on the other hand, the strain depends on the sum of the hydrated water molecules and those inserted by an osmotic process. Between the two frequency regions the strain decreases significantly. Therefore, the highest speed of response (larger strain at high actuation frequency) for PPy/DBS actuators is achievable in the cycling electrolytes containing cations having larger hydration numbers.

6.9**Synthesis and Characterization of Doped and Undoped Zircon based Ceramics.**

Alahakoon, W.P.C.M.

205p.

Ph. D. Degree, 2013.

Location No. 1285

Abstract

Homogeneous and fine sized starting powders of both undoped and doped zircon (Fe, Y, Fe and Al co-doped) were synthesized by the sol-gel technique following controlled hydrolysis and condensation steps. The powders were sintered for different temperatures and their structural characterization was carried out using wide range of characterization techniques such as XRD, NMR, SEM and TEM.

The densities and zircon yields of both doped and undoped samples have found to increase with temperature reaching a maximum at 1500°C. They show a slight dissociation beyond this temperature. A significant reduction in the starting temperature of zircon formation was observed in the Fe and co-doped sample from 1400°C to 1225°C and 1215°C respectively revealing the contribution of the dopants in zircon formation.

The microstructures of both doped and undoped samples revealed they are almost fully dense. The dopants are present in the grain boundaries in all the samples indicating no substantial solid solution formation with zircon. The Fe and Al co-doped sample is superior to all the other samples, showing promising microstructures without microcracking with fully densified zircon and high zircon yield. Almost single phase zircon was obtained at 1400°C. TEM micrographs reveal that a crystalline grain boundary phase containing some Fe and Al. This may be advantageous when high temperature creep resistance is a concern.

Another set of samples were prepared with the conventional solid state sintering method and compared with the sol-gel samples. Undoped and Fe doped samples have silica in the form of both crystalline and amorphous phases whereas Y doped sample has complex microstructure with multiphases due to yttrium. Dopants are present in the grain boundaries without substituting into the zircon sub lattice. A significant feature observed in the sol-gel samples is the absence of cristobalite phase which contributes towards crack formation in the sintered bodies.

Finally the electrical properties of both sets of samples were discussed. It was revealed that there is a transient current present due to some initial mobility within the samples, which masks the true conductivity values. Therefore the measured conductivity data could be due to the transient current combined with grain boundary conduction. Also it was suggested that doping does not help in oxygen vacancy migration due to the high activation energy of oxygen migration.

6.10**Synthesis and Characterization of Poly (Ethylene Oxide) (PEO) - Based and Polyacrylonitrile (PAN) - Based Polymer Electrolytes to be Used in Photoelectrochemical (PEC) Solar Cells.**

Bandara, T.M.W.J.

124p.

Ph.D. Degree. 2010.

Location No. 1071

Abstract

Dye sensitized photo-electrochemical (PEC) solar cells require solid state redox electrolyte systems with good conductivity, mechanical strength and chemical stability. Iodide ion containing polymer electrolytes are important as redox species in PEC solar cells as well as in iodide ion conducting batteries and other devices. In this work, ionic conductivity and thermal, dielectric and transport properties of some Polyethyleneoxide (PEO) and Polyacrylonitrile (PAN) based electrolyte systems and their applications in PEC solar cells were studied.

Solid polymer electrolyte membranes were prepared by complexing tetrapropylammonium iodide ($\text{Pr}_4\text{N}^+\text{I}^-$) and PEO. The $\text{PEO}:\text{Pr}_4\text{N}^+\text{I}^- + \text{I}_2 = 9:1$ ratio gave the best room temperature conductivity for the electrolyte. For this composition, by incorporating the plasticizer ethylene carbonate (EC), a conductivity enhancement of four orders of magnitude was obtained. A marked conductivity enhancement was observed during the melting of the polymer crystallites and above this polymer melting temperature (T_m) the conductivity reached values of the order of $10^{-3} \text{ S cm}^{-1}$. The T_m decreased from 66.1 to 45.1 °C and the glass transition temperature (T_g) decreased from -57.6 to -70.9°C due to the incorporation of the EC. The room temperature dielectric constant increased from 3.3 for the unplasticized sample to 17.5 for the plasticized sample. It can be inferred from the dielectric results, that the iodide ion is well dissociated and despite its large size and relatively low concentration it is a relatively efficient charge carrier. All solid solar cells were fabricated with plasticized electrolytes containing $\text{PEO}:\text{Pr}_4\text{N}^+\text{I}^- + \text{I}_2 = 9:1$ and EC. Maximum photocurrent of $98 \mu\text{A cm}^{-2}$ was obtained for the electrolyte composition $\text{PEO}:\text{EC} = 1:1$ under the irradiation of 1000 W cm^{-2} .

The effect of incorporating Al_2O_3 filler on the properties of the plasticized electrolyte was studied using electrical and dielectric measurements, and thermal analysis. In the differential scanning calorimetry (DSC) thermograms the existence of two endothermic peaks was observed on heating; one of these peaks is associated with the melting of the PEO crystallites, while the other peak at about 30°C is associated with the melting of the EC rich phase. The temperature dependence of the conductivity exhibited an abrupt conductivity increase in the 1st heating run due to the melting of the EC rich phase. Conductivity isotherms showed the existence of two maxima, one at ~5 % Al_2O_3 content and the other at ~15 %. The occurrence of these two maxima could be explained in terms of the interactions caused by alumina grains and the crystallinity of the electrolyte. However, a conductivity enhancement could not be observed in the $\text{PEO}/\text{EC}/\text{Pr}_4\text{N}^+\text{I}^-$ electrolyte due to incorporation of Al_2O_3 filler.

Enhanced ionic conductivity values were obtained for the ionic liquid tetrahexylammonium iodide containing PEO-based plasticized electrolytes. The conductivity measurements showed a marked conductivity enhancement during the melting of the plasticizer-rich phase of the electrolyte. Annealed electrolyte samples showed slightly better conductivity than non annealed samples revealing the existence of hysteresis. The optimum conductivity was shown for the electrolytes with $\text{PEO}:\text{Salt} = 100:15$ mass ratio and this sample exhibited minimum T_g of -72.2°C. For this optimum $\text{PEO}:\text{Salt}$ ratio, the conductivity of non-annealed electrolyte was $4.4 \times 10^{-4} \text{ S cm}^{-1}$ and that of the annealed sample was 4.6×10^{-4} at 30°C. The short circuit current density (I_{sc}), open circuit voltage (V_{oc}) and power conversion efficiency (η %) of the PEC solar cell fabricated with optimum conductivity electrolyte are 0.63 mA cm^{-2} , 0.76 V and 0.47% under the irradiation of 600 W m^{-2} light.

Gel polymer electrolytes based on PAN are potential candidates for photo-electrochemical solar cells. In this work, the plasticized gel polymer electrolyte $\text{PAN}:\text{EC}:\text{PC}:\text{MgI}_2$ was studied. At 20°C the optimum ionic conductivity of $1.9 \times 10^{-3} \text{ S cm}^{-1}$ was obtained for the $(\text{PAN})_{10}(\text{MgI}_2)_n(\text{I}_2)_{n/10}(\text{EC})_{20}(\text{PC})_{20}$ electrolyte where $n = 1.5$. The predominantly ionic nature of the electrolyte is seen from the DC polarization data. DSC thermograms of electrolyte with

different MgI_2 concentrations were studied and the glass transition temperatures were determined. The $I-V$ characteristics revealed that the I_{sc} , V_{oc} and η of the cell are 3.87 mA cm^{-2} , 659 mV and 2.5% respectively under the irradiation of 600 W m^{-2} .

6.11

Synthesis, Characterization and Electrical Properties of Some Solid Polymer Electrolytes Based on Poly (Ethylene Oxide), PEO.

Bandara, L. R. A. K.

238p.

Ph.D. Degree, 2000.

Location No. 92

Abstract

In recent decades, a considerable interest has been focused on polymer electrolyte materials, prepared by complexing suitable polymers with selected metal salts to give electrolyte membranes of interest for the development of electrochemical devices. The most classic example is the combination of poly(ethylene oxide), PEO, the lithium salts (LiX), which in fact are being explored for the development of high-energy density rechargeable batteries. Polymer electrolytes suitable for secondary lithium batteries are thoroughly studied in order to achieve better performance in terms of high ionic conductivity at room temperature and stability against lithium electrodes. However, one major problem of PEO based electrolytes is that the conductivity assumes practically acceptable values only at high temperatures around $100 \text{ }^\circ\text{C}$.

The objective of the present work is to study the characteristics of PEO based solid polymer electrolytes. This thesis focuses on enhancement of ionic conductivity and ionic transport mechanisms in these electrolytes. Efforts have been made to increase the ambient temperature conductivity by decreasing the crystallinity and increasing the segmental mobility of the polymer by the incorporation of salts and plasticizers into PEO. The two systems, PEO- LiCF_3SO_3 and PEO- $\text{LiN}(\text{CF}_3\text{SO}_2)_2$, have been chosen for this work. Low molecular weight PEGM ($M_w = 400$), EC and PC were used as conventional plasticizers. Furthermore, nano-composite electrolytes i.e. plasticized polymer-salt electrolytes with an added ceramic filler of small particle size, such as Al_2O_3 , has been found to enhance ionic conductivity.

The addition of finely dispersed non-miscible particles in a polymer electrolyte generally enhances the ion conductivity. PPFEMO ($M_w = 4000$) was introduced as a new type of plasticizer for PEO based polymer electrolytes. There are, up to now, no other examples of mixing this type of electrolyte with non-miscible liquids except with the PEO based electrolytes with PPFEMO systems presented here. The system PEO-LiX, with the addition of PPFEMO is a bi-phase stable emulsion. The micro-droplets present in the emulsion prevent or retard the crystallization of the electrolyte when it is cooled from the melting temperature to ambient temperature. The ion conductivity below the melting point temperature maintains stable values as long as the re-crystallization is prevented. The characteristics of the electrolytes were investigated by Complex Impedance Spectroscopy, Complex Dielectric Spectroscopy, Differential Scanning Calorimetry and transference number measurements. The temperature dependence of the conductivity was studied in detail for all materials. Dielectric properties, dynamical mechanical properties, glass transition temperature and degree of crystallinity of these materials were also discussed in detail.

For the systems, PEO- LiCF_3SO_3 , PEO- $\text{LiN}(\text{CF}_3\text{SO}_2)_2$, PEO- $\text{LiN}(\text{CF}_3\text{SO}_2)_2$ -EC/PC and PEO- $\text{LiN}(\text{CF}_3\text{SO}_2)_2$ -PPFEMO, the dielectric measurements reveal two peaks in the imaginary part of the dielectric function, a high frequency peak in the GHz region attributed to the α -process of

the pure polymer, and a lower frequency 'ion-pair' peak in the MHz region, the intensity of which is found to be dependent upon the concentration of the salt present in the polymer-salt complex. Considerable amounts of ion pairs were present in both plasticized and unplasticized polymer electrolytes and if the relaxation frequency can be taken as a probe of the local flexibility of the polymer chain it can be concluded that the conductivity increases in parallel to the increases in the local flexibility of the polymer segments.

6.12

Tidal Characteristics and Modelling of Tidal Wave Propagation in Shallow Lagoons of Sri Lanka.

Wijeratne, E.M.S.

263p.

Ph.D. Degree, 2002.

Location No. 217

Abstract

This contains a thorough investigation of the tides around Sri Lanka including the behaviour of tidal co-oscillations in some shallow lagoons. Measurements of tides, currents and related hydrographic parameters were carried out in Puttalam, Negombo and Chilaw Lagoons. Puttalam Lagoon is large with a relatively wide entrance. Negombo and Chilaw Lagoons are small, featuring "restricted" inlets and seasonally large freshwater supply. Numerical tidal models driven *primarily* by the oceanic tide were elaborated and tested against field data.

The sea level variations of Sri Lanka feature both tidal and non-tidal fluctuations. The seasonal sea level range due to steric height, air pressure, wind and current variability amounts to 0.25m with maximum height in January and minimum in August. There are also oscillations of 80 and 120 hr period, related to equatorially trapped internal waves. The oceanic tide is mixed semidiurnal with a spring tidal range of 0.40 – 0.60m. The air pressure features relatively strong diurnal and semidiurnal variations, which also affects sea level.

Spring tidal range in Puttalam lagoon is 0.30m. The range is slightly larger in the inner end than in central basin. 1-D and 2-D models with C_d 's of 0.0032 and 0.0025 respectively gave almost perfect agreements with measured tides throughout the lagoon. The phase difference between tidal elevation and currents shows that the tidal oscillation is a mixture of progressive and standing waves, where progressive waves dominate in the outer part and standing in the inner part of the basin. The distribution of energy dissipation was consistent with co-tidal charts. The 2-D model was also run to estimate water and salt exchange and sea level set up by wind.

Spring tidal ranges in Negombo and Chilaw lagoons are 0.14 and 0.10m, respectively. Thus, both Lagoons are subject to finite amplitude influences, such as well-developed fortnightly tides. Negombo lagoon was modelled using 1-D, 2D and choking models. Chilaw lagoon has two inlets, one of which is intermittently closed due to sand bar formation. A 1-D model with C_d of 0.0028 showed good agreement with measured sea levels for both case.

M.Phil. Theses

6.13

Clay Polymer Nanocomposites: Investigation of Mechanical, Thermal and Optical Properties of Selected Nanocomposites.

Soundararajah, Q.Y.

91p.

M.Phil. Degree, 2007.

Location No. 633

Abstract

Clay- Polymer nanocomposites are a new class of materials which recently attracted a great deal of attention as they offer enhanced mechanical, thermal and optical properties compared to their conventional materials. Because of these enhanced properties they find application in the fields of electronics, automobile industry, packaging and construction.

Three types of nanocomposites were prepared and their mechanical, thermal and optical properties were investigated in this study. A conducting polymer polyaniline (PANI) and a smectite type clay montmorillonite (MMT) were used to synthesize MMT - P ANI nanocomposites, a thermoplastic polymer poly (vinyl) alcohol (PVA) and MMT were used to prepare MMT-PVA nanocomposites and PVA was used with kaolinite (K) clay to make K-PVA nanocomposites. Several compositions with various clay contents were prepared for each nanocomposite.

The MMT-PANI nanocomposites exhibited enhanced mechanical properties over the pristine clay and neat polymer. The MMT-PANI nanocomposites that have the lowest clay contents showed the maximum enhancement in the mechanical properties as it has a structure in which the clay layers are randomly oriented or exfoliated giving good interfacial interactions between the polymer matrix and clay fillers. It is the nature and degree of such interactions that play a pivotal role on the characteristics of the resultant nanocomposites.

The MMT-PVA nanocomposites also displayed improved mechanical, thermal and optical properties compared to the neat polymer or clay. The PVA containing 4 wt% of MMT nanocomposite became superior to the other nanocomposites, probably due to its exfoliated structure. The dispersed clay layers are well embedded with PVA matrix *via* strong interatomic interactions enhancing their aforementioned material properties. Clay aggregates, flaws and the trapped air bubbles attribute to the poor mechanical, thermal and optical properties.

The K-PVA series formed micro composites rather than nanocomposites as the polymer was adsorbed only at the edges of the clay particles as kaolinite has low cation exchange capacity and low swell/shrink ability. The K-PVA micro composites showed poor material properties compared to the MMT-PVA nanocomposites. The clay aggregates, micro-voids and the trapped air bubbles may have attributed to the poor material performance.

In conclusion, it was observed that the MMT clay is suitable to synthesize clay polymer nanocomposites with various polymers in right proportion to give materials with enhanced mechanical, thermal and optical properties.

6.14

Dielectric and Thermal Properties of Polymer Electrolytes Based on Poly (Acrylonitrile) and Poly (Propylene Glycol).

Samantha, W.A.

115p.

M.Phil. Degree, 2001.

Location No. 178

Abstract

Polymer electrolytes are materials, which are becoming increasingly important in applications such as batteries, electrochromic devices and fuel cells. A goal of polymer electrolyte researchers since the discovery of ionic conductivity in Li salt complexes of poly(ethylene oxide) has been the identification of solid polymer electrolytes which have high enough conductivity to enable the development of solid state Li batteries with ambient temperature performance. These materials usually consist of organic polymers that are able to solvate different type of salts. The most thoroughly studied polymer electrolytes are those where alkali salts are mixed with polyethers, e.g. poly(ethyleneglycol), PEG, and poly(propylene glycol), PPG. The polymeric chain mobility contributes to the mechanism of migration of the ionic species dissolved and therefore the dynamics of the polymer is of great interest for the understanding of the conductivity mechanism. A completely amorphous material like PPG may be a simpler model in a study intended to isolate the relaxation processes.

The electrical and thermal properties of the systems PPG/LiCF₃SO₃ and PPG/LiN(CF₃SO₂)₂ have been studied using dielectric spectroscopy and differential scanning calorimetry (DSC). The dielectric measurements reveal two peaks in the imaginary part of the dielectric function, a high frequency peak attributed to the α -process of the pure polymer, and a lower frequency peak, the intensity of which is found to be very dependent upon the concentration of salt. The relaxation frequency of this peak is found to be very close to the α -process found in the pure polymer. The DSC results show that for both type of systems, the glass transition temperature, T_g , is increasing with increasing salt concentration from a value of -71.1 °C for pure PPG up to -25.9 °C for the PPG/LiTf system with the highest salt concentration. At a salt concentration corresponding to O:M=16, the step at T_g is quite broad, which may indicate the existence of two glass transitions, seen in other DSC studies on similar systems.

The conductivity, dielectric and thermal properties of poly(acrylonitrile), PAN, molecular weight of 86200, based lithium conducting plasticized electrolytes have been studied by impedance spectroscopy, X-ray diffraction, TG and DSC. X-ray results reveal that although the pure PAN powder is partially crystalline, the PAN based electrolytes show no traces of crystallinity, i.e. the polymers are highly amorphous. When the salt is dissolved in the polymer, no peaks are detected for the plasticized electrolytes, indicating that the sample is highly amorphous and that the salt is fully dissolved. The TG results suggest that in the PAN/PC/EC/LiCF₃SO₃ samples the initial weight loss corresponds to evaporation of the plasticizers, EC and PC, which is completed before 300°C and at higher temperatures, we see the decomposition of PAN and the salt. We thus see no interaction between the plasticizer and the PAN in this case. It can be observed from the DSC measurements that when PC is mixed with PAN/EC/LiCF₃SO₃, the plasticizers, EC and PC are homogeneously dissolved in the electrolyte and giving rise to good conductivity. It has been investigated from dielectric measurements that there is a large contribution to the dielectric relaxation of PC/LiCF₃SO₃ system due to the addition PAN. This suggests that there is an interaction between PAN and Li⁺ ions, presumably through the C≡N arm making a dipole. We believe that the PAN based electrolytes have, more or less plasticizers trapped in the PAN structure as a liquid giving rise to good conductivity at room temperature.

6.15

Electrical Conductivity and Optical Absorption Studies of Polyaniline Conducting Polymer.

Gunaratne, L.M.W.K.

119p.

M. Phil. Degree, 1998.

Location No. 17

Abstract

Polyaniline(PANI) has been synthesized in both aqueous and non-aqueous (Propylene carbonate) media by galvanostatic electrochemical polymerization with current densities ranging from 15.62 to 500 $\mu\text{A}/\text{cm}^2$. Also PANI films have been formed in aqueous medium by potentiostatic electrochemical polymerization at 0.7 V with respect to Saturated Calomel Electrode (SCE). The films obtained were characterized using cyclic voltammetry and optical absorption spectroscopy. Different growth rates used during polymerization strongly influence the quality of the polymer. The films, synthesized slowly at low current density, have a higher conjugation length and more regular structure than those prepared quickly at higher current densities. Simultaneous measurement of cyclic voltammograms and the absorption of selected spectral lines are used because of the complex nature of the polyaniline system which involves several redox systems as well as forms differing in the degree of protonation and morphology. The transient behaviour of the system was studied by measuring the decay of current with time due to the application of a potential step at different (0.16 to 1.00V) potentials.

The main result is that the method of galvanostatic synthesis at very low current densities ($\sim 16 \mu\text{A}/\text{cm}^2$) produces polyaniline films of different and more well-defined structure than those prepared at higher current densities. The value of π - π^* transition (band gap) obtained for the low current density form of P ANI is 3.70 eV which is lower than the values, 3.9 - 4.1 eV, reported in the literature.

To obtain high quality polyaniline films completely purified colourless monomer must be used and water must be rigorously excluded from monomer solution.

The pH of the electrolyte solution influences the conductivity of polyaniline and the conductivity decreases rapidly with increasing pH (above 3) of the solution.

6.16

Electrochemical and Electromechanical Behaviour of Polypyrrole Films.

Velmurugu, Y.

246p.

M.Phil. Degree, 2005.

Location No. 507

Abstract

In the present study the doping of polypyrrole with large anionic detergent Dodecyl Benzene Sulfonate (DBS) has been investigated by using cyclic voltammetry, optical spectroscopy, and electrochemical quartz crystal microbalance techniques. The study focused on improving the use of PPy /DBS films with respect to the actuation mechanism and on providing an experimental test of the proposed osmotic mechanism for the motion of species between the film and the electrolyte.

The analysis of the results indicated that the kinetics of the electrochemical doping of a conducting polymer films depends on the history of the electrochemical events undergone by

the film. The influence of different parameters (Wait-time at the starting potential, number of cycles) on the redox process is described, when doping is achieved by a potential scan.

During the redox process water is also inserted or expelled in two ways: as molecules bound to the moving ions and as a result of the osmotic effect. It was found that while the dominant cation motion does not depend very much on the speed of cycling, the water transport strongly depends on the rate of the potential scan, since the insertion caused by the osmotic mechanism is much slower, and does not follow the cations directly. Significant changes in the redox properties of the films were observed with the increase of the cycling electrolyte concentration. The effective diffusion coefficient of counterions in 0.1 M, 1 M and 3 M NaCl are nearly $3 \times 10^{-12} \text{ m}^2 \text{ s}^{-1}$, $20 \times 10^{-12} \text{ m}^2 \text{ s}^{-1}$ and $55 \times 10^{-12} \text{ m}^2 \text{ s}^{-1}$ respectively. The diffusion coefficient in 3 M NaCl is approximately 18 times the value in 0.1 M NaCl reflecting that the amount of salt and solvent taken up by the polymer is linked to the electrolyte composition by osmotic balances. These findings have implications for the design of polypyrrole based electrodes and actuators that are required to operate at higher frequencies.

Experiments were carried out for the purpose of elucidating the precise nature of the mobile species during redox cycling, and to seek confirmation for the osmotic mechanism of actuation. Three testable aspects of the model were confirmed:

- The number of inserted H_2O molecules decreases with electrolyte concentration.
- At the same time the mechanism gradually changes from almost pure cation transport to nearly equal amount of anion transport.
- Exchanging Br^- for Cl^- ions has only negligible effect at lower concentrations at equal osmotic pressures.

Nearly 4 H_2O molecules are tightly bound to each Na^+ ion at concentrations below 1 M.

The electronic conductivity of the PPy / DBS film has been characterized. The conductivity was measured by van der Pauw measurements on PPy / DBS in the oxidized, dry state as function of temperature. Synthesis at lower temperatures generally leads to higher conductivity.

The force and strain change during redox process of a PPy / DBS actuator was measured by using a potentiostat at combined with force measurement set up. The results show that the time constants for the change of length and for the stiffness change are significantly different. The change in stiffness is a faster process than the change in strain. In addition to this the Young's modulus of the PPy / DBS actuator during the redox process was measured using the force measurement set up. The results indicated that the Young's modulus is not a constant and it depends on the oxidation state of the actuator.

To improve the lifetime of the polypyrrole actuators, PPy films were cycled in an ionic liquid composed of 1-butyl-3-methyl imidazolium cations together with anion hexafluorophosphate. The results revealed that the films cycled in ionic liquids have enhanced lifetimes without failure (up to 4700 cycles). Experiments were performed under ambient conditions in four consecutive days, yet the polymer film showed negligible loss in electroactivity.

6.17

Fabrication and Characterization of Some Polymer and Pigment-Based Devices for Solar Cell and Electrochromic Applications.

Samaraweera, M.A.R.L.

107p.

M. Phil. Degree, 2009.

Location No. 862

Abstract

The anthocyanin pigment has a conjugated system and shows some properties characteristic to conjugated polymers and molecules. It has already been used as a photon harvesting material in dye-sensitized solar cells. In this study, the anthocyanin pigment was extracted from several plant materials using appropriate solvents such as methanol and acetone. The pigment was extracted mainly from seeds and roots of the plants and was used in the fabrication of dye-sensitized solar cell (DSC) device structures. Relatively better performances were shown by the pigments extracted from Maha-Bowitiya (*Melastoma malabathricum*) (BVT) and Hingurala (*Dioscorea purpurea*) (POT). In order to study the potential of using these pigments in DSC's, they were characterized using UV- Visible absorption spectra, cyclic voltammetry, FTIR and Mott-Schottky plots. The TiO₂- based DSC devices were fabricated using liquid and quasi-solid electrolytes that contained I⁺/I₃⁻ redox couple. Solid state devices were fabricated using CuI as the hole conducting material. The current-voltage characteristics of the fabricated devices were studied under dark and illuminated (1000 Wm⁻²) conditions. The maximum photo-current of 3.5 mA cm⁻² and the V_{OC} of about 500 mV was observed for the quasi-solid state DSC devices (of the type, FTO/TiO₂/pigment/gel-electrolyte/Pt) fabricated using the BVT pigment. The efficiency of the DSC device was about 0.9 %.

The Natural pigment extracted from BVT seeds shows electrochromic (EC) properties by anchoring onto TiO₂ films on optically transparent conducting glass (FTO) plates. The device of the type, FTO/TiO₂/pigment/gel-electrolyte/FTO showed blue and white switching states upon application of a voltage of reversible polarity in the range of 2.5- 4.5 V. The observed maximum transmittance variation (ΔT %) between two switching states was about 27 % and the best switching time was about 6 s which are both comparable with those of similar devices made with more elaborate device structures using artificial conjugated polymers.

Bulk-heterojunction (BH) organic polymer solar cell device structures of the type ITO/blend/LiF/Al were fabricated using fullerenes and MEH-PPV as the blend materials. The V_{OC}, J_{SC} and efficiency of about 590 mV, 2.21 mA cm⁻² and 0.92 % were observed respectively for the fullerene/MEH-PPV blended devices. The potentials of using natural pigments along with fullerenes in the fabrication of BH solar cell devices were studied. The pigment extracted from *Bixaorellana L* (MTH) seeds which contains carotenes, shows some ability to be used as an electron donor in the fabrication of BH devices along with electron acceptor fullerenes. The SC devices fabricated using the pigment extracted from MTH seeds shows I_{SC}, V_{OC} and efficiency values of about 0.43 mA cm⁻², 450 mV and 0.07 % respectively.

6.18

Fabrication of Low Cost Clay Bricks for Building Industry.

Fernando, H.D.N.S.

89p.

M.Phil. Degree, 2007.

Location No. 682

Abstract

Clay bricks are one of widely used building materials all over the world. The majority of clay brick makers used conventional methods for brick making. Generally these conventional clay bricks are fired at temperatures 800°C-1 000 °C. The major cost of clay bricks is due to the firewood utilization in the firing process and hence the cost can be brought-down by reducing the firing temperature and also minimizing the utilization or labor. The broad aim of this project was to fabricate chemically harden clay bricks for building industry using suitable minerals commonly available in Sri Lanka. Manufacturing of clay bodies with strong bonding at low temperatures using inexpensive chemicals and minerals is a suitable approach in reducing

the high demand for firewood in the brick industry. This will in turn help to prevent deforestation. Commonly available red colour soil and pottery clay were used as the major raw materials whereas Eppawala mineral apatite (EMA), Eppawala rock phosphate fertilizer (ERP) and Red Earth Mineral (REM) were used as additives. In order to obtain appropriate plasticity, phosphoric acid solutions of 0.1 M, 0.5M, 1 M and 3M were used. EMA, REM were individually mixed with the soil and small scale brick samples were prepared by adding phosphoric acid to obtain plasticity where as water was used in the preparation of ERP added samples.

Since red colour soil is commonly available and has relatively high amount of Fe^{3+} ions compared to pottery clay, red soil was preferred in the production of samples with different additive ratios while pottery clay was not subjected to that extend. All these samples were fired at three different temperatures such as 200 °C, 300 °C and 400 °C for one hour. The important physical properties, namely green and final density, drying and firing shrinkage, water absorption, compressive strength, bend strength, fracture toughness, material removal rate and impact energy of these brick samples were investigated. These properties were compared with those of unfired counterparts and conventional bricks made with the same soil and fired at 800°C.

It was observed that the properties of samples fabricated using phosphoric acid and fired at lower temperatures were superior to those of conventional bricks. On the other hand, the ERP added bricks fired at 300°C did not show any promising improvement. In the XRD patterns for the fired samples prepared with phosphoric acid, formation of new crystalline phases has been observed and they are compliance with the XRD peaks for the aluminum phosphate, iron phosphate and also with the magnesium phosphate. It was observed that the addition of phosphoric acid form bond with the Al^{3+} , Fe^{3+} , Mg^{2+} present in soil. In the scanning electron microscopy (SEM) of samples having better mechanical and physical properties, some needle shaped elongated grains were observed and subsequent Energy Dispersive Analysis of X-ray revealed that they are composed with Fe, Al, Mg, rich phosphate compounds. However in the SEM micrographs for ERP added samples and also in the conventional type samples this needle shaped elongated grains were not evident. This needle type elongated grains present in the samples may act as a reinforcement resulting high strength bricks.

6.19

Fracture Toughness and Craze Behaviour of Virgin and Filler Added Polystyrene Films.

Kuhanesan, Sinnathamby

75p.

M.Phil. Degree, 2005.

Location No. 509

Abstract

Brittle fracture commonly observed in many glassy polymers under tension is due to the formation and breakdown of crazes. Fillers exist in a variety of systems such as organic, biological and polymeric materials. In polymer systems, nanoscale fillers not only reduce the cost of the material but also improve mechanical properties, such as hardness and tear resistance. The broad aim of this study was to investigate the fracture behavior of virgin and filler added polystyrene thin films by the trouser leg tearing test. Critical strain energy release rate (G_c) can be regarded as a material property, often equated with toughness.

The thin films, required for the tearing test, were prepared by two different methods. In the first method, a glass slide was dipped and drawn with different speeds using a motor driven lifter through a polystyrene solution. The other method was spin casting, in which the

prepared solution was placed on a clean glass slide and spun with different speeds using a photo resist spinner. Toluene was used as a solvent. The virgin polymer films were prepared with a moderate solution of 14 wt-% of polystyrene in toluene. A solution of 14 wt-% of polystyrene and filler in toluene was used for filler added films preparation. The composition of the filler - added films was varied from 0 to 5 wt-% of fillers with respect to polystyrene content. In this study, carbon black (0.05 μm), alumina (0.075 μm) and fumed silica (255 m^2/g) fillers were used.

The slides were dried in a vacuum desiccator oven at 80°C for 12 hours for complete evaporation of toluene from the films. The samples used in this study were of rectangular shape (40 mm x 15 mm). They were stripped off from the substrate onto the surface of a water bath. The thickness of the films was measured using a Michelson interferometer and a locally made thickness measuring instrument. A cut of 10 mm was made along the center line of the sample and two free ends were separated at constant rates using a mechanical testing machine. Tearing was done in two different directions, one parallel and the other perpendicular to the film drawn direction.

The study revealed that the G_c values of virgin polystyrene were strongly dependent on the film drawing speed. When the films were torn parallel to the film drawn direction, there was a significant increase in G_c , with increasing film drawn speed from 0.5 cm min^{-1} to 2.5 cm min^{-1} and there after almost a plateau, was observed. On the other hand, value of G_c for all the samples torn perpendicular to the film drawn direction, there was a clear decrease in G_c with increasing film drawn speeds. The value of G_c for the films which were prepared by spin casting, torn in both perpendicular directions is 0.24 kJ m^{-2} . This is almost constant for all the films which were prepared with different spin speeds and this value is comparable with the G_c value corresponding to the above mentioned plateau. The reason for such a variation in the above films could be the high degree of orientation of the polymer chains in the film drawing direction due to the very slow drawing speed. When the drawing speed was increased the degree of polymer chain orientation decreases and becomes randomly oriented.

The study also revealed that a significant decrease in G_c with the increasing filler wt-%, in the films which contained alumina and carbon black fillers, prepared by both methods. On the other hand, the films which contained fumed silica and torn in the film drawn direction showed a decrease in G_c value with increasing filler wt-%. In contrast, an increase in G_c was observed, when the fumed silica added films were torn perpendicular to the film drawn direction. The spin cast films also showed an increase in G_c with fumed silica filler wt-%. The most likely reason why such a decrease in G_c was observed in alumina and carbon black filler added films is the propagation of the fracture mostly along the filler particles. It can be speculated that there may not be any extra - ordinary interaction between the polymer and fillers. Unlike other fillers, fumed silica has a chain - like particle morphology. The decrease in G_c value in the fumed silica added films which were torn parallel to the film drawn direction may be due to the fumed silica chains and polystyrene chains aligning parallel to the film preparation direction. Tearing parallel to the direction of preferential alignment requires the rupture of fewer bonds as orientation increases and hence, less stress is needed to tear the film in this direction. The polymer chains and fumed silica chains, in the spin cast films, were randomly oriented. These fumed silica chains give additional strength to the polystyrene.

Optical microscopic study shows the formation of craze areas ahead of the crack tip in a torn virgin polymer film. In addition to this, micro shear bands were also observed ahead of the craze region and on the sides of the fracture surfaces. The craze area ahead of the crack tip in torn polymer films showed birefringence indicating that there exists a certain degree of orientation of polymer chains in these areas. It was also observed that less amount of crazes in the alumina filler added films. Though the fumed silica added films which were torn

perpendicular to the film drawn direction showed higher G_c values, the amount of craze in the films was less compared to the virgin film. On the other hand, the films which contained carbon black fillers showed very low G_c value and no crazes were observed. Unlike cracks, crazes are load bearing since their surfaces are bridged by many fine fibrils. Crazes are the major toughening mechanism in the polystyrene amorphous polymer.

6.20

Identification of Standard Local Sand for Cement Testing.

Abeygooneratne, Kithsirimevan

84p.

M.Phil.Degree, 2007.

Location No. 634

Abstract

Standard sand is an important ingredient for cement testing. In all cement standards specified standard graded sand for strength testing. With the development of the technology various types of cement are being manufactured and mainly categorized based on the 28 day mortar strength. To define the standard sand for mortar strength testing, various standards are used worldwide. Such standards are American Society for Testing and Materials C 778, (ASTM C778), British Standards 4550, (BS 4550), European Norms 196-1 (EN 196-1), Bureau of Indian standards 650 (IS 650), International Standards Organizations 679 (ISO 679) etc. But most of the standards in addition to the requirements, sources are clearly defined such as Leighton-Buzzard for BS, Ottawa for ASTM, Ennore for Indian standard etc. However in the case of BSEN or ISO norms instead of the source of sand, development criteria is well defined as these standards are common for most of the countries. The aim of this project is identifying the local standard graded sand based on BSEN or ISO methods. This project consists of two parts, one is to ascertain the chemical requirements mainly the silica (SiO_2) content and the other is to verify the particle size distribution and the consistency of the test results when compared with the standard graded sand. To verify the consistency statistical criteria is defined in BSEN 196-1 or in ISO 679 standards.

For this sand project all fractions were collected from natural sand dunes, beaches and river sands available in North-western province. It was noted that fine fraction of the sand from Deduru-Oya were contaminated with black coloured particles which may be ilmanite and which affects the total silica content of the sand. It was also found that this sand was not complying with the compressive strength statistical criteria described in developing this standard graded sand.

However, the coarse fractions were suitable and used for the project. For the fine fractions, sands from dunes at Daluwa along Puttalam-Kalpitiya road and beach sand from Talawila also along Puttalam-Kalpitiya road were tried. The major problem encountered was the contamination of sand with black coloured particles which affects silica content of the sand. To overcome this, several purifying methods like washing and gravity separation (panning) were used and the results obtained were satisfactory. Finally Nathandiya sand dune was selected and performed a series of tests and found suitable. It was also found that mixing coarse fractions from Deduru Oya sand and fine fractions from Nathandiya were better than using the pure Nathandiya sand.

Furthermore, it was observed that mixing coarse fraction of sand from Deduru Oya and fine fraction of sand from Nathandiya provided better standard sand for cement testing. This combination of sand was found to be even better than the pure Nathandiya sand.

6.21

Sensitization of Titania with Natural and Moderated Flavylum Pigments and MEH-PPV Polymer for Photovoltaic Devices.

Premalal, E.V. Anura

73p.

M.Phil. Degree, 2007.

Location No. 683

Abstract

In this investigation titania was sensitized with natural and moderated flavylum dyes and MEH-PPY polymer in the fabrication process of efficient photovoltaic devices. Flavylum dye which is one of the pigments in the juice extracted from pomegranate fruit (rich with cyanin and exists as flavylum at natural PH) was utilized as a sensitizer dye. Further, flavylum dye was moderated coupling with mercurochrom dye and was used to sensitize titania. In addition, MEH-PPY polymer was used as a sensitizer as well as a hole collector of titania based photovoltaic devices.

The juice extracted from pomegranate fruit, which contains cyanin (flavylum) was utilized as the light-harvesting analog in TiO_2 |dye|CuI type dye sensitized solid-state photovoltaic cells. A higher incident photon to current conversion efficiency (IPCE) is observed in this TiO_2 /pomegranate pigment/CuI solar cell than the previously reported cells that were sensitized with natural pigments such as cyanidin, tannin and santalin. We have observed a maximum photocurrent of $5 \pm 0.5 \text{ mA cm}^{-2}$ and a photovoltage of $300 \pm 40 \text{ mV}$ with a higher reproducibility (over 80%) for TiO_2 /pomegranate pigment/CuI cells. Only a very few synthetic dyes (or dye cocktails) are found to produce higher photocurrents than that of pomegranate pigments.

The electronic coupling of a natural pigment extracted from pomegranate fruits with the organic dye mercurochrome enhanced the performance of solid-state TiO_2 |dye|CuI-type photovoltaic cells. The photocurrent and photovoltages of this cell are higher than those of the cells fabricated with pomegranate pigments or mercurochrome dye alone. Incident photon to current conversion efficiencies (IPCE) of 60% and 28% were observed for solid-state TiO_2 |dye|CuI type cells fabricated with mercurochrome and natural pomegranate pigment alone. Maximum IPCE of 58% was observed at 510 nm for the TiO_2 |mercurochrome|pomegranate pigment|CuI cell. In addition, IPCE was enhanced at longer wavelengths compared to that of the TiO_2 |pomegranate pigment|CuI cell.

A conjugated polymer poly[2-methoxy-5(2-ethyl-hexyloxy)-p-phenylenevinylene] (MEH-PPV) was utilized as the light-harvesting agent of a photovoltaic cell. Sensitized anodic and cathodic photocurrents were measured for CuSCN|MEH-PPV| TiO_2 cells and heterojunctions of MEH-PPV respectively. The maximum IPCE of 30% was observed for electrolyte|MEH-PPV| TiO_2 cells in the region of the maximum absorbance of MEH-PPV. The polymer MEH-PPV absorbs visible light of wavelength shorter than 550 nm and emits green luminescence.

A solid-state cell with the configuration of semiconductor |dye|polymer (SDP) was also prepared using poly[2-methoxy-5(2-ethyl-hexyloxy)-p-phenylenevinylene] (MEH-PPV) as a hole conducting material and mercurochrome dye as the sensitizer. TiO_2 |mercurochrome|MEH-PPV|I₂|Graphite cell produced an open circuit voltage of 700 mV and short circuit photocurrent of 2.35 mA cm^{-2} with an efficiency of 0.8 % at a light intensity of 1000 W/m^2 under AM 1.5 conditions.

6.22

Study of Electrical Conductivity and Dielectric Relaxation of PEO Based Composite Polymer Electrolytes and PAN Based Polymer Electrolytes.

Jayathilaka, P.A.R.D.

138p.

M.Phil. Degree, 2003.

Location No. 310

Abstract

Solid polymer electrolytes are formed by complexing an ionic salt with a solid polymer. These solid polymer electrolyte membranes have received much attention in the recent past due to the possibility of using them in novel-nano technological commercial applications. These systems show somewhat high ionic conductivity, which make them potentially important as electrolytes in high energy density rechargeable batteries. This thesis focuses on several important factors such as ionic conductivity, dielectric relaxation and thermal properties, which control the ion transport mechanism and conductivity enhancement mechanism in Poly(ethylene oxide), PEO, based composite electrolytes and poly(acrylonitrile), PAN, based gel electrolytes.

In the case of PEO systems, Lithium bis(trifluoromethanesulfone)imide, (LiTFSI), Lithium trifluoromethanesulfonate, (LiTf), and Copper(II)trifluoromethanesulfonate, (CuTf₂), have been used as the complexing salt to prepare the polymer electrolytes. PEO - LiTFSI, PEO - LiTf, PEO - CuTf₂, have been chosen for this work. For composite electrolytes, four different sizes (<10 μm, 37 nm, 10 - 20 nm, 5.8 nm) and four different types (acidic, basic, neutral, weak acidic) of alumina were used as ceramic fillers. In all three composite polymer electrolytes, the ionic conductivity has enhanced considerably due to the incorporation of alumina filler grains. In the case of PEO - LiTFSI - Al₂O₃ composite electrolyte, incorporating four different types of alumina grains, the results show that the filler particles do not interact directly with PEO chains and the degree of conductivity enhancement depends on the nature of the filler surface group and decreases as acidic > basic > neutral > weak acidic. Transient bonding with H⁺ and O²⁻ groups on alumina grain surface via Lewis acid-base type interactions appears to facilitate ionic motion by providing additional sites for ionic migration.

For the system, PEO - LiTf, out of the four different sizes of alumina fillers used, nano-porous alumina filler particles with pore size 5.8 nm have shown the highest conductivity increment. Furthermore, the conductivity versus filler concentration curves exhibit two conductivity maxima for filler grains with <10 μm, 37 nm, and 10 - 20 nm grain sizes. The conductivity increase appears to be consistent with the idea that Lewis acid-base type interactions of ionic species with surface groups on alumina grains are responsible for the enhanced conductivity.

For the system, PAN / LiTFSI / EC / PC with 15.39 wt.% PAN / 2.56 wt.% LiTFSI / 82.05 wt.% EC+PC has shown the highest conductivity. The PAN polymer matrix appears to play a positive role in the ionic transport mechanism of the gel electrolyte rather than acting merely as an inert host.

6.23

Study of Thermal and Electrical Properties of Some Polymer Electrolytes Based on PEO and PAN and some Intermediate Temperature Solid Oxide Fuel Cell (ITSOFC) Materials Based on Gadolinia Doped CERIA.

Bokalawela, R.S.P.

144p.

M.Phil. Degree, 2004.

Location No. 385

Abstract

Solid polymer electrolytes based on poly(ethylene oxide), PEO, and poly(acrylonitrile), PAN, have received much attention in the recent past due to the possibility of using them in novel technological commercial applications, such as primary and secondary batteries, electrochemical sensors, electrochemical displays, solar cells, fuel cells and chemical and biological stimulators. This thesis focuses on several important properties such as ionic conductivity, dielectric relaxation, transport numbers, melting temperatures, glass transition temperatures, cell parameters and dynamic structural properties of some PEO based polymer electrolytes, PEO based composite polymer electrolytes, PAN based gel polymer electrolytes and important electrical properties of some intermediate temperature solid oxide fuel cell electrolytes based on Gadolinia doped Ceria ($\text{Ce}_{0.9}\text{Gd}_{0.1}\text{O}_{1.95}$). It is important to investigate these properties in order to optimize the performance of electrochemical devices, which require a mutual compatibility of the electrochemical reactions and equilibrium during the charge transport process. In one of the projects, $\text{Mg}(\text{ClO}_4)_2$ has been used as the complexing salt in PEO and Al_2O_3 ceramic particles and Montmorillonite (MMT) clay particles have been used as the fillers to prepare composite polymer electrolytes $\text{PEO}_9\text{Mg}(\text{ClO}_4)_2 + \text{filler}$. For PAN based gel electrolytes, $\text{Mg}(\text{ClO}_4)_2$ and $\text{Pr}_4\text{NH}_4^+\Gamma^-$ salts were complexed in host PAN by heating with ethylene-carbonate (EC) and propylene-carbonate (PC) plasticizers respectively. In the case of synthesis and characterization of intermediate temperature solid oxide fuel cell electrolytes based on $\text{Ce}_{0.9}\text{Gd}_{0.1}\text{O}_{1.95}$ (GCO), commercially available GCO and laboratory synthesized GCO by sol-gel method were used respectively. Major studies were carried out on ionic conductivity, dielectric relaxations and fuel cell parameters of the fuel cell $\text{Pt}/\text{H}_2(99.9999\% \text{ppm}) (\text{fuel}) / \text{GCO} / \text{Air}(\text{oxidant}) / \text{Pt}$.

For the systems $\text{PEO}_9\text{Mg}(\text{ClO}_4)_2 + x \text{ wt. } \% \text{ MMT}$, $x = 10 \text{ wt. } \% \text{ MMT}$ shows the maximum ionic conductivity of $4.36 \times 10^{-6} \text{ S cm}^{-1}$ at room temperature and melting and glass transition temperatures are 55.97°C and -33.39°C respectively. From the study of this system, we conclude that the presence of montmorillonite particles enhances the ionic conductivity substantially, and the degree of enhancement depends on the content of MMT in the system.

In the case of $\text{PEO}_x\text{Mg}(\text{ClO}_4)_2$ polymer electrolytes, where $x = 3, 5, 6, 7, 9, 11, 13$, the composition $\text{PEO}_6\text{Mg}(\text{ClO}_4)_2$ shows the highest ionic conductivity of $1.98 \times 10^{-5} \text{ S cm}^{-1}$ at room temperature (27°C). The melting and glass transition temperatures are 63.99°C and -11.75°C respectively. Incorporation of Al_2O_3 into $\text{PEO}_6\text{Mg}(\text{ClO}_4)_2$ shows the highest ionic conductivity of $5.14 \times 10^{-5} \text{ S cm}^{-1}$ at room temperature (27°C) for the composition with $10 \text{ wt. } \% \text{ Al}_2\text{O}_3$ (acidic), where acidic alumina shows slightly higher value compared to basic alumina. The eutectic melting temperature and the glass transition temperature for this system are 60.68°C and -35.43°C , respectively.

The ionic transport number of this composite electrolyte is $t_i = 0.99$ suggesting that the electrical conductance is predominantly ionic in nature. The increase in conductivity due to Al_2O_3 is likely to be due to Lewis acid-base type interactions of ionic species with surface O and H groups on alumina grains.

For the system, PAN : EC : PC : Pr₄Ni the optimum composition with 18wt % PAN : 36 wt. % EC : 36 wt.% PC : 10 wt. % Pr₄Ni has shown the highest ionic conductivity of $1.35 \times 10^{-3} \text{ S cm}^{-1}$ at room temperature (27 °C). The cell Mg/ PAN: EC: PC: Pr₄Ni/(C, I₂) shows an initial open circuit voltage of 1.6V, and was able to deliver 10μA current at 1V for more than 1000 hrs. The drop in open circuit voltage due to self discharge appears to be negligibly small during a test period of 22 days.

For the PAN : EC : PC : Mg(ClO₄)₂ system, characterization of electrical and thermal properties and Mg/PAN : EC : PC : Mg(ClO₄)₂/ M (M = different cathodes) primary cell performances were investigated. The DSC traces of the electrolyte show the typical amorphous nature of the PAN based gel electrolytes. The highest ionic conductivity, of this system is $1.18 \times 10^{-2} \text{ S cm}^{-1}$ at room temperature (27 °C) for the optimum composition of 18 wt. % PAN : 36 wt. % EC : 36 wt. % PC : 10 wt. % Mg(ClO₄)₂. The activation energy of this system is $\sim 3.8 \text{ J mol}^{-1}$. Using the above optimum composition the primary cells, Mg / PAN : EC : PC : Mg(ClO₄)₂/M were fabricated, where M indicates different cathodes based on LiV₃O₈, V₆O₁₃, V₂O₅ and LiMn₂O₄.

Out of the materials studied for Intermediate Temperature Solid Oxide Fuel Cells the Gd_{0.1}Ce_{0.9}O_{1.95} electrolyte shows the ionic conductivity of the order of $10^{-2} \text{ S cm}^{-1}$ at intermediate temperature range from 500°C to 700 °C. The derivative of the real part of the permittivity shows the dielectric relaxations of GCO. The analysis of this dielectric relaxation gives rise to polarization at grain boundaries as well as bulk effects. Addition of a small amount (0 - 5) wt. % of metal oxides to GCO show an impedance to enhance the ionic conductivity, but the XRD spectra show that it does not change the fluorite crystal structure of the GCO.

6.24

Synthesis and Characterization of Li Transition-Metal Oxide Electrode Materials, and their Applications in Li-Ion Batteries.

Samarasingha, P.B.

128p.

M. Phil. Degree, 2009.

Location No. 863

Abstract

Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O₂ is an important member of the Li(Ni_yCo_{1-2y}Mn_y)O₂ system ($y = 1/3$), which, has recently been investigated as a promising candidate for positive electrode materials in lithium ion rechargeable batteries (LIB). Further expansion of this ternary system by replacing costly and electrochemically insignificant, Co with other potential but cheaper elements such as Al, Fe, Mg, Zn is of great research interest.

In this study, Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O₂ together with new material compositions of Li(Ni_{1/3}Co_{[(1/3)-x]Mn_{1/3}M_x)O₂ (M=Al, Fe, Mg, Zn and $x = 0.11, 0.22, 0.33$) and Li(Ni_{1/3}Co_{1/3}Mn_{[(1/3)-x]Mg_x)O₂ ($x = 0.11, 0.22, 0.33$) were synthesized in the form of fine powders by Pechini method and calcined at 900 °C.}}

The phase analysis by XRD revealed the formation of solid solutions of appropriate α -NaFeO₂ layered structure (R3m layered structure) in all the compositions but with the presence of a secondary phase in trace amounts in some compositions. The d.c electrical conductivity, measured by four probe method, increases with temperature in an exponential manner for all the materials, except for the Zn substituted system. Most of the materials prepared by Pechini method in this study show appropriate particle size for LI B positive electrode. Selected oxide powders were mixed with polyvinylidene fluoride (PVDF) binder (KynarFlex 2801) and Super P Carbon Black in proportions 1:0.25:0.10 by weight to prepare the positive electrode. CR2016

type stainless steel coin cells, assembled in an argon-filled glove box were used for electrochemical testing. All the electrochemical testing was done at room temperature. Used anode is a metallic lithium foil and the electrolyte was 1.2 M LiPF_6 (lithium hexafluorophosphate) in 3:7 (weight ratio) ethylene carbonate:ethyl methyl carbonate (EC:EMC). The cells were tested using galvanostatic charge / discharge mode using potential window of 3.0-4.5 V. For $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ a much better electrochemical performance is seen for the material calcined at 1000 °C, with a specific capacity close to 180 mA h g⁻¹. Conversely, the material calcined at 800 °C shows only a specific capacity of 140 mA h g⁻¹. In general some of the $\text{Li}(\text{Ni}_{1/3}\text{Mn}_{1/3}\text{Co}_{(1/3-x)}\text{M}_x)\text{O}_2$, M=Fe, Al and Mg materials show a considerably higher first cycle charge capacity than the state-of-art cathode material, LiCoO_2 of LIB.

The present study, shows the potential and the suitability of $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ and $\text{Li}(\text{Ni}_{1/3}\text{Mn}_{1/3}\text{Co}_{(1/3-x)}\text{M}_x)\text{O}_2$, M=Fe, Al and Mg materials prepared by Pechini method, for application as electrode (cathode) material in lithium ion batteries.

6.25

Synthesis and Characterization of Some Composite Polymer Electrolytes Based on Poly (Ethylene Oxide) (PEO).

Vignarooban, Kandasamy

89p.

M.Phil. Degree, 2007.

Location No. 635

Abstract

Due to the increasing demand for energy, development of materials for electrical power generation and storage systems are receiving much attention. An electrolyte is an essential component in batteries and in other electrochemical devices. Polymer based electrolytes have tremendous advantages compared to conventional liquid/solid electrolytes except their low ionic conductivity at ambient temperatures. Much research has been carried out to improve the ionic conductivity of polymer electrolytes in order to use them in practical applications. Poly (ethylene oxide) (PEO) is the commonly used host polymer in polymer electrolyte research.

In this work, several PEO based polymer electrolytes have been synthesized and characterized using Impedance Spectroscopy, Dielectric Spectroscopy, Differential Scanning Calorimetry (DSC) etc.

Several methods have been used to enhance the ionic conductivity of PEO₉ LiTf polymer electrolyte throughout this project such as incorporating various types of ceramic fillers to the PEO₉ LiTf, incorporating ceramic filler and a plasticizer to the PEO₉ LiTf, incorporating a second salt to the PEO₉ LiTf and incorporating two ceramic fillers together with PEO₉ LiTf polymer electrolyte.

Among the different types of ceramic filler incorporated PEO₉ LiTf electrolytes, the one incorporating the TiO₂ gave maximum enhancement and it would be due to the high Lewis acid character of TiO₂ compared to other fillers used.

Incorporating Ethylene Carbonate (EC) with PEO₉ LiTf : TiO₂ electrolyte resulted in further increase in conductivity due to the plasticizing effect of EC. DSC results also exhibit a reduction in T_g showing that the segmental flexibility of the polymer chains is increased and that could be the reason for conductivity enhancement. Mixed-filler incorporated samples did not show any enhancement in conductivity. It could be due to filler-filler interactions caused by the dielectric

constant gradient between the filler particles.

Incorporation of NiCl_2 as a second complexing salt with $\text{PEO}_9 \text{LiTf}$ and with $\text{PEO}_9 \text{CuSCN}$ showed an enhancement in conductivity, possibly due to the increased amorphous phase produced by the second salt. DSC results obtained also correlate this assumption.

6.26

Synthesis and Characterization of Some PEO-Based, Nano Composite Polymer Electrolytes.

Pitawala, H.M.J.C.

98p.

M.Phil. Degree, 2008.

Location No. 698

Abstract

An electrolyte is an essential component of an electrochemical power source. It is a medium with high ionic conductivity and negligible electronic conductivity. From the practical point of view, conventional liquid electrolytes have many drawbacks such as electrolyte leakage, electrolyte corrosion, weight and complex design, leading to a large volume expansion. Owing to their potential ability to replace the traditional liquid electrolytes in electrochemical cells, high molecular weight poly(ethylene oxide) (PEO)-based polymer electrolytes are emerging as the best candidates to be used as polymer electrolytes. Although these electrolytes have high solvation power, complexation ability and ion transport directly connected with alkaline salt (Li^+), their, the ionic conductivity at ambient temperatures (10^{-7} - $10^{-6} \text{ S cm}^{-1}$) is not high enough for most practical applications. In order to overcome this problem, many strategies have been attempted, such as the inclusion of cross-linking agents to form networks, incorporating low molecular weight additives and inorganic fillers. Among these, the incorporation of nano-sized ceramic oxide fillers, to the conventional PEO-salt matrix has been regarded as one of the most promising methods. However, systematic and detailed studies of such nano-composite electrolytes are still lacking.

In the present work, different types of PEO-based nano composite polymer electrolytes have been synthesized using common solvent casting method and characterized them mainly using Complex Impedance Spectroscopy (CIS) and Differential Scanning Calorimetry (DSC). The surface morphology of some selected samples has been studied using Scanning Electron Microscope (SEM).

For the system, PEO: LiTf, the addition of nano-sized alumina fillers have increased the ionic conductivity of the polymer salt complex giving the maximum conductivity enhancement for the samples with 15 wt. % Al_2O_3 . The conductivity at 25°C increased from $3.5 \times 10^{-7} \text{ S cm}^{-1}$ to $2.1 \times 10^{-5} \text{ S cm}^{-1}$ due to the addition of 15 wt. % Al_2O_3 . Incorporating ethylene carbonate (EC) with $(\text{PEO})_9 \text{LiTf} + 15 \text{ wt. \% } \text{Al}_2\text{O}_3$ polymer electrolyte resulted in further increase in conductivity, from $2.1 \times 10^{-5} \text{ S cm}^{-1}$ to $1.5 \times 10^{-4} \text{ S cm}^{-1}$ at room temperature.

In $(\text{PEO})_9 \text{LiTf} : \text{Al}_2\text{O}_3 : (\text{EC}/\text{PC})$ system, the combined effect of the plasticizer and the filler on ionic conductivity and thermal properties of the polymer electrolyte, $(\text{PEO})_9 \text{LiTf}$, have been studied in detailed and the maximum conductivity enhancement was observed for the polymer electrolyte, $(\text{PEO})_9 \text{LiTf} + 15 \text{ wt. \% } \text{Al}_2\text{O}_3 + 50 \text{ wt. \% } [75\% \text{ EC} + 25\% \text{ PC}]$, with a room temperature conductivity value of $\sigma_{\text{RT}} (\text{max}) = 1.2 \times 10^{-4} \text{ S cm}^{-1}$.

In the system, $(\text{PEO})_n \text{LiBF}_4$ ($n = 3, 6, 8, 10, 12, 15, 20$), the composition, $n = 12$, showed the highest conductivity of $8.7 \times 10^{-6} \text{ S cm}^{-1}$ at the room temperature (25°C) among different Li / EO ratios. The addition of nano-porous alumina filler to this electrolyte (with $n = 12$) increased the

ionic conductivity of the polymer salt complex giving the maximum conductivity enhancement for the sample with 15 wt. % Al_2O_3 [$\sigma_{\text{RT}} (\text{max}) = 6.1 \times 10^{-5} \text{ S cm}^{-1}$].

The ionic conductivity enhancement due to the incorporation of filler is evidently associated with the surface interactions of the filler with ionic species. One possible mechanism is the creation of favorable conducting pathways through Lewis acid-base type interactions of ionic species with O/OH surface groups on filler grains. The effect of filler on T_g suggest that the filler particles interact with main chain dynamics of the host polymer presumably through Lewis acid-base type interactions between the ether oxygen and filler surface groups leading to a lowering of the T_g . The filler also impedes crystallization and increases the amorphous phase content of the polymer electrolyte. Therefore, it is evident that a major contribution to the conductivity enhancement comes from the structural modifications associated with the polymer host caused by the filler.

M.Sc. Research Project Reports

MEDICAL PHYSICS

6.27

Analysis of Dosimetric Characteristics of Virtual Wedge.

Bandara, D.M.C.H.

106p.

M. Sc. Degree, 2009.

Location No. 857

6.28

Analysis of Patient Integral Radiation Dose Using Ionization Chamber and Thermoluminescence Dosimeter for External Beam Radiation Therapy.

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6.29

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6.30

Characteristics of Clinical Electron Beams in Radiation Therapy.

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Construction of Some Quality Control Test Tools to Evaluate medical diagnostic X-Ray Machines.

Singh, Shilpa

105p.

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6.33

Dosimetric and Clinical Characteristics of Multi-Leaf Collimator in Radiation Therapy.

Rajaratnam, Dhanushia

94p.

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Location No. 1169

6.34

Dosimetric Characteristics and Optimization for a Multislice Computed Tomography.

Balamurali, S.

96p.

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Location No. 931

6.35

Effect of Alumina Filler on Spherulite Growth and on Ionic Conductivity of $\text{PEO}_9(\text{LiClO}_4)$ and Al_2O_3 Composite Polymer Electrolyte.

Nugera, F.A.E.

51p.

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6.36

Effect of Gypsum on the Compressive Strength of Cement.

Sanjeewa, K.B.K.

56p.

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Location No. 1167

6.37

Effective Half Life of ^{131}I in Thyroid Cancer Patients.

Loganathan, N.

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Estimation of Absorbed Dose to Thyroid Carcinoma Patients who are Treated with Radioactive Nuclide Iodine - ^{131}I .

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6.39

Gonadal Dose of Radiation in Patients Undergoing Chest Radiography.

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6.40

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6.41

Mechanical Properties of Mullite/ Zirconia Composite with Ferric Oxide and Yttrium Oxide Additives.

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6.42

Patient Dose Management in Computed Tomography and Interventional Fluoroscopy with Special Emphasis on Pediatric Patients.

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6.43

The Performance Characteristics of Gamma Camera.

Jeyasugiththan, Jeyasingam

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6.44

Performance Characteristics of Well Counter in Radioassay.

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6.45

Performance Testing for Scintillation Camera.

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6.46

Proposed Regimes for High Dose Rate (HDR) Treatments for Cancer of the Cervix Based on Linear Quadratic Model.

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6.47

Quality Assurance Measurements on Radiological Imaging Equipments.

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6.49

Quality Control of Gamma Camera.

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6.50

Quality Control Parameters of Fluoroscopic X-Ray Units Used in Sri Lanka.

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Location No. 542

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Radiation Dose Verification and Radiobiological Review of Carcinoma Cervix in Amersham Brachytherapy Manual Afterloading System.

Herath, Herath Mudiyansele Sisira Bandara

50 p.

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6.52

Study of Fragmentation of Upper Ureteric Calculi by Extracorporeal Shock Wave Lithotripsy (ESWL).

Jayasekera, Upul Gamini

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6.53

Tissue Compensators in Radiotherapy Treatment.

Pathmathas, T.

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6.54

Variation of Molybdenum Concentration in Daily Elution of Tc^{99m} at Nuclear Medicine Unit University of Peradeniya.

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33p.

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Location No. 610

PHYSICS

6.55

Effect of Carbon Filler on Conductivity of (PEO)₉ LiCF₃SO₃ Polymer Electrolyte.

Keerthisinghe, K.M.

51p.

M. Sc. Degree, 2008.

Location No. 1165

PHYSICS OF MATERIALS

6.56

¹H NMR Study of the Role of Alumina Fillers in Conductivity Enhancement in the PEO Based Solid Polymer Electrolytes.

Wijesiri, W.D.D.

61p.

M.Sc. Degree, 2004.

Location No. 435

6.57

Application of Dynamic Light Scattering to Probe Molecular Dynamics in Polymer Gels.

Galappaththige, S.K.

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6.58

Artificial Muscles Using Polypyrrole Conducting Polymer.

Perera, N. Yamuna Srimathi

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6.59

Cathodic Electrodeposition of ZnO Thin Films for Solar Energy Conversion.

Kumaraarachchi, K.H.D.

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Location No. 593

6.60

Construction and Testing of an Apparatus for Thermal Conductivity Measurement.

Ahilan, Sitpalan

43p.

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6.61

Construction of a Vibrating Sample Magnetometer to Measure Magnetization of Some Ferromagnetic Materials.

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Location No. 784

6.62

Construction of Super Capacitors Based on Activated Carbon.

Herath, H.M.S.N.

43p.

M.Sc. Degree, 2010.

Location No. 1061

6.63

Design and Construction of a Testing Machine to Study the Impact Behaviour of Materials.

Samarakoon, S.M.D.K.

39p.

M.Sc. Degree, 2007.

Location No. 644

6.64

Development and Characterization of Macroporous Ceramic Structures.

Gnanapragasam, G.

62p.

M. Sc. Degree, 2010.

Location No. 927

6.65

Development of a Computer Model Representing Bulk Diffusion in Semiconductors.

Wijesinghe, D.D.

51p.

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Location No. 18

6.66

Development of Clays or Minerals as Backfill Materials in Lightning Conductors.

Jayasinghe, H.B.A.U.

40p.

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Location No. 500

6.67
Drying Behavior of Few Commercially Available Paint Samples Using Dynamic Light Scattering.

Krishantha, L.H.C.

66p.

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Location No. 928

6.68
Dye Sensitized Photo Electro Chemical (PEC) Solar Cells Using PEO Based Solid Polymer Electrolyte.

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41p.

M.Sc. Degree, 2006.

Location No. 598

6.69
Effect of High Energy Radiation on Poly (Ethylene Oxide) Complexed with Copper Thiocyanate.

Peiris, A.R.K.

54p.

M.Sc. Degree, 2005.

Location No. 499

6.70
Electrical Conductivity of Synthesized Zircon Ceramics Doped with Different Dopants.

Fervin, S.Z.R.

41p.

M.Sc. Degree, 2006.

Location No. 580

6.71
Electrochemical Behaviour of Polypyrrole/Dodecyl Benzene Sulphonate Films in Highly Concentrated Electrolytes.

Jeyasuthan, A.

54p.

M.Sc. Degree, 2006.

Location No. 599

6.72
Experimental Correlation among Some Mechanical Properties of uPVC Pipes.

Fernando, K.J.P.

50p.

M.Sc. Degree, 2007.

Location No. 642

6.73

Fabrication and Characterisation of $\text{Bi}_{1.6}\text{Pb}_{0.4}\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ Superconductors Prepared by Solid State Reaction Technique.

Fernando, Pius Rodney

77p.

M.Sc. Degree 2006.

Location No. 595

6.74

Fabrication of Grinding Wheels Using Locally Available Minerals.

Karunathilake, R.M.L.C.

47p.

M.Sc. Degree, 2006.

Location No. 576

6.75

Growth of CuO Thin Films for Possible PV Applications.

Kumarage, W.G.C.

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M.Sc. Degree, 2013

Location No. 1270

6.76

Hydrothermal Synthesis of Hydroxyapatite Nanopowders.

Tennakone, Harshani

39p.

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Location No. 579

6.77

An Investigation of Electrical Properties of Barium Titanate Based Ceramics.

Ravirajan, Punniamoorthy

42p.

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Location No. 24

6.78

Ion Transport Mechanisms in Mixed Alkali Glass.

Gamage, M.A.S.K.

48p.

M.Sc. Degree, 2006.

Location No. 575

6.79

Mechanical Properties of Ancient Clay Bricks and Plasters of Jethawana Sthupa.

Gunasinghe, M.P.R.N.

44p.

M.Sc. Degree, 2007.

Location No. 643

6.80

Neutron Activation Analysis of a Meteorite Sample.

Ranganathan, Kalpana

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Location No. 577

6.81

Preparation and Characterisation of Bismuth Based High T_c - Superconductors.

Ganesan, Kumaravelu

50p.

M.Sc. Degree, 1998.

Location No. 20

6.82

Preparation and Characterisation of Polyaniline/Titanium Dioxide Heterojunctions for Possible Use in Solar Cells.

Kodikara, R.R.M.

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M.Sc. Degree 2006.

Location No. 597

6.83

Proton Conduction in Condensed Phase.

Sivarupan, Tharmalingam

31p.

M.Sc. Degree, 2006.

Location No. 578

6.84

Schottky Junctions with Some Conducting Polymers.

Nawarathna, N.M.V.K.

54p.

M.Sc. Degree, 2004.

Location No. 434

6.85

Solar Cells Based on Dye Sensitized Nanoporous TiO_2 semiconducting Films.

Bookolandeniya, H.C.S.

26p.

M.Sc. Degree, 1999.

Location No. 110

6.86

Studies on Electrodeposited ZnSe Thin Films.

Zainudeen, Umer Lebbe

31p.

M.Sc. Degree, 1999.

Location No. 12

6.87

A Study of Electrical Conductivity of Natural Rubber Containing Some Selected Additives.

Guluwita, Sudath Peiris

34p.

M.Sc. Degree, 2000.

Location No. 109

6.88

A Study on Cuprous Oxide/ Cuprous Sulphide Thin Film Solar Cells.

Wanninayake, W.T.M.A.P.K.

55p.

M.Sc. Degree, 2008.

Location No. 785

6.89

Study on Physical and Mechanical Properties of *Bambusa vulgaris* and *Dendrocalamus giganteus* for Possible Value Addition in Industrial Flooring.

Peratheepan, Pararajasingam

99p.

M.Sc. Degree, 2006.

Location No. 594

6.90

A Study on Polypyrrole/ Dodecyl Benzene Sulphonate (PPy/DBS) Based Actuators.

Divaratne, Dilupama I.

32p.

M.Sc. Degree, 2006.

Location No. 596

6.91

A Study on Setting Time of Cement.

Aliyar, M. S. Mohamed

33p.

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Location No. 276

6.92

Thin Film Growth at Finite Temperature.

Poopalasingam, Sankar

38p.

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Location No. 436

6.93

Thin Film Growth: Studies on 2+1 D Shadow Model.

Sivayogan, Thusheeta

54p.

M.Sc. Degree, 2001.

Location No. 186

6.94

Transport Properties of Polymer Electrolytes Based on Poly (Acrylonitrile) and Poly (Ethylene Oxide) Complexed with Copper Salts.

Udakara, S.

68p.

M.Sc. Degree, 2004.

Location No. 391

6.95

Transport Properties of Polymer Electrolytes Based on Poly (Ethylene Oxide) Complexed with Copper Salts.

Jayathilaka, P.A.M.T.

47p.

M.Sc. Degree, 2005.

Location No. 498

6.96

Transport Properties of Polymer Electrolytes Based on Poly (Ethylene Oxide) Complexed with Magnesium Salts.

Karalliyadde, L.H.

77p.

M.Sc. Degree, 2004.

Location No. 390

7 - PLANT SCIENCES

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Research Project Reports

Ph.D. Dissertations

7.1

Biodiversity of Ecological Communities and the Biogeography of Their Species in Three Isolated Hills in Sri Lanka.

Fernando, R.H.S.S.

475p.

Ph.D. Degree, 2011.

Location No. 1072

Abstract

As the biota of isolated hills in Sri Lanka have been poorly studied, I investigated three isolated hills (Monaragala, Doluwakanda, Kokagala) of the island's intermediate zone, with respect to their (i) ecological plant communities, (ii) species richness and diversity of the vascular plants and selected fauna, within and among the ecological communities hill-wise and among hills, and (iii) the biogeographical affinities of their component plant and bird species.

In this study the gradsect method was used for field sampling; univariate/multivariate methods were used for data analyses and published information to identify the biogeographic affinities of species.

In the three hills collectively, 727 plant- and 357 animal species were recorded. They represented 17% of Sri Lanka's angiosperm-, 11% of her fern- and 15% of her endemic flora. Hill-wise, species richness decreased in the order Monaragala, Kokagala and Doluwakanda, for plants (443, 372, 244, respectively) and also animals (272, 217, 210, respectively).

Among hills, plant species were similar in the lower elevation disturbed communities identified; that in the respective relatively undisturbed mid- and upper elevation forest communities were distinct and were dominated by Lauraceous species in Monaragala, by *Balanocarpus brevipetiolaris* or *Calophyllum moonii* and *Humboldtia laurifolia* in Doluwakanda and by *Memecylon* spp., and *Cleistanthus pallidus* on ridges or *Vatica obscura* along lower slopes in Kokagala. The grassland/savanna communities, in Monaragala and Kokagala, had a very rich ephemeral herbaceous flora, imparting a more complex taxonomic structure to this community, compared to the tree/liana and understory floras in other communities. The plant community composition of the three hills also differed from that recorded for lowland forest communities surrounding these hills.

Three different bird communities were identified in Monaragala (low/mid-elevation, ridge/upper-elevation, grassland) and in Kokagala (dense forest, rock outcrop, savanna/grassland). The lattermost communities in both hills were distinct from each other. Doluwakanda had only a lower scrub-forest bird community and a tall-forest bird community. Bird species distribution in Monaragala and Doluwakanda varied significantly with altitude.

Biogeographically, of species inventoried in the three hills 33% are wet zone elements (most in Monaragala and Doluwakanda) and of them 33% are endemic. Kokagala had more dry and intermediate species. These hills are refugial outposts for some of Sri Lanka's endemic and threatened biota.

In this study among the flora, two new *Nervilia* species from Kokagala, new to Sri Lanka and possibly to science, *Didymoplexis seidenfadenii*, previously known only from India, *Liparis barbata*, *Hyalisma janthina* and *Stachyphrynium zeylanicum* found after a century, and among the fauna, *Nannophrys* species new to science, a Black Eagle's nest in Doluwakanda, the first for Sri Lanka, and a resident population of endemic Wood Pigeon in Monaragala were noteworthy discoveries.

Considering the above findings, conservation of these three hill forests, outside Sri Lanka's current protected area network, is of critical importance to protect the island's biodiversity.

7.2

Biological and Chemical Elicitors of Banana Fruit Defence.

Wanigasekara, U.W.N.P.

255p.

Ph.D. Degree, 2009.

Location No. 866

Abstract

Phyllosticta musarum could infect the developing banana fruits producing minute, pin-head sized freckles. Such infections do not expand into progressive lesions during fruit ripening. Freckle infected fruits show resistance to the anthracnose pathogen, *Colletotrichum musae*. This was previously shown to be due to several defence responses induced in the banana peel tissues following *P. musarum* infection.

In the present study the defence responses in banana (cv. Embul) fruit peel induced due to *Phyllosticta musarum* infection were further characterized. Superoxide (O_2^-) production was observed when *P. musarum* infected sites of fruit peel were inoculated with conidia of *C. musae* as an early defence response. The duration of O_2^- release following *C. musae* inoculation was longer in *P. musarum* infected fruit peel compared to the healthy fruit peel. *P. musarum* infection in banana fruit peel was associated with significant levels of chitinase and β -1,3-glucanase activities. The level of enzyme activity increased with ripening and also upon challenge inoculation with *C. musae*. Constitutive levels of both enzymes were also observed in fruit peel. Two chitinase isozymes were identified with molecular weights 18 kDa and 12 kDa. Significantly enhanced levels of total phenolic acids, free phenolic acids, ester bound and glycoside bound phenolic acids and cell wall bound phenolic acids were observed in *P. musarum* infected peel compared to the healthy peel.

A cell wall derived elicitor was isolated from *P. musarum* and partially purified using bioassay guided gel filtration column chromatography. The elicitor activity of fractions was screened by placing drops on young banana pseudostem where elicitor active fractions induced distinct browning and antifungal compounds. The elicitor was characterized to be a high molecular weight glucan.

The effect of pre- and postharvest application of chemical elicitors, Bion[®], salicylic acid (SA) and di-potassium hydrogen orthophosphate (K_2HPO_4) on anthracnose development during ripening was examined. Postharvest spray of Bion[®] at 200 mg/L or SA at 1000 mg/L reduced severity of anthracnose disease by 68 - 38 % and 41 - 33 % respectively. The study revealed that pre-harvest treatment of developing fruit at a more mature stage (nine weeks after bunch emergence) could make better protection against anthracnose than treating fruit at younger stage. SA (500 mg/L) treatment provided 100 - 58 % control against anthracnose disease while Bion[®] (200 mg/L) gave 75 - 30 % protection. Treated fruits when inoculated with *C. musae* showed enhanced chitinase and β -1,3-glucanase activity. These enzymes are considered to play

an important role in plant disease resistance. Application of chemical elicitors had no adverse effect over fruit ripening, physicochemical parameters or sensory qualities of the banana fruit. However, a slight reduction in fruit size was observed in SA or Bion[®] treated fruits.

The study revealed that *P. musarum* infection induces significant chitinase, β -1,3- glucanase activity and phenolic compounds in banana fruit peel. In addition, prolonged superoxide generation in *P. musarum* infected peel following *C. musae* inoculation was established. The cell wall derived elicitor of *P. musarum* is characterized as a high molecular weight glucan. The application of chemical elicitors, SA and Bion[®], would offer great promise as an alternative method in controlling anthracnose in banana.

7.3

Comparison of Bacteriological Methods for Detecting Total Coliforms and *Escherichia coli* in Water.

Mannapperuma, C.K.

207p.

Ph.D. Degree, 2010.

Location No. 1074

Abstract

Bacteriological analysis of water, using indicator bacteria is a routine practice around the world to assure the microbiological quality of water. The current study investigated the performance of four alternative methods compared with the reference Sri Lanka Standard-Multiple Tube Fermentation (SLS-MTF) method, for the detection and enumeration of total coliforms and *Escherichia coli* in different water sources (tap water, bottled water, well water, surface water and effluent water-to cover a wide range of contamination levels), collected from different geographical areas. The four alternative methods were American Public Health Association (APHA)-MTF method, Colilert-MTF method, Sri Lanka Standard -Membrane Filtration (SLS-MF) method and m-ColiBlue24-MF method. Colilert and m-ColiBlue24, which are enzymatic methods, detect total coliforms and *E. coli* simultaneously, by the activity of enzymes β -D galactosidase (in total coli forms) and β -D glucuronidase (in *E. coli*), while the other methods are based on lactose fermentation.

Variance analysis results revealed that Colilert, m-ColiBlue24 and SLS-MF methods detected significantly higher ($p \leq 0.05$) total coliform counts, compared to the SLS-MTF method. In *E. coli* detection, Colilert ($p \leq 0.05$) and m-ColiBlue24 ($p \leq 0.1$) methods detected significantly higher counts compared to SLS-MTF method. Simple Linear Model showed, the three alternative methods detected several folds higher total coliforms counts than SLS-MTF method (3.8, 1.75 and 1.55 times higher counts were detected by Colilert, m- ColiBlue24 and SLS-MF methods respectively). For *E. coli*, 2.93, 1.83 and 1.35 times higher counts (than SLS-MTF) were detected by m-ColiBlue24, Colilert and SLS-MF methods respectively. ISO performance criteria (sensitivity, specificity, efficiency, false positive and false negative ratios), showed the two enzymatic and SLS-MF methods were superior to the conventional SLS-MTF method. Method performances by paired count evaluations showed inconclusive results due to inadequate valid data resulted by contaminations and missing data during subculturing. Confirmational rates obtained for both bacterial types were higher in three alternative methods, than SLS-MTF method. Values being: for colifonns, Colilert (78.2%), SLS-MF (75.2%), m-ColiBlue24 (72.1%) and SLS-MTF (71%) and for *E. coli*, Colilert (66.6%), m-ColiBlue24 (50%), SLS-MF (50%) and SLS-MTF (37.5%).

Cost comparison showed that MTF methods (SLS, APHA and Colilert) were more expensive compared to MF, for drinking water analysis. The most economical method for drinking water

analysis was SLS-MF method (6.7 times cheaper than SLS-MTF); followed by m-ColiBlue24 (2.1 times cheaper). For surface water analysis SLS-MF method was the cheapest (4.3 times cheaper), followed by the Colilert method (2.1 times cheaper) than the SLS-MTF method.

Conventional MTF methods (SLS and APHA) showed several drawbacks such as, need for longer incubational periods, confirmational tests, more labour and subjective nature of results interpretation. In comparison, Colilert was very efficient in all aspects. Among MF methods, m-ColiBlue24 was more efficient than the conventional SLS-MF method with the advantages of simultaneous detection of both types of bacteria, absence of heavy background growth or atypical colony formation, easy preparations and easy result interpretations, less time and labour requirement, etc.

Bacteriological identifications revealed 60 % identifications of non-coliforms by the SLS- MTF method. In contrast, Colilert, m-ColiBlue24 and SLS-MF methods identified more than 60 % of coliform bacteria. Identifications showed that, even the drinking water sources tested were contaminated with fecal (pathogenic) organisms, suggesting threats on drinking water quality in Sri Lanka.

In conclusion, results of the current study revealed that the conventional SLS-MTF method is less efficient, compared to the Colilert, m-ColiBlue24 and SLS-MF methods. SLS-MF method was the most economical method for analyzing both drinking and surface water samples. m-ColiBlue24 and Colilert methods, with their superior performance could be recommended as alternative methods for analyzing drinking water and surface water samples respectively, when cost is not the limiting factor.

7.4

Diversity and Taxonomy of Lichens in the Areas Affected by Forest Die Back at Horton Plains National Park, with a View to Biomonitor the Ecosystem Health.

Peramunugama, D.H.P.

257p.

Ph.D. Degree, 2013.

Location No. 1397

Abstract

Lichens are useful in different ways and play a major role in the water cycle and are also important in nutrient cycling in some ecosystems. They act as pioneers of vegetation and are consumed by some vertebrates, birds and insects. Lichens produce a wide range of unique secondary metabolites, which are being examined for new pharmaceuticals, agrochemicals, enzymes for use as biosensors, biotransformation reactions and diagnostic kits and as environmental indicators for pollution monitoring processes and for biomonitoring.

This research was conducted to correlate the distribution of lichens in the forest areas in Horton Plains National Park (HPNP) affected by dieback with degree of die-back and to determine the forest ecosystem health based on ecological continuity using the diversity, composition and frequency while providing taxonomic descriptions.

Study sites were selected from remote sensed map of HPNP. Results showed that there are 69 lichen species belonging to 38 genera and 21 families, comprising 35 crustose, 31 foliose, 3 fruticose species in the 0.8 hectares of dieback forest of HPNP studied.

Two dieback forest types were recognised in the study area based on presence or absence of *Strobilanthes* (S+ and S-). Trebouxian photobionts, which prefer dry conditions, were the most common type of lichens followed by shade-loving Trentepohlian lichens. Cyanolichens which

prefer shade and wet conditions were found in both type of dieback forests. More species of lichens were recorded in *Strobilanthes* free dieback sites than in dieback forests frequented by *Strobilanthes*.

Strobilanthes stands create wet conditions enhancing the growth of bryophytes and increase foliose lichens including cyano-lichens. Consequently, the number of Crustose lichen species decrease due to the reduction of the bark surface. Changes in *Strobilanthes* vegetation has an impact on lichen growth and diversity.

A dendrogram depicting different clusters of cover values indicated 4 different clusters. Two clusters represent later stages of dieback with *Strobilanthes* plants and other two clusters are represent *Strobilanthes* free vegetation and regenerating forest stands, comprising young and mature host plants.

The ecological index of macro lichen genera, between two types of forest, highlighted the stability of the *Strobilanthes* free forest and indicated that ecological continuity is highly preserved in vegetation. Cluster analysis using frequency and cover values of ECI genera showed that the difference between two different dieback forests may be due to the higher ecological disturbances which may have occurred in the *Strobilanthes* forest.

The minimal levels of air pollutants recorded the area ((IAP = 54.22) suggested that the forest health at HPNP is highly conserved and the presence of *Strobilanthes* free dieback forest indicate the regeneration of the vegetation and therefore, it is imperative to maintain at least the present state of dieback forest of HPNP in order to regenerate its unique biodiversity.

7.5

Effect of Soil Organic Matter on Nutrient Availability under Different Land Use Patterns with Special Emphasis on the Role of Carbohydrates.

Ratnayake, R.R.

150p.

Ph.D. Degree, 2006.

Location No. 550

Abstract

Extensive areas of native vegetation in Sri Lanka have been replaced by agriculture over the last 100 years. Although soil fertility may decline under cultivation, the intensive management of the land could improve soil fertility leading to large increases in productivity. An understanding of the factors influencing soil degradation in relation to different forms of vegetation cover will help the adoption of sustainable practices. Studying the variations of different soil organic matter (SOM) pools is one method of detecting these changes.

This study evaluated the influence of land-use change from natural vegetation to cultivated lands on the change in SOM composition with special emphasis on soil carbohydrates. The effects of different SOM fractions on the nutrient availabilities in these land use patterns were also studied.

Litter in the form of free soil litter (FSL) outside aggregates or clay bound organic matter (CBO) behaved differently in the retention and hence availability of limiting nutrients in different land use patterns studied. In the forests with high FSL contents, the nutrient availability was limited possibly by the microbial and chemical immobilization in the litter fraction. However, a major fraction of soil litter in the cultivated lands could be transferred to a clay bound state forming CBO, preventing further immobilization of nutrients microbially or chemically.

The agricultural management not only influenced the amount of SOM but also changed its chemical composition in these tropical soils. Increased SOM turnover in cultivated lands is generally important to increased and sustained agricultural production. Hence, it is important to develop appropriate agronomic practices to overcome the current depletion of SOM and to ensure sustained agricultural production.

Differences in carbohydrate concentrations were detected between two adjacent land types, forests and the cultivated lands mainly due to differences in litter inputs as well as soil management practices especially soil disturbances. In the forests, there was a higher contribution of microbially derived sugars to the nutrient availability. In contrast, in the cultivated land the nutrient availability was determined by plant derived sugars. Heavy land management including the application of agrochemicals may have reduced the carbohydrate concentration in tea and potato soils by lowering the litter inputs and microbial activities.

This study confirmed that the effect of the SOM on the availability of nutrients is through the effects of soil carbohydrates. Also the complex biological, chemical and physical processes involved in the SOM turnover can partly be deduced from the changes of soil carbohydrates. The soil carbohydrates and their relationships with soil nutrients could provide vital information on the availability of limiting nutrients under different land uses in tropical conditions.

The study demonstrated that the use of fine fraction in soil analysis allowed to emerge the relationships existing between the SOM including carbohydrates, and soil nutrients. This lead to disclose the relationships existing among soil characteristics even under heterogeneous land-use patterns, which are otherwise masked by the variability introduced by coarse fractions and debris in the soils.

Another important outcome of the present study is that the disclosure of combustion temperature of FSL. Modified weight loss on ignition (LOI) method used in this experiment can be used as a quick and simple technique for the determination of FSL compared to the time consuming density fractionation methods. The composition of the complex structure of CBO was also determined by using activation energies of oxidation of the other SOM fractions at different temperatures in a multiple regression model and predicted that CBO is composed of a mixture of FSL and the fulvic fraction (FF).

An understanding of the changes of SOM pools including the soil carbohydrate pool is necessary in assessing the impact of organic matter build up and nutrient availability in improving sustainable land management in tropical ecosystems. Such information will be valuable in the proper management of land resources in Sri Lanka.

7.6

Evaluation of Microbiological and Chemical Quality of Commercially Available Bottled Drinking Water in Sri Lanka.

Herath, W.H.M.A.T.

167p.

Ph.D. Degree, 2013.

Location No. 1286

Abstract

Use of bottled water in Sri Lanka has increased over the last decade, while new brands of bottled water are often introduced to the market. However, the manufacturers' adherence to bottled water regulations is questionable, raising concerns over the quality of bottled water. The objective of the current study was to investigate microbiological and chemical quality of

bottled drinking water in Sri Lanka and determine if these parameters are within permitted levels, and thereby create an awareness of the quality of bottled drinking water in Sri Lanka.

Numerous bottled water brands were subjected to several experiments to determine the microbiology and chemical quality of bottled water. Most of the brands tested exhibited high numbers of Heterotrophic Plate Count bacteria. The study also revealed that most bottled water brands exceeded the permitted level of total coliform (0-10 cfu/100 ml) and fecal coliform (0 cfu/100 ml) counts determined by the membrane filtration method which is used by the National Water Supply and Drainage Board and many private laboratories. Variance analysis revealed a significant reduction in microbial numbers between the numbers of microorganisms initially (1 -3 months) present in the water and those present after one year of storage.

Results of the confirmation tests showed that, among presumptive total and fecal coliforms colonies detected, only typical red colonies with a metallic sheen on M-Endo medium were confirmed as total coliforms and not the pink/red colonies without a metallic sheen. Considering fecal coliforms, even typical blue colonies on M-FC medium and blue colonies on m-ColiBlue24 media were most often not confirmed as fecal coliforms.

Biochemical tests, API 20E and API 20NE revealed that bottled water samples were contaminated with coliforms and non-coliform species. Among the coliforms species *Klebsiella pneumoniae* ssp. *pneumonia* and *Enterobacter cloacae* were identified. *Escherichia coli* was not detected in any of the samples tested. The presence of thermotolerant coliforms (*Klebsiella* sp. and *Enterobacter* sp.) provides a possibility of fecal contamination in some brands of bottled water sold in Sri Lanka.

Pseudomonas aeruginosa, an opportunistic pathogen, and *Pasteurella haemolytica* were non-coliform isolates detected in this study. Detection of *P. aeruginosa* in 18 (50%) brands out of 36 brands is of considerable interest. Out of 186 isolates, 108 isolates were identified as *P. aeruginosa* according to the results of ISO 16266:2006 standardized procedure and API 20NE identification system. The presence of *P. aeruginosa* was confirmed by molecular identification with bidirectional direct DNA Sequencing using the primer pair rD1 and fD1 (forward: 3'AGAGTTTGATCCTGGCTCAG5'; reverse: 3'AAGGAGGTGATCCAGCC5'). Experiments revealed that an UV dose of approximately 17,300 μ W/cm² was effective against *P. aeruginosa*, eliminating all bacteria within 5 seconds of exposure time.

Considering the chemical parameters of bottled water, electric conductivity, alkalinity, hardness, ammonium, nitrite, nitrate, sulphate, phosphate, sulphide, chloride, fluoride, manganese, iron, calcium and zinc were at a satisfactory level. Ninety three percent of brands investigated were below the minimum recommended pH value (6.5) imposed by the Health Ministry of Sri Lanka. When considering the relationship between microorganisms and chemical parameters, bacterial counts showed a positive correlation with Ca and a negative correlation with Cl.

In conclusion, the results of the current study raises concerns over the bottled water industry in Sri Lanka and a need for the bottling industry to be monitored closely by relevant authorities, in order to provide safe bottled drinking water to consumers in Sri Lanka.

7.7

Freckle Disease Caused by *Phyllosticta musarum* in Banana: Biology, Control and Host Defense Responses.

Abayasekara, Charmalie Lilanthi

295p.

Ph. D. Degree, 1998.

Location No. 04

Abstract

Freckle disease (*Phyllosticta musarum*) in banana is characterized by minute, dark brown spots, represented by pycnidia surrounded by necrotic tissue. Heavy infections lower the market quality causing major concerns to the exporters. This thesis presents investigations on freckle disease in local banana cultivar "Embul" (Mysore, Group AAB).

Freckle infections take place at a very early stage of bunch development by conidia dispersed via rain splash, the infected leaves serving as a major source of inoculum. A direct correlation between the freckle incidence and rainfall exists. Many attempts to culture the pathogen on several media proved unsuccessful. This together with the lack of extensive colonization of host tissue may suggest that this pathogen behaves similar to obligate parasites.

A combination of field sanitation, bagging of bunches and a monthly fungicidal spray (Maneb) effectively reduced the disease. Another field trial conducted subsequently in a plantation raised from tissue cultured stocks (cultivar 'x') showed that fungicide and bagging were the main factors contributing to the reduction of the disease.

The restricted nature of individual freckles suggested strong host defense responses against infection. TLC bioassay of extracts of freckle-infected peel of mature fruit showed the presence of at least five phytoalexins. Extracts from infected tissue were fractionated by column chromatography and HPLC with concurrent bioassay. Three phytoalexins were separated, of which two were obtained in pure form. One (C4) was a new phytoalexin belonging to the phenyl phenalenone group and spectral data compared well with 2-hydroxyanigorufone. The second (C2) was a colourless oil. A direct positive correlation was observed between the extent of necrotic tissue and the amount of phytoalexin accumulated in different banana cultivars. Unripe bananas, when inoculated with *Colletotrichum musae*, also accumulate a similar profile of phytoalexins found in freckle-infected tissue but in very much smaller quantities.

Freckle infections were also associated with lignification and suberization of host cell walls, increased PAL activity, additional peroxidase isozymes and 4-5 pathogenesis-related proteins.

Anthraxnose incidence was observed to be significantly less in freckle-infected fruits than in those without freckles during ripening. *C. musae* was present in quiescent state in the freckle-infected fruit peel which, however, fail to initiate anthracnose lesions during ripening. The freckle-induced defense responses in skin tissues which remain effective even after ripening, may be providing protection to the fruits against anthracnose development. The study revealed that the freckle-induced resistance may have a potential to be used in the control of anthracnose.

7.8

Inflorescence Diseases and Natural Disease Resistance in Mango (*Mangifera Indica* L.) in Relation to Anthracnose Development.

Sinniah, G.D.

240p.

Ph.D. Degree, 2010.

Location No. 1073

Abstract

Mango production is limited by inflorescence and fruit diseases. This study investigated mango inflorescence diseases and re-assessed the natural disease resistance (NDR) mechanisms, particularly the induced NDR and their role in the resistance of unripe fruit to anthracnose disease caused by *Colletotrichum gloeosporioides*. Blossom blight, powdery mildew and sooty moulds were the most common inflorescence diseases. Inflorescence malformation and *Cladosporium* disease were recorded for the first time in Sri Lanka. The causal agent of mango malformation was identified as *Fusarium mangiferae* and confirmed by artificial inoculation and Polymerase Chain Reaction (PCR) analysis.

Several local mango cultivars were evaluated for resistance against anthracnose disease. The cultivars, 'Gira', 'Karuthacolamban' and 'Malvana' were found resistant while 'Ambalavi', 'Neelam' and 'Rata' were moderately resistant. 'Seylum', 'Dilpasan', 'Petti' and 'Willard' were susceptible to anthracnose. To understand the basis of resistance of unripe fruit to anthracnose, the defences that operate at structural and biochemical level were investigated. Anthracnose development was negatively correlated with the cuticle thickness ($r = -0.84$). Removal of surface wax increased fruit susceptibility. Germination and appressoria formation of *C. gloeosporioides* *in vitro* were enhanced by epicuticular wax. Preformed antifungal system in mango is composed of resorcinols and gallotannins in the peel and chitinase, resorcinols and some non-resorcinol antifungal compounds in the latex. The level of each preformed defence constituent varied among the mango cultivars tested conferring different level of resistance to the fruit.

Inoculation of unripe mango fruit with *C. gloeosporioides* resulted in localized generation of superoxide (O_2^-) and hydrogen peroxide (H_2O_2) within hours in the challenged epidermal cells, as early defence responses. O_2^- production was greater in a more resistant cultivar, 'Karuthacolamban', than the susceptible 'Willard'. O_2^- production was also greater in inoculated unripe fruits than the ripe fruits. *C. gloeosporioides*-infected epidermal cells showed autofluorescence indicating pathogen-induced hypersensitive reaction.

Constitutive peroxidase and chitinase enzymes were present in the fruit peel and they were enhanced after pathogen inoculation. The induced chitinase isozymes had molecular weights, 59.4-56.4 kDa and 52.3-45 kDa. There was enhanced Phenylalanine ammonia-lyase (PAL) activity in the inoculated peel which may have a role in lignification and enhanced level of phenolic compounds. Transcriptional activation of defence genes and difference in the gene expression between 'Karuthacolamban' and 'Willard' were revealed in mRNA differential display. In general, the induced defence responses were more prominent in the resistant cultivar 'Karuthacolamban' than the susceptible cultivar 'Willard'.

Application of a silicon-based defence elicitor, Kasil[®], as a soil supplement prior to fruit set or a postharvest treatment delayed anthracnose development in fruit at ripe stage, suggesting the potential of Kasil[®] to be used as a defence inducer.

In conclusion, it would appear that multifaceted constitutive defences with structural and biochemical components confer initial resistance to invading pathogens which is reinforced by

further defences induced during pathogen infection.

7.9

Natural Defence Mechanisms in Mango Fruit and their Potential in Management of Postharvest Diseases.

Karunanayake, K.O.L. Chathurika

297p.

Ph. D. Degree, 2008.

Location No. 701

Abstract

This thesis examines the constitutive defences in mango fruit in greater detail, taking into account fruit peel and latex and also the possibility of protecting fruits from postharvest pathogens by application of defence elicitors.

Unripe mango peels were extracted and partitioned to obtain a dichloromethane phase and an aqueous methanol phase. Unreported antifungal activity was detected in the aqueous methanol phase of the mango peel extract. TLC guided fractionation of the active component and HPLC analysis established the activity to be due to a mixture of several gallotannins.

HPLC of the dichloromethane phase of mango peel extracts confirmed the presence of 5-(12-cis-heptadecenyl) resorcinol and 5-pentadecyl resorcinol in Sri Lankan cultivars. Two additional peaks were present in the HPLC chromatograms which showed general features of the spectrum for resorcinols. One was thought to be due to a resorcinol and the other due to a derivative of a resorcinol.

Mango latex can be separated into an oily phase and an aqueous phase. The oily phase of latex is reported to contain resorcinols. Conidia of *C. gloeosporioides* lyzed when exposed to the undiluted aqueous phase of mango latex suggesting the presence of chitinase. The presence of chitinase was confirmed by a gel diffusion assay using glycol chitin as the substrate.

The role of the above defences in regulating differential resistance to postharvest anthracnose was examined using six Sri Lankan mango cultivars. 'Willard' and 'Petti', were more susceptible while 'Kohu' and 'Rata' were moderately so and 'Karutha Colomban' and 'Gira' were less susceptible. One or more of the constitutive defences discussed above were present in higher amounts in the more resistant cultivars as opposed to the more susceptible cultivars.

Infection of unripe mango fruit by *C. gloeosporioides* elicited prompt defences. Browning and accumulation of tannins was observed in cells beneath sites of attempted penetration. However, cells remained viable for up to 24 hours after infection. Chitinases, cell wall bound phenols and peroxidases were induced in infected tissue.

The possibility of inducing fruit resistance with the use of elicitors and fertilizer was investigated. Salicylic acid and Bion® applied as postharvest sprays significantly reduced anthracnose. In pre-harvest treatments, the development of anthracnose in inoculated harvested fruits was best reduced (65 to 95%) in the fruits treated at mid fruit-fill. Chitinase and phenols were induced in the salicylic acid treated fruits while gallotannin activity was not significantly different among treatment and the control. Stem-end rot was significantly less in mango fruit harvested from trees treated with three times the Department of Agriculture recommended dose of potassium while anthracnose was best reduced by applying the recommended regime of fertilizer. Gallotannin activity was increased in the high potassium treatments but not significantly.

The study established that the mango fruit has several constitutive defences in addition to resorcinols. Elicitors and potassium fertilizer can enhance fruit defences and thereby reduce major postharvest diseases of mango.

7.10

Rhizobial-Fungal-Phenolic Interactions in N₂ Fixing Symbiosis.

Arachchi, H.S. Jayasinghe

174p.

Ph.D. Degree, 2004.

Location No. 460

Abstract

Phenolic compounds are a major group of natural chemical present in large quantities in the soil with variable structures and concentrations. Soil fungi constitute a major fraction of soil microbial biomass, influencing other microbes. Rhizobia interact with these natural chemicals and fungi which may affect the biological nitrogen fixation. Rhizobial growth and N₂ fixing symbiosis in the presence of soil phenolic compounds and fungi were examined in this study. This could help to understand the behavior of microbes in the soil.

Effects of different concentrations of four phenolic acids (protocatechiuc, p-coumaric, ferulic and vanillic) on population size of four rhizobial strains (*Bradyrhizobium elkanii* SEMIA 5019, *B. japonicum* TAL 102, TAL 620 and *Azorhizobium caulinodans* ORS 571) were studied. Further, the effects of phenolic acid affected rhizobia on N₂ fixing symbiosis of soybean were also investigated.

The effects of phenolic acids were concentration and structure dependant, and strain specific. The population size of TAL 102 increased when the culture medium was supplied with different phenolic acids as the sole carbon source. In many cases the presence of manitol in the medium masked the differential effects of phenolic acids on the population size. All four phenolic acids suppressed the population of TAL 620. Strain ORS 571 showed low population sizes at low concentrations followed by a growth recovery at high phenolic concentrations. All concentrations of ferulic acid increased the growth of SEMIA 5019 significantly. In different combinations, rhizobial growth and N₂ fixing symbiosis were negatively or positively affected by phenolic acids. Utilization of phenolic acids by rhizobia led to their biochemical changes, resulting in alteration in their symbiotic ability.

Based on the molecular weight, the possibility to fractionate different polyphenolic compounds present in diferent soils and plant materials without prior purification using one dimensional polyacrylamide gel electrophoresis was explored. Different polyphenolic compounds, extracted using 70% acetone were separated on 24% polyacrylamide gels (43% acrylamide and 3% bis-acrylamide). But, low molecular weight phenolics were not separated on the gel and retained at the bottom of the gel. This method provides a rapid fractionation of polyphenolic compounds according to their molecular weight. Further studies are however needed to fully establish the method.

Mycelial colonization of common soil fungi (*Aspergillus niger*, *Penicillium* spp. and *Mucor* spp.) by the rhizobial strains, resulting in the formation of biofilms was also studied. Further, the effects of fungal exudates and their secondary metabolites on the growth of rhizobia were evaluated. Bradyrhizobia gradually colonized the mycelia for 18 days, after which the biofilm structures collapsed with the release of rhizobial cell clusters to the medium. In general, there was no. mycotoxin effects of the fungal exudates on the bradyrhizobial strains used, instead the strains utilized the exudates as a source of nutrition. This study indicates that the present microbial associations with the biofilm formation have important implications in the survival of

rhizobia under adverse soil conditions devoid of vegetation. Moreover, it could have developed an as yet unidentified nitrogen fixing systems that could have contributed to the nitrogen economy of soils.

The effects of different concentrations of tannic acid on the rhizobial growth and on the soybean-rhizobial symbiosis were studied. Further, the effects of different concentrations of tannic acid on the fungal growth and fungal-rhizobial biofilms were examined. Population size decreased significantly in all the rhizobial cultures treated with different concentrations of tannic acid. Degradation products of tannic acid produced by the fungi were used as carbon and nutrient sources by the rhizobia.

Exudates of different fungi tested positively or negatively affected on the growth of different strains of the rhizobia. Rhizobial colonization on mycelia enhanced with the length of incubation time of the tannic acid treated co-cultures. Plant growth, nodulation and N accumulation of soybean were reduced when the rhizobial strains were affected by tannic acid.

Further studies are needed to unravel at molecular level, these alterations and their relatedness to N₂ fixing symbiosis and rhizobial persistence in the soils.

7.11

The Role of Natural Antifungal Substances, Peel pH and Potassium Fertilization in Banana Fruit Resistance to Anthracnose.

Weerakoon, W.R.W.M.A.U.

306p.

Ph. D. Degree, 2009.

Location No. 865

Abstract

This thesis examines the role of constitutive and freckle induced antifungal substances, peel pH and potassium fertilization in banana fruit resistance to anthracnose caused by *Colletotrichum musae*.

Peel extracts of eight local banana cultivars tested had varied amounts of constitutive phenolic compounds with weak antifungal activity. However, the amounts did not correlate with cultivar resistance to anthracnose. Freckled peel extracts of five cultivars showed clear antifungal zones against *Cladosporium cladosporioides* with one at $R_f = 0.4-0.5$ being the most prominent. Substances eluted from this zone in cv. "Embul" inhibited germination and appressoria formation of *C. musae* at 100 ug ml⁻¹ and above.

Bioassay monitored Medium Pressure Liquid Chromatography and Thin Layer Chromatography of freckled banana peel extracts of cv. "Embul" produced six pure phytoalexins. Four of them have not been reported previously. One compound appears similar to hydroxyanigorufone in chromatographic behaviour and physical properties.

C. musae inoculation of healthy bananas did not induce detectable levels of phytoalexins. However, inoculation of freckled fruits with *C. musae* further enhanced the phytoalexin levels in peels which was concomitant with the onset of disease.

Potassium (K) is generally known to increase growth and yield, enhance quality and resistance in plants against diseases. The Present study showed that the uptake of K in banana differed according to the initial soil K status. The tissue K levels had a significant influence on growth, yield and more importantly resistance to disease.

In a soil already with high K levels, addition of different levels of K did not result in increased

level of K in tissues or have any effect on anthracnose, stalk end rot or freckle disease. In contrast addition of twice the Department of Agriculture recommended level of K [380 g/pit] to a soil deficient of K, increased the peel K levels and also significantly reduced anthracnose disease compared to the control. This reduction was shown to be due to increased sclerenchymatous tissue in the fruit peel. K [380 g/pit] treatment also increased constitutive antifungal activity and induced additional compounds in fruit peel. Application of K had no effect on stalk-end rot. However, a progressive reduction of freckle disease was observed with increasing rates of K. Addition of K [380 g/pit] further increased growth and yield and reduced the time to initiate flowering by 3-4 months.

It is reported that fungal pathogens can alter the local pH at the infection site to suit the increased expression of pathogenicity factors. This study showed that *P. musarum* and *C. musae* could increase the peel pH of banana fruits. Mechanism of pH increase with respect to *C. musae* was shown to be through the production of ammonia. Growth of *C. musae in vitro* in a medium at pH 4 resulted in the production of 59.6 mg/L ammonia corresponding to an increase of medium pH by 2.31 units. The growth, pH alteration, ammonia and enzyme production depended on the initial pH of the medium.

C. musae was shown to produce at least 3 -pectolytic enzymes of which one is active at pH 4.5 and the other two at a slightly higher pH 5.5-6.5, which are probably PG and PL respectively. The peel of some local cultivars more resistant to anthracnose had a pH below 5.5 while those of less resistant cultivars had a pH above 5.5. This indicates the possibility of the involvement of PL enzymes in anthracnose development. Whether the ammonia production facilitates the activity of these enzymes in *C. musae-banana* pathosystem is however not clear. In addition a reduction of peel pH, following K [380 g/pit] treatment to soil was also observed which contributed to increased resistance.

In conclusion it could be stated that the *P. musarum* infection elicits a complex system of defences, phytoalexins been prominent among them. Furthermore, there are possibilities in reducing disease by manipulating fruit pH. Application of K fertilizer as 380 g/pit to soils deficient in K, proved to be effective in increasing resistance against anthracnose, increasing growth and yield and decreasing the period of flower initiation, all of which are of immense economic importance to a banana cultivator.

7.12

Studies on Ovary, Ovule and Anther Culture of Coconut (*Cocos nucifera* L.).

Perera, P.I. Prasanthi

189p.

Ph. D. Degree, 2008.

Location No. 700

Abstract

Breeding in coconut is hampered by the lack of homozygous lines for hybrid production and a clonal propagation method. Thus the present study was undertaken to develop suitable techniques for production of dihaploids (OH) *via* anther and ovule culture. Further, the unfertilized ovary was tested as a novel explant for clonal propagation through somatic embryogenesis. The suitable developmental stages of explants were determined by a detailed histological study on inflorescence development.

Consistent callogenesis was observed when unfertilised ovaries at -4 stage were cultured in CRI 72 medium containing 100 μ M 2,4-dichlorophenoxyacetic acid (2,4-D) and 0.1 % activated charcoal. Callusing was improved by application of Thidiazuron (TDZ). Embryogenic calli were

sub-cultured into somatic embryogenesis induction medium containing 66 μM 2,4-D followed by maturation medium devoid of any hormones. Germination of somatic embryos and shoot formation was induced by addition of 6-benzyl aminopurine (BAP) and Gibberellic acid (GA_3) while 2-isopentyl adenine (2iP) increased the frequency of plant regeneration. Histological studies illustrated the sequence of events during somatic embryogenesis while genetic stability of calli and somatic embryos was confirmed by ploidy analysis. *In situ* hybridization indicated that the cell cycle controlling gene, Rb is a potential marker to assess regeneration potential of cultures.

Induction of embryogenesis in ovules failed while anther culture gave promising results. Embryogenic calli / embryoids were produced when anthers at 3 WBS stage, pre-treated at 38 °C for 6 days, were cultured in Eeuwens Y_3 liquid medium containing 9% sucrose, 100 μM 2,4-D and 0.1 % activated charcoal. Androgenic response was enhanced by combining 2,4-D with 1-naphthalene acetic acid (NAA) and cytokinins (2iP and kinetin). Use of phytigel- solidified medium promoted plant regeneration. Anther orientation of 'abaxial surface up' promoted formation and germination of embryoids. Histological studies revealed that the origin of calli/embryoids were from pollen. Ploidy analysis revealed that some of these structures were haploid whereas the others were diploid. Microsatellite marker analysis revealed that all the tested samples containing diploid chromosome complement were DHs. To the best of our knowledge, this was the first successful attempt of obtaining haploid calli/embryoids and DH plants *via* anther culture in coconut.

7.13

A Study of Internal Browning of Two Cultivars of Pineapple with Special Reference to Heat Shock Treatment as a Control Measure.

Weerahewa, H.L.D.

274p.

Ph.D. Degree, 2002.

Location No. 216

Abstract

Internal browning, commonly encountered in pineapple during prolonged cold storage, is a major obstacle to long distance export of fruit under sea freight. In the present study, the internal browning of fruit of two pineapple cultivars was investigated with the view of establishing suitable postharvest physical treatments that induce tolerance to the disorder.

Three-week storage trials were conducted simulating the sea freight export conditions at 10°C and 85% RH. In *Mauritius*, the internal browning symptoms appeared within a week of storage at 10°C initially in the marginal core tissue which subsequently spread to the surrounding flesh. But in *Kew*, the symptoms commenced only after 2-3 weeks of storage as isolated patches in the tissue surrounding the core. There was a clear difference in the time of incidence and the pattern of symptom development between the two cultivars. The cv. *Mauritius* showed comparatively faster ripening and respiratory rates and greater accumulation of acids during cold storage, than the cv. *Kew*. In both cultivars the tissues undergoing browning displayed greater PPO, peroxidase activity and electrolyte leakage. Harvesting fruit early at 100% green stage reduced the incidence and severity of internal browning in both cultivars.

Several postharvest physical treatments were tried out to induce cold tolerance in fruit. Heat shock treatment in the form of hot water dip immediately after harvest was found to induce fruit tolerance to internal browning in both cultivars and the best temperature-time combination was 38°C for 60 minutes. The treated fruit developed 75% and 50% lesser browning in the flesh and core region respectively. The overall reduction of internal browning

was about 55-60%. The results obtained from different temperature-time combinations suggested that an internal tissue temperature of 36-38°C is a prerequisite for induction of fruit tolerance. Although heat treatment significantly reduced internal browning, it slowed down fruit ripening and associated changes and increased water loss compared to untreated controls. However, provision of modified atmosphere conditions to heat-treated fruit during cold storage enhanced cold tolerance by another 10% and resulted in lesser water loss, hence better appearance. The mechanism of induction of fruit tolerance following heat treatment appeared to be through production of heat-shock proteins. It is possible that the cellular repair mechanism following cold injury may be taking place more rapidly in treated fruit.

A cold shock at 4°C for 60 minutes, preceded or followed by heat treatment, also effectively reduced the internal browning of cv. *Mauritius*. Here the treated fruit remained firmer and showed lesser cell damage than the fruit provided with heat shock treatment alone or heat shock followed by MA. Intermittent warming of fruit during the cold storage regime also reduced internal browning in cv. *Mauritius*.

7.14

Study of Wood Rots in Tea (*Camellia sinensis*) with Special Reference to That Caused by *Nemania diffusa* (syn. *Hypoxylon vestitum*).

Balasuriya, Abhaya

254p.

Ph. D. Degree, 1998.

Location No. 01

Abstract

Two broad types of wood rot were identified in tea. The first, general wood rot was common in all tea growing districts. The highest incidence was recorded in the low country wet zone, where the ambient temperature and the relative humidity were higher. A range of fungi from *Fusarium oxysporum*, *F. solani*, *Gliocladium roseum*, *Lasiodiplodea theobromae* to *Myrothecium roridum* were found in close association with this condition. *Pestalotiopsis guepini* was most common. Predisposing factors, both climatic and environmental, seem to play an important role in causing general wood rot. The worst affected are the seedling teas. But certain vegetatively propagated clones too showed a high propensity to contract general wood rot when they become predisposed by other reasons.

The second, **specific wood rot**, recorded only at higher elevations of 1500 m or above, was always associated with one predominant fungus. Two specific wood rot situations were identified. **Thorny stem blight**, caused by *Tunstallia aculeata* and the **Hypoxylon wood rot** caused by *Nemania diffusa* (syn. *Hypoxylon vestitum*). Both cause **soft rot** type of decay in tea stem wood and can be much more damaging than the general wood rot. Both these diseases have shown distinct affinities to certain clones. Of the two specific wood rots, that caused by *N. diffusa* was found to be more aggressive. The pruning knife through the operation of pruning can aid in the dissemination of these wood rots caused by *T. aculeata* and *N. diffusa*. all tea growing districts. The highest incidence was recorded in the low country wet zone, where the ambient temperature and the relative humidity were higher. A range of fungi from *Fusarium oxysporum*, *F. solani*, *Gliocladium roseum*, *Lasiodiplodea theobromae* to *Myrothecium roridum* were found in close association with this condition. *Pestalotiopsis guepini* was most common. Predisposing factors, both climatic and environmental, seem to play an important role in causing general wood rot. The worst affected are the seedling teas. But certain vegetatively propagated clones too showed a high propensity to contract general wood rot when they become predisposed by other reasons. The second, **specific wood rot**, recorded only at higher elevations of 1500 m or above, was always associated with one

predominant fungus. Two specific wood rot situations were identified. **Thorny stem blight**, caused by *Tunstallia aculeata* and the **Hypoxyton wood rot** caused by *Nemania diffusa*. (syn. *Hypoxyton vestitum*) Both cause **soft rot** type of decay in tea stem wood and can be much more damaging than the general wood rot.. Both these diseases have shown distinct affinities to certain clones. Of the two specific wood rots, that caused by *N. diffusa* was found to be more aggressive. The pruning knife through the operation of pruning can aid in the dissemination of these wood rots caused by *T. aculeata*. and *N. diffusa*.

When Hypoxyton wood rot disease is actively spreading, its intensity could increase at an annual rate of about 11 % under natural field conditions. Similar field with a susceptible clone at the age of about 25 years, an estimated yield reduction in the range of 24-34% is possible. The **decay potential** of immature or mature stems of both resistant and susceptible clones was similar when exposed to *N. diffusa*. *in vitro*. Susceptibility of a clone did not have a direct dependence on the relative density of stem wood, mineral composition or their ratio with C% and pH of stem wood. These parameters, were found to be location dependent. The wood of susceptible tea stems is richer in fibre cells, ray parenchyma cells and vessels. In clones resistant to *N. diffusa* attack, wall thickness of fibre cells increased significantly, with maturity.

On culture media *N. diffusa* is adaptable to a wide range of C:N ratios ranging from 50: 1 to 200:1. In its vegetative growth there is a possible optimum in C:P at about 1750:1 C:K ratios less than 400: 1 (higher K levels) have affected initial establishment of the fungus. Among enzymes produced by *N. diffusa*, phenoloxidase, peroxidase and laccase enables it to be a potential lignin degrader as well which could make it more damaging. In culture, *N. diffusa* grows fairly well in a range of pH from 4.5 to 6.0. The optimum growth was at around 4.8. The best growth on culture medium was at 25°C. Growth was inhibited at or above 31°C and its growth continued uninterrupted, at 19°C.

Three systemic fungicides **tridemorph**, **propiconazole** and **tebuconsazole** were effective at 500 ppm concentration of the product when incorporated into the Potato Dextrose Agar medium. Several biological control agents, *Aspergillus niger*, *Trichoderma viride*, *Bacillus* sp. (bacterium) and *Penicillium* sp., showed some promise, *in vitro*. Tridemorph (Calixin) had the least effect on *A. niger*, *T. viride* and *Penicillium* sp., *in vitro*, at the normally recommended rates.

Manual mossaing (MM), hydrated lime spraying (HL), protective painting (P), fungicide spraying (Tridemorph 0.1 %), dosage rate of K fertilizer, etc., could have some influence at one stage or the other in reducing some disease parameters at field level.

M.Phil. Theses

7.15

Biofilms with Nitrogen Fixing Bacteria and Fungi: A Novel Biofertilizer Technology for Sustainable Maize (*Zea mays* L.) Cultivation.

Buddhika, U.V.A.

77p.

M.Phil. Degree, 2013.

Location No. 1395

Abstract

Use of nitrogen fixing bacteria as biofertilizers for particularly legumes is a common practice and rhizobia have been formulated as biofertilizers for more than a century. As a recent development, N₂ fixing bacteria from a wide range of genera have been combined with rhizosphere fungi to form fungal-bacterial biofilms (FBBs). These FBBs can be developed as

biofilmed biofertilizers (BFBFs) to be coupled with 50% chemical fertilizers (CF) to achieve comparable yields with 100% CF for several crops. Therefore, the current study was focused to develop an effective BFBF for maize cultivation in Sri Lanka.

Microbes were isolated and screened, thereby two BFBFs were developed, and they were compared with their monocultures for biological nitrogen fixation (BNF), seed germination, seedling vigor and indole acetic acid (IAA) production. Fertilizing potential of the two BFBFs were tested in greenhouse and two farmer fields. Treatments were, 100% CF, 50% CF, 50% CF + BFBF 1 and 50% CF + BFBF2. One of the two BFBFs was selected and further tested in four fields representing different localities in the maize belt of the country. Effect of the BFBFs on soil quality was tested by evaluating microbial diversity and seed germination.

The BFBFs significantly enhanced nitrogenase activity. Further, seedling vigor was increased significantly over the monocultures with a reduced IAA production by both BFBFs, possibly through a regulation of the hormone. The application of 50% CF + BFBFs gave a yield comparable to 100% CF. The 50% CF + BFBFs maintained high soil NH_4^+ and low PO_4^{3-} availabilities with significantly high root associated BNF. High photosynthetic activity and chlorophyll content, high diversity of fungi, bacteria and cyanobacteria in the soil-plant system with a significant contribution to soil health were observed with 50% CF + BFBFs compared to 100% CF. Regulation of the IAA production by the BFBFs showed their social communication for improved mutual benefits in their symbiosis, which was not observed in the microbial monocultures. This led to increased microbial diversity, resulting in a healthy soil. Accordingly, BFBFs are not only biofertilizers, but also act as microbial ameliorators, supporting to establish sustainable agroecosystems in maize cultivation. Furthermore, as CF could be reduced by 50% with the use of this BFBF technology, the country could save half the expenses on CF imports, thus contributing immensely to the country's economy.

Since, initial soil total P below 0.06% limited yield potential of the BFBFs over the 100% CF, future research is warranted to formulate improved BFBFs with high acid producing capacity and optimized NPK in CF formulations to be coupled with the BFBFs, in order to maximize the use of BFBFs.

7.16

Characterization of Accessions and Reproductive Biology of *Elettaria cardamomum* L. Maton in Sri Lanka.

Dharmaparakrama, A.L. Sarathchandra

211p.

M.Phil. Degree, 2003.

Location No. 304

Abstract

Cardamom [*Elettaria cardamomum* L. Maton, family *Zingiberaceae*] belonging to Malabar, Vashukka, and Mysore types were studied under different agro-ecological conditions viz., wet zone, low country 1 (WLI) (>2500 mm rainfall, <150 m elevation, 30°C under a rubber canopy), intermediate zone, up country 1 (IU 1) (>2000 mm rainfall, > 1000 m elevation, 24°C under a forest canopy) and intermediate zone, mid country 3 (1M3) (1000.;2000 mm rainfall, 350 m elevation, 28°C under 50% shade polythene net).

Results revealed that the capsule size and shape, panicle angle and inter-nodal length and texture of leaflet are the inherited characters. Number of capsules harvested per year per clump in the Mysore and Vashukka types in the IU 1 region was 2071, 1016, 1183, 1051, 1061 from Ec 201, Ec 300, Ec 301, Ec 401 and Ec 700, whereas it was 534, 572 and 593 from the

Malabar type accessions Ec 100, Ec 101 and Ec 102 and 641 from Ec 400 of the Vashukka type, which performed best in the WL 1 region.

Well-distributed rainfall was the best condition for clump development. Four suckers and four panicles were produced alternatively on opposite sides of a pseudostem. Early sucker development was observed at WL 1. The first sucker developed after 5 - 6 months age; the 2nd, 3rd and 4th suckers on a pseudo stem were activated after 9 - 10, 10 - 12 and 18 - 19 months age. A maximum of 6 generations of daughter suckers were observed in a matured clump at a time.

Early maturity (15 months) and early death (36 months) of pseudo stems were recorded at WL 1 whereas that at IU1 was 40 months. At WL 1, the first panicle on pseudostems was observed after 15 - 25 months. The 2nd, 3rd and 4th panicles on pseudo stems were observed after 5-7 months, 14-16 months and 18-20 months respectively after the first panicle emerged irrespective of the type of cardamom. Considering the age of the individual pseudostems of a matured clump, the first panicle emerged at 8 months, while 2nd, 3rd and 4th panicles emerged respectively at 12-14, 16-18, 24-26 months ages in the Malabar type accession at WLI. Late first panicle initiation (9 months) was observed at IUI and IM3 regions. Capsules were taken 90 -100 days for its maturity at WLI and 95 - 105 days at IM3 and IUI regions.

The optimum shade for cardamom is 50%. Under more than 70% shade, the clumps were tall and big but with few pseudostems (< 10) per clump, the leaflets were dark green, the panicles were fewer and the yield was low. Under less than 50% shade, the clumps were short and thin but with many pseudostems, curved or dried and yellowish leaflets, few, short and thin panicles with low yield.

Differences in flower morphology may have some effect on yield in different eco-regions. Anthesis commenced before 4.00 am and peaked at 5.00-5.30 am. Anthers dehiscence peaked between 6.00-8.00 am and was completed before 11.00 am. Stigma receptivity commenced before 6.00 am, was best between 7.00 and 9.00 am and decreased after 12 noon to a nil at 6.00 pm. Pollen grains were of two different sizes ($35.31 \mu \pm 9.2$, and $44.93 \mu \pm 9.8$). The Malabar type had smaller pollen grains. They were highly stainable (> 75%) and had a high percent of germination under a wide range of sugar concentrations (16 -18%). Self-pollinated flowers expressed the lowest (< 5.8%) fruit set. Pollination within a clump or accession was 10.7 to 15.4% fruit set and within a type 21.3 - 26.2%. The best cropping system is a mixture of accessions at least from the same type of cardamom.

7.17

The Climate and Flowering Phenology of Eight *Shorea* Species in Sinharaja Rain Forest, Sri Lanka.

Munidasa, B.K.H. Chandrika

114p.

M.Phil. Degree, 2005.

Location No. 456

Abstract

The study was carried out in the Sinharaja rain forest in Sri Lanka. The canopy of Sinharaja rain forest is dominated by species of *Mesua* and *Shorea* spp., of which majority are endemic to Sri Lanka. Flowering of selected individuals had been recorded fortnightly as a percentage of the observable part of the crown in flower buds and flowers. To understand the climate and the climatic changes of the area, time plots were prepared for three climatic parameters (rainfall, maximum and minimum temperatures and the number of dry days) of the time series (1984-

2002). Annual, seasonal and monthly scales of these parameters were studied to find out the differences between El-Niño, La-Niña and normal events. The effect of environmental parameters on flowering was assessed using Spearman rank correlation coefficient.

The results of the present study show strong deviations in all three climatic parameters from the average climate of the study area. Wet season irradiance or a reduction of rainfall during the south west monsoon period was observed in two out of three El-Niño years. The flowering pattern shown by *Shorea* during the study was bimodal with peaks observed in March and May and in November and December. Two flowering patterns were observed among the eight *Shorea* species: annual flowering species and supra-annual flowering. Time of bud emergence among the study *Shorea* species in the community was observed in September, February or August. Bud maturation varied over a period of 1-11 months. Results of the present study also revealed that flowering among the eight *Shorea* species was staggered in a given year. Intra specific synchronization was evident in the flowering of all selected *Shorea* species in Sinharaja. Among the eight *Shorea* species studied, monthly rainfall significantly affected flower bud production only in *S. congestiflora*, *S. disticha* and *S. cordifolia*.

7.18

Crown Rot of Banana and Its Possible Control Using Papaya Latex.

Indrakeerthi, S.R.P.

136p.

M.Phil. Degree, 2006.

Location No. 539

Abstract

Crown rot of banana has become an important postharvest disease in Sri Lanka as, currently there is a tendency to display deheaded bananas in local retail markets and increased banana exports. A survey conducted within the Kandy area showed that about 32% deheaded bananas were affected by crown rot. Among the popular cultivars "Ambun" (AAA) and "Aanamalu" (AAA) recorded the highest incidence of crown rot, while "Embul" (AAB) and "Kolikuttu" (AAB) showed somewhat lesser disease incidence.

Examination of diseased crowns showed that *Fusarium semitectum*, *Colletotrichum musae*, *Colletotrichum gloeosporioides* and *Verticillium theobromae* are the most predominant fungi involved in crown rot. *Botryodiplodia theobromae* and several other unidentified fungi were also occasionally found associated with the disease.

A mixture of conidia of *F. semitectum* and *C. musae*, *C. gloeosporioides* when artificially inoculated into freshly exposed unripe crown tissue, began to develop symptoms of crown rot within 3-5 days while ripening. Control of crown rot was attempted by using the water-soluble fraction of papaya latex (*Carica papaya* L). The papaya latex is a complex mixture of enzymes notably chitinase, proteases, glycosidase, lipase and simple sugars. The water-soluble fraction of papaya latex can completely digest conidia of many fungi upon a brief exposure *in vitro*. Among them were several important postharvest pathogens including *F. semitectum*, *C. musae* and *C. gloeosporioides*, which incite crown rot in banana. Conidia of many other fungal species lost their viability when exposed to latex. *Rhizopus arrizus* is exceptional as it can infect unripe papaya fruits containing latex and also grow profusely in the presence of papaya latex *in vitro*. Papaya latex exhibits properties of an excellent natural fungicide. Application of water soluble fraction of papaya latex on to the crowns of boxed bananas pre-inoculated with a mixture of conidia of *F. semitectum*, *C. musae* and *C. gloeosporioides* prevented crown rot development completely. The latex-treated crowns developed a black coloration on the surface but remained hard.

Latex, when applied immediately after dehanding, was not found effective in suppressing crown rot development. This was found to be due to the coagulation of proteins in the papaya latex by polymeric carbohydrates and tannins present in the banana latex. The crown should therefore be devoid of any banana latex at the time of treatment with papaya latex for its effectiveness.

Storability is an important property of a fungicide. However, fresh papaya latex cannot be stored at room temperature for long periods due to rapid bacterial growth that brings an unpleasant odour too. Solar-dried or oven-dried water soluble fraction of papaya latex could be successfully stored at -18°C . This retains spore digestion property for about 6 months. Freeze-dried water soluble fraction of papaya latex retains spore digestion property for more than 6 months during storage at -18°C .

The research findings conclude that papaya latex was successful in controlling crown rot of banana.

7.19

Developing a Biocontrol Method Against, *Botryodiplodia theobromae* and *Colletotrichum musae* Causing Crown Rot of 'Embul' Banana.

Gunasinghe, W.K.R. Niroshini

152p.

M.Phil. Degree, 2004.

Location No. 384

Abstract

Two common pathogens associated with crown rot in the Asian region, *Colletotrichum musae* and *Botryodiplodia theobromae* (*Lasiodiplodia theobromae*), on 'Embul' (*Musa*, AAB), bananas were assessed for their relative ability to cause disease. Experiments were conducted by inoculating banana hands or fingers with either of these pathogens or in combination. All crowns or stems developed disease at varying degrees of severity and inoculation of pathogens onto healthy crowns or stems always increased severity. However, the combined effect of both pathogens was always less than their individual effects. *B. theobromae* inoculated hands showed significantly ($P=0.05$) higher crown rot lesion development rates. The highest values for lesion development were on fingers inoculated with *B. theobromae*. Generally, when both pathogens were inoculated together, the frequencies of recovery of each pathogen from hands or fingers, were significantly lower (Dunn's test, $P=25\%$) than when inoculated individually. The results suggest that *B. theobromae* is relatively more robust, and there does not appear to be a synergistic effect between *Colletotrichum musae* and *Botryodiplodia theobromae*.

Two bacteria (*Flavobacterium* sp. [W5481 (a)] and *Pantoea agglomerans* (W5482) on the above mentioned pathogens were tested on 'Embul' (*Musa*, AAB) bananas, to determine their effectiveness as an alternative, to use of fungicides and to determine their mode of antagonism. Both live cells and culture filtrates were tested by germination assays, agar well diffusion, and TLC bioassays. Effects on banana tissues were tested either using banana peel disks (bioassay) or banana hands. Conidial germination of pathogens was significantly ($P=0.05$) reduced in formulations with live cells and cell free culture media significantly ($P=0.05$) reduced in formulations with live cells and cell free culture media (CFCM), although CFCM of *P. agglomerans* were not effective on *C. musae*. On agar well diffusion assays too, CFCM of *Flavobacterium* sp. was effective, and that of *P. agglomerans* was not. TLC-bioassays showed that extent of inhibition, and Rf values of active areas of methanolic extracts of spent media, varied according to the growth medium used for preparation of CFCM and according to the test fungus. Autoclaving the CFCM partially reduced its activity on mycelial growth, but not on

conidial germination.

The rot development on peel disks was significantly ($P=0.05$) suppressed by the treatments with livecells but not with CFCM. None of the biocontrol applications were as effective as the fungicide, thiabendazole. On banana hands, viable cell preparations of each antagonist reduced crown rot significantly ($p= 0.05$). Antibiotics of *Flavobacterium sp.* appeared to be more potent directly on the pathogens. In spite of the differences in antibiotic production by the antagonists, live cells of each antagonist separately suppressed crown rot to the same extent.

Experiments were conducted to determine nutrient competition between antagonist and pathogens, at the site of inoculation by adding the extra nutrient (10 % sucrose in Davis and Mingioli minimal medium or 10% sucrose). There was no indication that these treatments enhanced the efficacy of the antagonists. However, although there was no significant difference in disease incidence, the additional hydration of the infection site by adding nutrient solution or sterile distilled water appeared to favor the pathogen establishment on banana tissue.

Of the two pathogens, *B. theobromae* appeared to be more liable to control by both antagonists. Finally the results obtained from crown rot suppression data showed that there is a chance to develop an environmental friendly, effective control method for crown rot development using these antagonistic bacteria: *Pantoea agglomerans* and *Flavobacterium sp.*

7.20

Development of Propagation Techniques and Agronomic Practices of Two Medicinal Plants: *Asparagus racemosus* Willd. and *Cyperus rotundus* L.

de Alwis, K.K.S.K.

120p.

M.Phil. Degree, 2005.

Location No. 538

Abstract

Asparagus racemosus Willd. and *Cyperus rotundus* L. are widely used in Ayurvedic medicine, however, scientific information on their propagation techniques and agronomic practices are scarce. The present study was therefore focused on the development of simple, rapid and cost effective propagation techniques and the initial establishment methods of these two species.

The mature seeds of *A. racemosus* treated over night with 500 ppm gibberalic acid followed by piercing the seed coat with a fine needle gave only 70 % germination. Propagules comprising parts of the shoot in the primary growth stage, tuber and condensed stem grown in a coir and sand medium gave 94% success. The best growth performance of *A. racemosus* after 15 months of growth in terms of freshshoot weight (20 ± 1.5 g), fresh root weight (137 ± 8 g), dry shoot weight (7.8 ± 0.5 g), harvest index of shoot (56 %) and biological yield (34 ± 2 g) was observed when grown in the media comprising soil: sand: manure mixed in 1:2:1 ratio. Exposure to average shade gave the highest fresh shoot weight (41.3 ± 2 g). Fresh root weight, shoot dry weight, root dry weight and biological yield of plants grown for 12 months under full sun light and the average shade were significantly higher than those parameters obtained under high shade.

Percentage sprouting of *C. rotundus* (95%), and total biomass and mean number of leaves per plant were the highest when plants were raised from propagules comprising the full tuber without parts of the mother plant treated with rooting hormone IBA (3000 mg/l). Mean plant height (27 ± 1.4 cm) and average leaf length (14 ± 0.73 cm) were highest in the plants raised

from the same propagule type grown in coir and sand medium, but the number of buds per plant were the highest (1.7 ± 0.2) when the propagules were grown in water. The best growth performance in terms of harvest index (88 %) was observed when plants were grown in the medium comprising one part each of soil, sand and farmyard manure. Plants grown under full sun ensured the highest harvest index (53%), biological yield (25 ± 1.5 g) and tuber weight (13.5 ± 0.7 g) 360 days after planting. Plants grown in containers and harvested 255 days after the initial establishment gave the best tuber yield. The thesis concludes with a synthesis of research findings.

7.21

Edaphic Characteristics at the Ussangoda Serpentinite Deposit.

Weerasinghe, H.A.S.

89p.

M.Phil. Degree, 2011.

Location No. 1177

Abstract

Serpentinite localities are unique habitats with altered soil characteristics giving rise to a localized entity with unusual composition of vegetation. The Ussangoda serpentinite deposit is one of the five identified in Sri Lanka close to the Precambrian suture zone between the Vijayan and Highland Complex. The current study is to determine the characteristics of Ussangoda serpentinite soil, its spatial and temporal variability, identify plant-soil relationships and heavy metal accumulation of selected species. Serpentinite soils are a result of weathering of ultramafic rocks where these soils have characteristic chemical properties of low Ca/Mg ratio, N, P, K and high Fe, Cr, Ni and Co. Considering the physical properties, these soils have a low level of silt and clay. These special edaphic features of physical and chemical properties are collectively referred to as the 'serpentine syndrome' and it highlights the infertility or the severity of the edaphic factors to which plants must adapt to thrive in serpentinite ecosystems.

The Ussangoda serpentinite deposit is located on the southern boundary of Sri Lanka with an extent of 1 km² and is sharply demarcated by dense shrubby vegetation around the perimeter. The area has two distinct vegetations; prostrate plants and shrubs adapted to the soil and are referred to as serpentinite plains and 'shrub and tree dominated patches' respectively. The soil has a characteristic red colour.

The soils were sampled for the initial survey and then the detail study was carried out by sampling the stratified locations namely, serpentinite plains, 'shrub and tree dominated patches' and the boundary area. These samples were tested for selected physical and chemical parameters. In addition a survey of plants was carried out and their metal content analyzed.

The results of the plant survey revealed that there are 29 plant species belonging to 21 families on the entire Ussangoda serpentinite deposit. Among them 10 prostrate plant species belonging to seven families were on the serpentinite plains. The remaining 19 plant species belonging to 16 families were on the 'shrub and tree dominated patches'. The species, *Hybanthus enneaspermus* on the serpentinite plain accumulated a mean Ni concentration of 1828 µg/g and considered as a Ni hyper-accumulating plant while none of the shrubs exhibited Ni hyper-accumulation. The soil physical and chemical results showed that the site at Ussangoda exhibits typical characteristics of serpentinite soil, though with a degree of variation. The mean Ca/Mg ratio was less than 1 in the serpentinite plains but at certain locations it was below the 0.7 limit. The 'shrub and tree dominated patches' had high concentrations of C, N, P, K and organic matter than in the serpentinite plain area. Correlation analysis showed that organic matter influences many other parameters and is considered as an

important soil parameter to describe the differentiated vegetation at the Ussangoda serpentinite deposit. The C/N ratio was low in the 'shrub and tree dominated patches' and this results in mineralization and favour the release of N to the soils. The soil Ni concentration was low in the newly emerging small 'shrub and tree dominated patches' and comparatively high in the mature large 'shrub and tree dominated patches'.

This study reveals that the soil at Ussangoda exhibits variation in the Ca/Mg ratio and it is not the best parameter to explain its differentiated vegetation. A group of soil factors which include Ca/Mg ratio, Ni, C/N ratio, organic matter, N, P and K are a combination of edaphic characteristics that favour mosaic vegetation pattern at the Ussangoda serpentinite deposit. Initially low soil Ni and high Ca/Mg ratio helps the establishment of 'shrub and tree dominated patches', however with maturity plants exhibit tolerance to the above conditions and thereafter its influence dilutes with time. Organic matter is crucial and affects the cation exchange capacity and the C/N ratio is an important determinant of the characteristic vegetation in the Ussangoda serpentinite deposit.

7.22

Effect of Pre and Postharvest Treatments on Postharvest Quality of Selected Varieties of Decorative Cut Foliage.

Perera, L.N.S.

108p.

M.Phil. Degree, 2012.

Location No. 1282

Abstract

A field survey was carried out to gather information on problems encountered in the export-oriented postharvest handling of decorative cut foliage. Based on the survey, some priority areas of the exporters' needs were identified including; identification of proper harvesting maturity for different varieties, pre- and postharvest chemical treatments to extend the postharvest longevity of the varieties in demand and selection of packaging systems for different varieties.

Effect of different maturity stages; first fully expanded leaf (FEL) (L_1) second FEL (L_2) third FEL (L_3) fourth FEL (L_4) on vase life of cut foliage species *Calathea aemula*, *C. lietzei*, *C. zebrina*, *Aglonema pseudobracteatum*, *A. trebuii* and *Cordyline terminalis* was tested. L_1 of *C. zebrina* and L_3 of *C. lietzei* exhibited vase lives (15 and 14 days, respectively) that are usually accepted by exporters as the minimum period to be exported as a cut foliage. The best harvesting maturity was species-dependent.

Effects of preharvest foliar application of gibberellic acid (GA_3) and cytokinin (Kinetin) on the vase life of *Codiaeum variegatum* (croton) shoot top-cuttings was investigated with varieties 'Mariana', 'Batik', 'Gold Star' and 'Sunny Star'. Plants were sprayed with 0.1 mM GA_3 , 0.1 mM Kinetin, 0.1 mM GA_3 + 0.1 mM Kinetin and distilled water (control) 4 days before harvest. Both GA_3 and Kinetin was effective in extending the vase life of 'Mariana', 'Batik' and 'Gold Star' varieties to varying degrees by keeping the freshness and reducing the rate of defoliation. 0.1 mM Kinetin treatment was the most effective in extending the postharvest longevity of top-cuttings.

Effect of different preservative solutions on the vase life of three *Calathea* species; *C. aemula*, *C. lietzei* and *C. zebrina* was tested. Cut foliage were pulse-treated (24 hr) in 17 different solutions; 20, 30, 40 or 50 ppm BAP, 5, 10, 20 or 30 ppm GA_3 , 1% Sucrose + 100 ppm Citric acid + 100 ppm Physan, 1% Sucrose + 200 ppm Citric acid + 100 ppm Physan, 2% Sucrose + 100 ppm

Citric acid + 100 ppm Physan, 2% Sucrose + 200 ppm Citric acid + 100 ppm Physan, 50% coconut water + 1 % lime juice + 100 ppm Physan, 50% coconut water + 1 % lime juice + 200 ppm Physan, 30% coconut water + 1% lime juice + 100 ppm Physan, 30% coconut water + 1 % lime juice + 200 ppm Physan and distilled water as a control. Out of the treatments, 1%- 2%, sucrose + 100 ppm / 200 ppm citric acid + 100 ppm physan / 30% coconut water + 1% lime juice + 200 ppm physan / 10 ppm - 30 ppm GA₃ / 20 ppm - 40 ppm BAP were effective in increasing the postharvest longevity of most of the *Calathea* spp. tested. The degree of effectiveness varied upon the treatment as well as on the species.

Effect of different Corrugated Fibre Board (CFB) package lining materials, on the postharvest longevity of cut foliage *Chrysalidocarpus lutescens* and *Pleomele reflexa* top-cuttings was investigated. The treatments were; no lining material (control), newspaper only, Low Density Polyethylene (LDPE) gauge 150, LDPE gauge 300, newspaper + LDPE 150 and newspaper + LDPE 300. Lining with LDPE 300 gave the best vase life for *C. lutescens* cut leaves while LDPE 300 + newspaper was the best with *P. reflexa*.

Using information gathered through the field survey and incorporating some of the findings of this study, a technical manual was prepared for the benefit of cut foliage growers, traders and exporters in Sri Lanka.

7.23

Effect of Preharvest Treatments with Gibberellic Acid and Bagging, on Quality and Shelf-Life of Banana (CV. 'EMBUL').

Ikiriwatte, C.J.

160p.

M. Phil. Degree, 2008.

Location No. 831

Abstract

'Embul' banana (Mysore group, AAB) has a potential for export. Therefore, shelf life extension and appearance are important. It is reported that bagging increases fruit size and gibberellic acid (GA) improves shelf life of some fruits. Thus, preharvest bagging and GA sprays were tested on bunches in a monoculture plantation.

The suitable GA application time for desirable postharvest effects was determined. Bunches were sprayed (GA, 100 ppm) at five maturity stages [bunch emergence (M 1), 2nd (M2), 4th (M3), 6th (M4) and 8th (M5) weeks after bunch emergence). Four bunches (n=4) were investigated per maturity stage except in M2 (n=2) for circumstances beyond our control.

Effects on physicochemical parameters (fruit circumference, length, pulp diameter, peel thickness, firmness, pH, titratable acidity- TA and soluble solid content -SSC), ripening (visual, colorimetric and ethylene evolution), susceptibility to diseases (freckles, anthracnose, crown rot), peel anatomy and composition were assessed. GA sprayed at M 1 resulted in thicker peels. Stomatal densities gradually increased with maturity stage of treatment. Early GA spray reduced freckling but increased anthracnose. Delayed ripening and increased size and weight of fruits were achieved when GA was sprayed at M 1 or M4.

A combination of GA sprayed at M1 and bagging (combination) was carried out to overcome the drawbacks of individual treatments. Banana bunches were subjected to bagging (n=17), GA spray (100 ppm) (n=12), combination (n=15) and control (n=12). Combination, increased fruit circumference (14%), fruit length (10%), fruit weight (35%) but decreased curviness (2%), weight loss during ripening (33%), SSC (3%) and firmness (7%). Fruits treated differently were equally preferred sensory evaluations. Colour development was delayed in the combination.

Late climacteric rise was visible in both GA and combination.

The effect of GA on conidial germination and lesions of the pathogens, *Colletotrichum musae*, *Botryodiplodia theobromae* and *Fusarium* sp. were assessed *in vivo* (n=4 bunches) and *in vitro* (n=3 bunches). All treatments reduced crown rot incidence. Anthracnose incidence increased significantly ($p=0.05$) when bagged but remained at the level of control in combination. Also, bagging reduced freckle disease.

The best results in terms of fruit size, shelf life, ideal fruit shape for packing and sensory qualities were achieved with the combination. Hence, after an economic evaluation, combined treatment can be recommended for field application.

7.24

The Effect of Potential Biocontrol Agents Isolated from Food Sources on Fungal Contamination of Copra and Fresh Coconut and on Quality of Coconut Oil.

Nawas, Noorul Fahima

202p.

M.Phil. Degree, 2002.

Location No. 212

Abstract

The present study was a preliminary investigation to determine fungi organisms growing on coconut kernel and copra. Succession of fungal invasion on fresh coconut kernels was investigated in two distinct seasons; June to September, 1996, and December 1996 to April 1997. The temperature ranges and the relative humidities of the two seasons were 25 – 27°C and 28 – 32°C respectively, and 67 – 77% and 55 – 65% respectively. Among the organisms isolated were potential mycotoxin producers, *Aspergillus* spp., *Penicillium* spp., and *Fusarium* spp. Of these, the following were used as test fungi; *Aspergillus flavus* (coconut), *Aspergillus niger* (coconut), *Aspergillus clavatus* (coconut), *Fusarium* sp. (coconut), and *Penicillium* sp. (copra) to determine their response to microbial antagonists. Potential antagonists to control these fungi were isolated from several food sources. Initially, 13 microorganisms were isolated which consisted of 4 yeasts (from coconut water, black gram paste, curd and Kampucha tea mushroom) 9 bacteria (from coconut water, rice flour slurry, black gram paste, yoghurt starter culture, curd, Kampuch tea mushroom and gingelly paste). Of these antagonists, one yeast (*Candida lusitanae*, from coconut water), and four bacteria (*Pantoea agglomerans*, *Flavobacterium* sp. and *Bacillus macerans* from rice flour, and *Enterobacter* sp. from coconut water) inhibited growth of all test fungi in cultural plates. Therefore they were selected for further investigations. Different techniques were used to screen the antagonists. They were growth inhibition on culture plates, conidial germination assays, and mycelial growth reduction in broth cultures. Their effect on fresh coconut was investigated by using pieces of coconut and scraped coconut as the substrate. There was evidence that all five antagonists produced antibiotic compounds into the substrate. Both live cells and cell-free culture filtrates of antagonists were effective in controlling the test fungi.

Out of the five antagonists *Bacillus macerans* was selected to evaluate the effect of quality of coconut oil obtained from fresh coconut and copra treated with this antagonist. Both laboratory experiments and field-based experiments were performed. There was no evidence that the treatment affected the quality of coconut oil. The quality parameters observed were density, free fatty acid, refractive index, matter volatile, impurities, mineral acidity and acid value. None of these were significantly different ($P=0.05$) from the respective controls, and they were within the range specified by the Sri Lanka Standards Institute. An attempt was made to characterize the antifungal compounds produced by *Bacillus macerans* by using Gas-

chromatography-mass spectroscopy. These investigations suggested that the compounds may be a derivative of 1,2 – Benzenedicarboxylic acid and diphenyl ether or Benzenedicarboxylic acid.

7.25

Effect of Soil-Related Factors on Habitat Specialization in the 25 ha. Forest Dynamics Plot at Sinharaja Rain Forest, Sri Lanka.

Chandrasekara, C.M.C.K.

116p.

M.Phil. Degree, 2011.

Location No. 1178

Abstract

Most tropical rainforest trees have strongly aggregated spatial distribution patterns. This aggregated spatial distribution of tropical trees remains an unanswered question in tropical forest ecology so far. Such a distribution pattern in some of the tree species is observed in the 25 ha forest dynamic plot at Sinharaja lowland rain forest, Sri Lanka. The floristic composition and structure within this plot varies along a small-scale altitudinal gradient and the spatial distribution patterns of tree species show an interesting correlation with topography.

This study attempted to examine whether the soil-related factors may have contributed to the aggregation of tropical tree species or not. The endomycorrhizal spore density and diversity was compared along this small-scale elevational gradient and it was correlated with the variation in soil parameters. Different morphotypes of spores were identified using external spore characteristics. To examine the variation of soil parameters with elevation, soil chemical and physical properties such as water potential, pH, organic Carbon, Olsen Phosphorus were analyzed using standard methods.

Secondly, growth performances of selected plant species in their native soil and non native soil were tested by carrying out pot experiments with two valley dominant species (*Semecarpus gardneri*, and *Agrostistachys hookeri*) and two ridge dominant species (*Agrostistachys intramarginalis*, and *Mesua nagassarium*) in the 25 ha Forest Dynamics Plot at Sinharaja, Sri Lanka. The influence of mycorrhizae on species aggregation was also tested by growing seedlings in mycorrhizal suppressed and un-suppressed soils. Seedling height, Root Collar Diameter (RCD) and leaf number were recorded once in three months throughout the experimental period. After 18 months of growth, seedlings were harvested dried to constant weight and dry weights were determined.

The results showed a decreasing trend in spore density and diversity with increasing elevation. This trend was significant at 95% significance level (P value = 0.014). Higher density of spores at lower elevations could be explained by the accumulation of spores, due to washing down of spores with rainwater. Notably, the number of small spores (45- 125µm) contributed more to the total spore count in all samples examined. About 15 different spore morphotypes were identified; among them two were dominant. None of the soil parameters tested showed significant correlations with Vesicular Arbuscular Mycorrhizae (VAM) spore density and diversity, but spore diversity showed a significant moderate positive correlation with soil water potential.

Of the four species tested, *S. gardneri* performed poorly and was excluded from the analyses. The two *Agrostistachys* species showed higher survival rates and better seedling growth in their native soil, compared to their respective results in non-native soil. *Mesua* performed differently to the two *Agrostistachys* species and showed a higher survival rate in the non-

native soil (89%) compared to that in native soil (72%); it also showed better growth always in its non-native soil than in the native soil.

Seedlings of all plant species studied showed comparatively higher survival rates and better growth in their native soils and non-native soils than in the mycorrhiza suppressed respective soils. Neither the seedlings grown in fungicide treated soils, nor in the soils not treated with fungicide, had mycorrhizal colonization in their roots. Therefore, poor seedling survival in fungicide treated soils may be due to some toxic effect of the fungicide on the seedlings. Root Weight Ratio (RWR) of valley specialist, *A. hookeri*, does not vary significantly in the seedlings grown in fungicide treated soils and non treated soils, but the RWR (biomass allocation to roots) of seedlings of both ridge specialists, *A. intramarginalis* and *M. nagassarium*, were significantly higher in fungicide treated soils than that in non treated native and non-native soils.

Results suggest that some soil physical, chemical, and biological factors could play a role in habitat specialization and hence contribute to maintenance of tree species diversity in tropical lowland forests. Therefore, it is important to study about this, relative to other mechanisms.

7.26

Effect of some Carbon Substrate Supplementation, on Associative Dinitrogen of Rice.

Rizvi, E.M.J. Muhammed

126p.

M.Phil. Degree, 2002.

Location No. 221

Abstract

Rice is the staple food in Sri Lanka and of a large proportion of the world population. Nitrogen is a major limiting factor that affects rice yield. Fertilization with chemical N in wetland rice is associated with various problems mainly inefficient use of it by the plant resulting in a loss into the environment leading to pollution. A good way for the synchronous supply of at least a part of the N requirements of rice plants is associative Biological Dinitrogen Fixation (BDF). However, for this fixed N to contribute to high yields the efficiency of BDF must be improved. One of the factors with regard to inefficiency of associative BDF is the limitation of C substrates in the rhizosphere for the diazotroph to continuously support the plant.

Rice variety BW 267-3 and *Azospirillum irakense* KBC1 association was selected, based on *in vitro* inoculation experiments of various rice-bacterial combinations. This strain supported this rice variety probably via contribution of fixed nitrogen. Hence this plant-bacterial combination was used for further studies. The bacteria strain was initially tested for its competitiveness with native diazotrophs in supporting the host plant using a pot experiment. High rates of inoculum were given by repeated inoculation under competitive and non-competitive soil conditions (un-autoclaved and autoclaved soils, respectively). An inoculation effect was found in non-competitive soil conditions indicating a low competitiveness of the strain. However, the bacterial density reduced drastically indicating inadequacy of C substrates for the strain to survive.

The effect of the C substrate supplementation was tested under *in vitro* and greenhouse conditions. Malate was used as a pure C substrate for *in vitro* studies. No significant effect of malate was found on *Azospirillum* strains in their associative BDF. Rice straw (3 t ha⁻¹) was tested as the C substrate on *A. irakense* KBC1- rice variety BG 94-1 association in a pot experiment using ¹⁵N dilution technique. An additional contribution of ca. 3kg N ha⁻¹ to the above ground plant parts by straw supported fixation of the strain was detected. The straw supported total BDF contribution to the whole rice-soil system in the pots was estimated to be 13 kg N ha⁻¹. Also this study revealed that inoculated strain has utilized straw efficiently than

the native diazotrophs for their BDF. Thus by employing suitable diazotroph-plant-C substrate as straw combinations under controlled conditions, the benefits of the associative BDF could be increased. The potential for a positive contribution of associative BDF was shown in this preliminary investigation. Therefore, long-term field trials must be carried out to study the performance of such combinations.

7.27

Feasibility Studies on Underplanting Multiple Use Species in Buffer Zone Pine Plantations of the Sinharaja MAB Reserve.

Sunil, Ahangama Gamage
150p.

M.Phil. Degree, 1998.

Location No. 71

Abstract

Strips of different replicated widths were cut within a 15 years old *Pinus* plantation in July 1991. Nine commercially important tree species, four forest non timber species and four export agricultural crops were planted across and adjacent to the strips and in understorey conditions. Over the course of two years, growth and mortality were monitored. Light intensity was measured in different size strips. Soil fertility was tested and understorey vegetation was also examined.

Test species were grouped into plantings that evaluated their potential for restoration and for production. In the restoration plantings the indigenous species (*Mesua ferrea*, *Shorea disticha*, *S. megistophylla*, *Dipterocarpus zeylanicus*, *S. trapezifolia*) include those that dominate the *Mesua-Shorea* forest type. As the forest non timber species *Elettaria cardamomum*, *Calamus ovoideus*, *Cosciniumfenestratum* and *Arundina graminifolia* were tested.

Results showed all had lower mortality and higher growth in all locations except that of understorey conditions. Different species performed best in light regimes of particular strip width. Based on height, basal stem diameter and survival, the most suitable light intensities were 22 mols/m²/day (three rows removed) for *S. trapezifolia*, *D. zeylanicus*, *S. megistophylla* and *M. ferrea*. *Shorea disticha* performed best in 22 mols/m²/day (three rows removed) and 10 mols/m²/day (one row removed). Among the non timber species, based on height, basal stem diameter, shoot number and fruits/flowers and survival, suitable light intensities for *C. ovoideus* and *C. fenestratum* were 5 mols/m²/day (three rows intact). 22 mols/m²/day (three rows removed) was suitable for *A. graminifolia* and 10 mols/m²/day (one row removed) for *E. cardamomum*.

The production planting species were *Caryota urens*, *D. zeylanicus*, *Pericopsis mooniana*, *S. stipularis* and *Swietenia macrophylla*. *Cinnamomum zeylanicum*, *Coffea arabica*, *Piper nigrum* and *Elettaria cardamomum* were tested as the export agricultural crops.

Similar to the restoration study, findings have direct relevance to the construction of enrichment planting guidelines in *Pinus* plantations for the lowland wet zone of Sri Lanka. Based on height, basal stem diameter and the survival 19 mols/m²/day (narrow gap center) was suitable for *C. urens*, *P. mooniana*, *S. macrophylla* and *S. stipularis*. 25 mols/m²/day was best for *D. zeylanicus*. Considering the height, basal stem diameter, shoot number, fruits/flowers and survival 6 mols/m²/day (eastern inner edge and western inner edge) was suitable for coffee and cardamom. 18 mols/m²/day (western outer edge) and 11 mols/m²/day (eastern outer edge) were suitable for pepper and cinnamon respectively.

This trial provides valuable information to construct enrichment planting guidelines suitable for

the conversion of lowland wet zone pine plantation into restoration forests of primary forest timber and non-timber species or productive stands of valuable timber species and export agricultural crops.

7.28

Floristic Structure and Aspects of Regeneration of Tree Species in the Kahalla Forest Reserve.

Liyanage, Sunil

164p.

M.Phil. Degree, 1998.

Location No. 28

Abstract

A precursory survey was carried out in the natural forests of Anuradhapura district to identify floristic aspects and the forest communities. Later, systematic analysis was carried out in the identified vegetative communities to evaluate floristic characteristics such as species composition, stratification, tree density etc. Observations were made on leaf fall, flowering and fruiting of woody species of the natural forests in the district for nearly two years.

A few large less disturbed natural forests were identified in the precursory survey. Kahalla Range (KR) is one of the comparatively less disturbed large forests located in the southwestern border of the district. Due to the presence of perennial streams, springs and the riverine forest communities, KR was selected for an in depth study. The study was carried out to collect information on vegetation communities, floristic structure, species composition and few other aspects of the KR for nearly 3 years (1988-1990). The KR is a contiguous forest, consisting of four forest areas, Kahalla, Parawahagama, Maneruwa and Namaluwa.

Based on tree density, stratification, species composition, succession stages, special features like occurrence of streams, springs and human interference, twelve vegetation communities were identified within the Dry Monsoon Forests of the Anuradhapura district. They are (i) Ridge Forest Community, (ii) Forest Community in the Rocky hilly areas, (iii) Dense Forest Community in the lowland areas, (iv) Forest Community in the low humic gley soil, (v) Forest community in the seasonal inundation areas, (vi) Forest community on the stream banks, (vii) Riverine forest community inside the natural forest, (viii) Grassland community, (ix) Forest community in the neluwa scrubland, (x) Secondary forest in the hilly areas, (xi) Secondary forest in the lowland areas and (xii) Abandoned chena lands with shrub forest. These communities occur in different parts of the district.

In depth analysis of two forest types, (i) Dry monsoon Forest (DMF) and (ii) Riverine Forest (RF) in the KR showed the followings: among the 57 woody species identified in the RF, there were few tree species, which are not common in the dry zone forests but are frequently found in the wet and intermediate zones. The DMF of the KR was comparatively less disturbed and rich in species diversity. The ridge-top vegetation was floristically and structurally different within the range. These differences may be due to the changes in elevation, edaphic factors and intensity of sunlight etc, but detailed studies are necessary for confirmation. The presence of perennial streams and the springs have increased the value of KR as an important catchment area for many tanks (reservoirs) around the KR. The higher species diversity, presence of several endemic species and the presence of few wet zone species have increased the conservation value of KR.

The variation in leaf fall, flowering and fruiting seasons among tree species is an important aspect in forest management. The study revealed that, according to leaf fall tree species could

be grouped into, (i) fully deciduous species, (ii) semi-deciduous species and (iii) evergreen species. The results showed that the flowering and fruiting seasons of the tree species varied. Based on this information, tree species found in the natural forests of the district could be grouped into, (i) early flowering species, (ii) late flowering species and (iii) irregular flowering species.

The results of this study show the diversity of natural forests of the district and the conservation value of the remaining large forests like Kahalla Range. The National Conservation Review (NCR) study of the Forest Department has identified some natural forests of the district as important forests for conservation of biodiversity, soil and water resources. However, due to the national level ranking, the natural forests of the district were not ranked high. However intensive studies like my study in KR confirm the importance of the remaining large natural forests as catchment areas and refugia for forest biodiversity, particularly for endemic species. Since the dry zone natural forests are depleting very fast, it is becoming very important to implement conservation measures immediately to protect the floristically diverse natural forests like the Kahalla Range.

7.29

Floristics and Soil Nutrient Status of Hantana Forests, Sri Lanka.

Ratnayake, R.M.C.S.

192p.

M.Phil. Degree, 2001

Location No. 181

Abstract

The phytosociology and soil physico-chemical parameters of five woodland: *Alstonia* woodland (ALW), a *Paraserianthes* woodland (PAW), a mixed species woodland (MSW), *Pinus* woodland (PIW) and an adjacent natural forest (NF) in the Hantana Campus land in Kandy district, Sri Lanka was investigated in this study. Stratification, life form distribution, girth class distribution and basal area of each woodland were examined understand their vegetative structure. Their floristic features were investigated by recording the origin of plant species cumulative taxon richness, family importance values (FIV) species diversity based on diversity indices, rank abundance plots, similarity coefficient and β diversity, species composition with respect to their native climatic zone and ethno botanical value of the constituent species in each of the woodlands. Further soil physico-chemical parameters such as soil pH, electrical conductivity, total Nitrogen, nitrate, exchangeable; Ca Mg and K, available P, cation exchange capacity, soil organic matter content, loss on ignition of soil, C/N ratio, water saturation capacity and soil colour of each content, loss on ignition of soil, C/N ratio, water saturation capacity and soil colour of each woodland were studied.

Stratification of most plots in the PIW was limited to the canopy layer whereas in the broad-leaved woodlands it was complex with three or four strata. Life form distribution in both the overstorey (≥ 10 cm gbh) and understorey (< 10 cm) of the PIW was confined to few life forms. In contrast by many life forms were present in the other woodlands. Regeneration of tree juveniles in the understorey of the PIW was lower than that of the other woodlands. Relatively better plant regeneration was observed in the ALW sites, compared to the woodland with secondary vegetation. Girth class distribution of the PAW showed reverse 'J' shaped curves but not in the other woodlands. The merchantable timber class (>150 cm gbh) was highest in the PAW due to the presence of dominant species *Paraserianthes falcataria*. Total basal area of the five woodlands decreased in the sequence of: PAW>MSW>PIW>ALW>NF. The basal area and the FIV values of Pinaceae in PIW, and Fabaceae in PAW and Apocynaceae in

ALW indicate their comparatively higher dominance due to Individuals of *Pinus caribaea*, *P. falcata* and *Alstonia macrophylla* respectively.

The study area contained 53 endemic, 36 exotic and 193 indigenous species comprising a total of 281 plant species, which belonged to 213 genera and 85 families. The total species count of ALW showed the highest species richness (154) followed by NF (134), MSW (113), PAW (107) and PIW (50). The cumulative taxon area curves revealed that the distribution of species within the woodlands was patchy. Both rank abundance plots and diversity indices revealed that plant diversity of the PIW sites was lower than that of other secondary woodlands. Results of the "t" test of Shannon index indicated that PIW and NF sites were characterized by significantly lower and higher species richness ($p \geq 0.001$) than in the secondary broad-leaved woodlands with few exceptions. The β diversity values also indicated that the secondary woodlands were different from the NF. The ethno botanical study of the species identified indicates that the study area contained 91 medicinal, 47 timber, 38 edible, 25 ornamental and 7 shade tree species. Due to plant introductions during the plantation era, 36 exotics were recorded in the study area. Even though the land was cleared and cultivated for a long period during the plantation era, the area now harbours a considerable number of endemic species (52).

The major soil nutrient contents of the NF showed the highest values except for exchangeable Mg. The PIW sites showed the lowest values except for nitrates. Among the secondary broad-leaved woodlands, the soil parameters studied were lower in the PAW compared to ALW and MSW.

The results of the-multiple comparisons of soil parameters in the 5 woodlands studied revealed that there were no significant differences between woodlands with respect to soil pH and C/N ratio ($p \geq 0.05$). However, with respect to the other parameters soil fertility status of the PIW was significantly lower than all the other woodlands except for nitrates ($p \geq 0.05$). Apart from the nitrate and soil organic matter content, no significant differences were revealed between the NF and the other broad-leaved woodlands. Further among the secondary broad-leaved woodlands differences were not significant except for exchangeable Mg. Interestingly, both soil and floristic parameters of the present study showed a more or less similar pattern indicating a close soil-vegetation relationship.

Among impacts, annual fire and fuel wood collection have been identified as two major impacts and which contribute to the present degraded state of the forest. Therefore as a long-term solution to manage fire problem, the grassland area and Pinus woodland should be converted to broad-leaved woodlands or appropriate agro forestry system. According to the findings of the present study, use of mixed species seems to be more effective than mono-species plantations for land rehabilitation. The ecological implications of the results are briefly discussed with particular emphasis on the plant species and soil conservation, and the sustainable management of Hantana for the future.

7.30

Impacts of Soil Biological and Chemical Properties on Forest Dieback at Horton Plains National Park, Sri Lanka: Influence of Arbuscular Mycorrhizal Fungi on the Growth of *Syzygium rotunfolium* Arn.

Yapa, P.N.

105p.

M. Phil. Degree, 2012.

Location No. 1256

Abstract

The montane forests of Sri Lanka are of great interest as they represent centers of world's biodiversity. Horton Plains National Park is in the central highland of Sri Lanka and is covered by montane cloud forest and wet patana grassland. One of the most striking observations at Horton Plains National Park is the dying of trees which is termed as 'forest dieback'. Moreover, endemic tree species such as *Syzygium rotundifolium* and *Calophyllum walkeri* in particular show a relatively high vulnerability to dieback and a few saplings of dying tree species are found in the dieback affected areas. Although research has been done on forest dieback in Horton Plains National Park, the etiology of forest dieback remains unresolved. This study was carried out to investigate the impacts of soil biological and chemical changes on forest dieback especially to investigate the impacts of native arbuscular mycorrhizae on forest dieback at Horton Plains National Park.

Three sites including 0.5-20% -dieback, 41-60% -dieback and 81-100% -dieback sites were selected for the study. Twenty four permanent plots of 20 m x 20 m were established randomly to cover 41-60% tree dieback area at Horton Plains National Park. Four treatments were set up as follows: control, addition of compost, compost with native mycorrhizae isolated from Horton Plains National Park and native mycorrhizae only. The application of treatments started in September 2008 and was repeated every six months for five randomly selected *Syzygium rotundifolium* saplings in each 24 plots in 41-60% -dieback site. After 21 months of treatment application composite soil samples were analyzed for mineral nutrients and heavy metals. Roots of selected *Syzygium rotundifolium* saplings were assessed for arbuscular mycorrhizal fungi colonization. Relative growth rate of *S. rotundifolium* saplings was estimated.

Arbuscular mycorrhizal fungal colonization of *S. rotundifolium* saplings in 0.5-20% - dieback site was significantly higher than the 41-60% -dieback and 81-100% -dieback sites at Horton Plains National Park. Significantly higher arbuscular mycorrhizal colonization was showed in 41-60% - dieback site after 21 months of AMF inoculum addition. Soil analysis showed a relatively low fungal spore count of 37 spores per 100g of soil. Of the soil nutrients analyzed, only total phosphorus concentration was significantly increased in plots with mycorrhizal addition than in the control plots. Soil pollution with Pb and Cd is evident in all the three study sites. Foliar heavy metal concentrations significantly decreased in standard compost added plots. Both compost and native mycorrhizae addition significantly improved relative growth rate of *S. rotundifolium* saplings. These findings highlight the importance of improving the soil quality and abundance of native mycorrhizae to enhance the growth and establishment of *S. rotundifolium* saplings in forest dieback areas at Horton Plains National Park.

7.31

The Invasive Potential of *Pinus caribaea* Morelet in Wet and Intermediate Agro-Ecological Zones in the Knuckles Range, Sri Lanka

Medawatte, W.W.M.A.B.

139p.

M. Phil. Degree, 2010.

Location No. 939

Abstract

After 1967, more than 25,000 ha of abandoned, highly eroded, unproductive tea lands were converted to *Pinus caribaea* plantations by the Forest Department of Sri Lanka. Since the introduction of *P. caribaea*, now a globally listed invasive species, the possibility of its natural spread has not been scientifically investigated. This study investigated the natural spread of *P. caribaea* into surrounding habitats of plantations in the Knuckles Range (KR) in relation to its seed production, ground cover, agro-ecological zones (AEZ) and anthropogenic fire:

Eight *P. caribaea* plantations in two AEZs were selected for the investigation by using stratified random sampling method. Habitats next to each *P. caribaea* plantation was stratified into three belt transects (width 50 m) parallel to the plantation perimeter and mapped using Arc GIS software. *Pinus caribaea* that has spread into these transects were recorded. Their growth stage, whether sapling, juvenile or adult (1-2, 2-4, >4 m height respectively) and density per ha were quantified and analyzed. Cone production gradient, seed and cone production, seed germination potential, wind effect on tree crowns and fire history of randomly selected *P. caribaea* plantations were investigated.

Grasslands adjoining the plantations appear to be highly vulnerable to *P. caribaea* invasion compared to tea plantations, home gardens, scrub lands and forests. Grasslands in the intermediate zone mid-country 1b AEZ (IM1b) are most vulnerable to *P. caribaea* invasion ($p < 0.05$). *Pinus caribaea* density in the wet zone mid-country 3b AEZ (WM3b) grasslands showed a significant negative correlation with increasing distance away from the perimeter of the original plantation ($p < 0.05$). However, grasslands in the 1M 1b zone did not show such a correlation ($p > 0.05$). *Pinus caribaea* trees grown on the perimeter of the respective plantations carried a significantly higher number of cones responsible for the bulk of the seed production in each of the plantations ($p < 0.05$). However, there was no significant difference ($p > 0.05$) in the dispersible seed quantity per cone (~180 seeds per cone) and germination potential between the *P. caribaea* plantations in the two different AEZs. Even though the cone production of *P. caribaea* in the perimeter of the 1M1b zone was significantly less compared to that in the WM3b zone, grasslands in this particular zone were recorded to be the most affected by *P. caribaea*. Local wind pattern has an important role to play in regard to the tree growth and seed dispersal of *P. caribaea* in the 1M1 b zone compared to these features in the WM3b zone. *Pinus caribaea* trees in the 1M1 b zone are relatively short with asymmetrical (flagged) tree crowns compared to those in the WM3b zone ($p < 0.05$) indicating the presence of strong wind, which mostly affects migrating seed density and long distance seed dispersal. Furthermore, factors such as variations of ground cover, soil erosion and fire regime in these grasslands may also affect the *P. caribaea* spread. An understanding of the invasive potential of *P. caribaea* into different vegetation types in the KR and further research into the management of invaded *P. caribaea* are called for to contain *P. caribaea* spread at this very early stage.

In this respect, the pilot studies carried out in *P. caribaea* plantations, (near the NW boundary of the Sinharaja World Heritage Site and in Lower Hantana in the Peradeniya campus), provide insights in to (i) the manipulation of the stand structure of established *P. caribaea* plantations to create suitable above ground environments favorable for establishment of native species, and (ii) to match suites of plant species to appropriate sites in different agro-ecological regions. These models could also be extended into the naturally regenerating *P. caribaea* populations in the KR.

7.32

Microorganisms and Microbial Biofilms as Agents of Cellulosic Biodegradation of Invasive Weeds in Sri Lanka.

Gunathilake, K.M.D.

86p.

M.Phil. Degree, 2012.

Location No. 1281

Abstract

Cellulose is an important feedstock in the biofuel industry. Microbial-derived cellulases are

commonly used to break complex cellulose from pretreated plant substrates into simple sugars. The crystalline structure of cellulose makes it difficult to hydrolyze. Hence, cellulase production is the most expensive step in cellulosic biofuel production. Some microbial communities may deviate from their component organisms living in isolation due to phenomena such as biofilm formation. Biofilm organisms may increase the rates of biodegradation as they live inundated in protective polymeric matrices which facilitate inter cellular communication. In this study the ability to use cellulose degrading microorganisms to produce efficient cellulose degrading communities was explored.

Cellulose degrading fungi and bacteria were isolated from soils, composts and leaf litter samples using specific media. The isolates were screened for most efficient cellulose degrading bacteria and fungi. Several combinations of selected, efficient organisms were tested in batch cultures of cellulose broth, in order to figure out most efficient communities to be used in cellulose breakdown. An *Acremonium* spp. (F23) in monoculture was found to record significantly higher sugar yields compared to other monocultures and mixed cultures. Among fungal mixed cultures, the community of *Acremonium* spp. (F23) and *Fusarium* spp. (F 12) was found to be an effective sugar yielder. Among the produced fungal-bacterial biofilms, the culture with *Acremonium* spp. (F23) and *Bacillus* spp. (B89) was one of the effective biofilms.

Four invasive weeds: *Eupatorium odoratum*, *Panicum maximum*, *Lantana camara*, *Mimosa pigra* were selected as raw-material for degradation studies due to their abundance in Sri Lanka. The average w/w cellulose concentration of *E. odoratum* and *P. maximum* was significantly higher than that of *L. camara* and *M. pigra*. Weed media: dried, ground weed materials in distilled water were inoculated separately with microbial cultures mentioned above. Analyses of the cumulative sugar yields of each plant substrate and of each microbial culture revealed that the highest sugar yield was obtained with a monoculture of *Acremonium* spp. The lowest sugar yield was from the biofilm between *Acremonium* spp. and *Bacillus* spp. This was true for all four plant substrates. The sugar yields from *E. odoratum* and *P. maximum* were higher than those from *M. pigra* and *L. camara*; probably due to their high cellulose concentrations (w/w). The *Acremonium* spp. monoculture produced its highest sugar yield from *E. odoratum* substrate; second highest from *P. maximum*; which were significantly higher than those from the other two weeds, Hence, for biofuel production *E. odoratum* and *P. maximum* can provide better raw materials over the other two weeds. The rate of biological cellulose degradation did not increase with the microbial communities (fungal-bacterial biofilms and fungal mixed-cultures) tested in this research. Perhaps the tested biofilms were not the right combinations of microorganisms.

7.33

Performance of Selected Forest Species Providing Non-Timber Forest Products in Sinharaja MAB Reserve, Sri Lanka.

Kathriarachchi, Hashendra Suvini

224p.

M.Phil. Degree, 2002.

Location No. 211

Abstract

The Sinharaja forest, Sri Lanka's only natural world Heritage Site, was selectively logged from 1972 to 1977, when the logging was banned. Since then it has been declared as a conservation forest and *Pinus caribaea* was planted in the buffer zone around it. This study conducted during 2000 - 2002 covered three main aspects. Firstly, the evaluation of the growth performance of selected primary forest species introduced to a part of the Pinus buffer zone and secondly the regeneration of same species in a selectively logged part of the forest was

carried out. Thirdly a preliminary community survey was carried out to examine the potential to develop a community based management system in the buffer zone of Sinharaja.

In 1991 a field trial was initiated to enrich a part of the *Pinus caribaea* buffer zone of Sinharaja using selected timber and non-timber primary forest species after creating different size gaps by thinning the *Pinus* trees. Since then the pine trees as well as the species used for enriching the *Pinus* stand have grown and the initial light environment in the gaps had gradually changed. In this restoration field trial the selected enrichment species were also planted in the understorey of the *Pinus* stand which was not thinned. This served as the control.

In the present study, the light variations at different canopy levels in the different size gaps and the control in this restoration trial were examined. The adaptability of six selected non timber forest species *Shorea disticha* (Thw.) Ashton, *Shorea megistophylla* (Thw.) Ashton *Caryota urens* L. *Calamus ovoideus* Thw., *Coscinium fenestratum* Colebr and *Elettaria cardamom* var. major Thw.,) to the different light levels in the treatments and the control were also investigated.

The present vertical gradient of total daily photosynthetic photon flux within the treatments and the control, at the top of the crown of the enriched species and at ground level, during both rainy and dry periods ten years after initial establishment of the trial was observed.

After ten years (1991-2001) of growth the following observations were made. The endemic, late successional canopy dominants, *S. disticha* and *S. megistophylla* performed well under the 3 rows and 1 row removed canopy gaps. *Elettaria cardamomum* var. major showed its best height, height increment, number of fronds/plant and net photosynthetic rates in the 3-pine rows intact treatment (144 cm, 11.5 cm/yr, 17 fronds/plant and $1.8 \mu\text{mol m}^{-2}\text{s}^{-1}$ respectively) and the closed canopy control (140 cm, 9 cm/yr, 18 fronds/plant, $2.9 \mu\text{mol m}^{-2}\text{s}^{-1}$ respectively). Both liana species *C. ovoideus* and *C. fenestratum* grew poorly in the *Pinus* understorey compared to that in the other canopy removal treatments. The best height (12.5m) growth for *C. ovoideus* was recorded in the three-row canopy removal treatment. In contrast to cane, the growth performances and physiological features of *C. fenestratum* showed only a smaller variation among the canopy removal treatments. This suggests that they can tolerate the light levels in the 3 pine rows removed, 1 pine row removed and 3 pine rows under planting treatments. After 10 years, the growth performance and net photosynthetic rates of *C. urens* were significantly higher in the 5 rows removed and the 2 rows removed treatments compared to the closed canopy control treatment.

The population structure of this selected non-timber forest species except *C. urens* in disturbed sites, indicating that these species could survive and regenerate naturally in the selectively logged disturbed sites. The better growth performances of these species in gaps of the *Pinus* enrichment trial corroborate that the intensity of selective logging was at a level favourable for the regeneration of these species.

The findings of the preliminary community survey showed that there is a great potential to initiate a community participatory management program within the buffer zone of Sinharaja forest with native non-timber forest species. Among the study species tested *Caryota urens*, *Calamus ovoideus*, *Coscinium fenestratum* and *Elettaria cardamomum* var. major) *C. urens* and *Elettaria cardamomum* var. major could be introduced to initiate such a project in the buffer zone by using the traditional knowledge and the resourcefulness of local community in the periphery.

The silvicultural, biological, ecological and physiological information gathered on each study species in this investigation enable us to recommend the optimal growing conditions for each

species in reforestation and enrichment planting programs in the buffer zones of protected areas throughout the lowland wet zone of Sri Lanka. These findings could also be used as a guideline to recommend the intensity of selective logging that would encourage advanced regeneration in the forest.

7.34

Postharvest Losses and Induction of Resistance in Aubergine (*Solanum melongena*) against Anthracnose caused by *Colletotrichum capsici*, Using a Weak Pathogen, *Fusarium solani*.

Mahendranathan, C.

109p.

M.Phil. Degree, 2003.

Location No. 305

Abstract

A market survey conducted in Kandy area in the central province of Sri Lanka, revealed that approximately 19% losses occur in aubergines at the market and several factors including improper handling practices, fungal diseases, insect damage and physiological disorders contribute to the loss. Anthracnose caused by *Colletotrichum capsici* was identified as a major postharvest disease in aubergine and *Phomopsis* rot and *Fusarium* rot were also encountered during the survey. Investigations were conducted to examine the possibility of inducing resistance in aubergine against anthracnose disease using a relatively weaker pathogen, *Fusarium solani*, and establish the mechanism involved in induction of resistance. Anthracnose disease is currently controlled by application of fungicides. Enhancement or induction of natural resistance mechanisms could have a potential for controlling postharvest diseases in fruits and serve as an alternative approach for fungicides.

C. capsici develops anthracnose lesions in both wounded and unwounded aubergines and the lesion development was observed to be faster in the wounded fruit. *F. solani*, however, caused lesions only when the fruits were inoculated after wounding and not in intact fruits and it shows that *C. capsici* is a more aggressive pathogen in aubergine than *F. solani*. Treatment of unwounded sites with conidia of *F. solani*, at least two days prior to inoculation with *C. capsici* delayed anthracnose development by six days, compared to controls, treated with sterile distilled water. Co-inoculation with conidia of both fungi did not slow down *C. capsici* rotting.

The growth of neither *C. capsici* nor *F. solani* was affected on agar medium. Also *in vitro* germination studies on a mixed preparation of conidia of the two fungi indicated that germination of conidia or appressoria formation of *C. capsici* was not affected by the presence of conidia of *F. solani*. These observations confirm that *F. solani* has no antagonistic effect on *C. capsici*.

Ethyl acetate extracts of peel tissue obtained from aubergines two days after inoculation with conidia of *C. capsici* or *F. solani* when bioassayed on TLC plates with either *C. capsici* or *Cladosporium cladosporioides* showed one prominent antifungal zone at Rf 0.70 and not in healthy tissue showing that the aubergine tissue accumulates phytoalexin/s in response to inoculation by either pathogen. Inoculation of aubergines with either pathogen after wounding resulted in accumulation of more phytoalexin than the fruit inoculated without wounding. In both, the amount of phytoalexin increased progressively with the increase of incubation period after inoculation. The amount of phytoalexin accumulated in fruit tissue inoculated with *F. solani* was significantly greater at all incubation periods than in the tissue obtained from fruits inoculated with *C. capsici*. It shows that the pre-inoculation of aubergines with *F. solani* results in greater phytoalexin accumulation, which is sufficient to prevent the lesion development by

C. capsici. *F. solani* appears to be a more effective elicitor of host natural resistance than *C. capsici* and it appears to be associated with phytoalexin accumulation rather than the other mechanisms involved in the induced resistance responses in plants.

To purify phytoalexins, 50g of tissue inoculated with *F. solani* were extracted and the extract was fractionated by flash chromatography. Two compounds with antifungal properties were obtained in pure form. The major compound that accounts for the most antifungal activity was identified as lubimin.

It can be concluded that natural resistance in aubergines against *C. capsici* could be induced using a weaker pathogen, *F. solani* and phytoalexin accumulation appears to be one of the mechanisms of induced resistance.

7.35

Potential Use of Vesicular Arbuscular Mycorrhizal Fungi to Improve the Seedling Growth of Lesser Known Tree Legumes with Special Reference to *Pericopsis mooniana*.

Karagaswewa, Jinanjali Malmi Kumari

251p.

M.Phil. Degree, 1998.

Location No. 27

Abstract

Four lesser known, legume tree species were selected to investigate their mycorrhizal status. Among those one species (*P.mooniana*) was selected for detailed mycorrhizal studies where green house and field experiments were carried out to ascertain whether dual inoculation with VA mycorrhizal fungi (VAM) and *Rhizobium* is beneficial to plant growth and N₂ fixation, how different levels and sources of P fertilizer affect mycorrhizal inoculation and plant growth and to determine spatial and temporal heterogeneity of VAM fungi in soils of a forest plantation.

The investigation on distribution and mycorrhizal status suggest that nodulated leguminous tree species form VAM, whereas non nodulated species belonging to the sub tribe Amherstieae (Caesalpinoideae) form ectomycorrhizae. Different types of VAM spores are abundant in P limiting, forest soils and spores of the *Glomus* species are the most common ones. However the inoculum potential of the collected forest soils were low and even in habitats with similar vegetation and climate, the VAM spore distribution is patchy in space and time. With reference to *P. mooniana* it was noticed that the rainy season and physiological stress faced by the roots of the tree may impose pressure on VAM fungi to start sporulation.

Inoculation studies implies that indigenous VAM fungi have a low colonization capacity due to low inoculum density, but have proved to be effective when colonization capacity of these VAM fungi increased. Inoculation of *P. mooniana* seedlings with VAM fungi significantly improved the growth, nutrient uptake, nodulation as well as N₂ fixation at 6 months after inoculation, the delay response being possibly an effect of minerals stored in the large seeds. The inoculation of VAM with P fertilizer has shown that the growth, nutrient uptake and nodulation responses of seedlings to both fertilizer applications were low unless accompanied by VAM inoculation. VAM inoculation with P fertilizer increased the P efficiency of the plant and reduced the amount of P fertilizer by 50% that required to reach the optimum growth under uninoculated conditions. The decrease in mycorrhizal inoculation effect at the highest soil solution P concentration suggest that *P. mooniana* is a highly mycorrhizal dependent species.

7.36

Restoration of Plant Diversity in a Monoculture Pinus Plantation in Lower Hantana, Sri Lanka.

Ambagahaduwa, I.M.

216p.

M.Phil. Degree, 2008.

Location No. 756

Abstract

Over 18,000 ha of *Pinus caribaea* plantations established in degraded wet lowland and lower montane areas in close proximity to traditional villages in Sri Lanka are poorly managed and subjected to frequent fires, set by local people who do not see much value in them for their subsistence. These plantations thus remain under-productive and under-utilized, particularly due to the paucity of plant and economic diversity for rural development. Therefore, more imaginative, community-friendly and low-cost management interventions are required to restore plant and economic diversity in these biodiversity-poor mono culture plantations.

This investigation mainly evaluates the growth performance of four broad leaved species introduced to a *Pinus* enrichment trial. Conducted in the *Pinus* stand in Hantana, in the University of Peradeniya the existing overstorey and understorey vegetation in the site was documented before initiation of the trial. In addition, the above ground biomass of *Pinus caribaea* trees felled for creating light gaps was determined to evaluate the total biomass and productivity of these pines.

The enrichment trial in the *Pinus* plantation in Hantana was initiated in 2002. There are two treatments (partial shade: three pine rows removed; full shade: *Pinus* understorey) and a control (full sun: open grassland area). The growth performances of the study species *Artocarpus nobilis* Thw. (Bedi del), *Madhuca longifolia* (L.) Macbride (Mee), *Michelia champaca* L. (Gini sapu) and *Terminalia bellirica* (Geartn.) Roxb. (Bulu) introduced to the enrichment trial were evaluated; the soil physico-chemical properties and light variations of treatments and control were also examined. At the study site, over 90% of the existing overstorey vegetation was *P. caribaea* trees, while 50-85% of the understorey cover was *Panicum maximum* Jacq., both fire tolerant species. The above ground biomass of the 25-yr- old *P. caribaea* was 194 t/ha.

The total Daily Photosynthetic Photon Flux (DPPF) differed significantly among the treatments and control. The highest was in the full light control ($27 \text{ mol m}^{-2} \text{ day}^{-1}$), In the canopy removal treatment it was $13 \text{ mol m}^{-2} \text{ day}^{-1}$ while that in the *Pinus* understorey was $5 \text{ mol m}^{-2} \text{ day}^{-1}$. The soil physico-chemical properties were richer under the grassland (full light), and the values in the canopy removal treatment were better than those under the *Pinus* understorey.

The root collar diameter and plant height performances of the four broad-leaved species, 28 months after initial planting, varied significantly among the two treatments and control. The root collar diameter and plant height after 28 months were significantly higher in the full light compared to that in the full shade for *Terminalia bellirica* and *Madhuca longifolia*. In *Michelia champaca*, the root collar diameter and height were greatest in partial shade and least in full shade and in between in full light. This study demonstrates the better performance of broad-leaved species in the canopy removal treatment than in the *Pinus* understorey treatment in *P. caribaea* stands in lower Hantana. More specifically, *Michelia champaca* is well adapted to grow under the three pine row removed treatment. *Madhuca longifolia* and *Terminalia bellirica* showed better performance in full light. *Artocarpus nobilis* showed better performance similarly in partial shade and also in full light.

The results of this study could be applied to the cultivation of these study species in Sri Lanka's Central Province. As the four study species provide food to different herbivores, the biodiversity in enriched pine plantations would be much higher than in the non-enriched monoculture stands. Further, as the planted species are of utility value to local communities, anthropogenic fires leading to environmental degradation would also be considerably reduced.

7.37

Some Morphological and Reproductive Features of *Santalum album* L. and *Piper longum* L.

Etampawala, E.R.L.B.

108p.

M.Phil. Degree, 2012.

Location No. 1284

Abstract

This research was aimed to evaluate the morphological variations among three sandalwood (*Santalum album*) populations in the intermediate zone of Sri Lanka, investigate fruit formation of *Piper longum* and study low-cost propagation techniques of both these medicinal species that could be easily adopted by growers.

In sandalwood, fruit length and width and seed length varied significantly ($p < 0.01$) among the populations, germination was best in seeds treated with 750 mg/l Gibberellic acid, and viability of 55% of seeds was retained even after 12 months storage in sealed polyethylene bags kept at 4°C. Seedling growth of sandal was significantly higher ($p < 0.01$) (a) with the host species *Tithonia diversifolia* and *Mimosa pudica*, compared to that in the control (without host species) and other host species tested, and (b) when grown in a substrate of river sand, top soil and farm-yard manure in equal proportions, as compared to them in other proportions. *P. longum* too, gave the best results in this medium.

Piper longum stem cuttings comprising the two uppermost nodes of branches and from vertically growing reproductive parts were the best for propagation. *Piper longum* cuttings grew best under medium shade ($850 \mu\text{mol m}^{-2}\text{s}^{-1}$). Cutting raised from vertical branches produced fruit earlier than those grown from horizontal branches. However, nearly 50% of the fruits were prematurely shed during the fruit maturation period.

These studies show that sandal and *P. longum* could be easily grown using simple and low cost techniques. By integrating the cultivation of these species the livelihoods of local communities could be uplifted. In turn, their importation for the preparation of *ayurveda* medicine could be reduced and valuable foreign exchange saved for the country as well.

7.38

Species Limits and Phylogenetics of the Endemic Genus *Stemonoporus* THW. (Dipterocarpaceae).

Rubasinghe, S.C.K.

217p.

M.Phil. Degree, 2007.

Location No. 681

Abstract

Stemonoporus Thw. is the most species rich endemic dipterocarp genus in Sri Lanka. All its members are categorized as highly threatened or threatened category in the IUCN red data book. Species limits within this important taxon had been ill defined, with some authors

recognizing only a few variable species, and others recognizing a number of separate morphologically circumscribed species. These controversial ideas regarding the species limits of *Stemonoporus* Thw. stand as a barrier for implementing conservation and management measures on this taxon. The main aim of the present study was to re-evaluate the species limits of the endemic genus *Stemonoporus* using morphological and phytochemical characters and to determine the phylogenetic relationships within the genus.

Phenetic and phylogenetic analyses were performed based on morphological and phytochemical data taken from specimens collected from different geographical locations and herbarium specimens. The data sets were analyzed independently and in combination.

Cluster analysis and Cladistic analysis divided the genus into 27 different clusters, corresponding to 26 recognized species and a new morphologically different taxon. New characters were found that strongly supported the recognition of vaguely defined taxa. Phylogenetic analysis resulted in a monophyletic *Stemonoporus* Thw. with poor support. But leaving *S. wightii* the rest of the genus received good support as a monophyletic group. Phylogenetic relationships between the taxa were resolved based on morphological data.

7.39

Study of Microsporogenesis and Haploid Induction in Selected Species of Theaceae and Solanaceae.

Wijesekara, Kolitha Bandara

145p.

M.Phil. Degree, 2002.

Location No. 222

Abstract

Microsporogenesis in selected plants species such as, *Gordonia dassanayakei*, *Camellia sinensis*, *Datura metel* and *Solanum pseudocapsicum* was studied prior to attempting haploid induction. A deviation from normal pollen development was observed in two *Gordonia* species of the family Theaceae. Here, some pre-determined parenchymatous cells in the connective tissue undergo cell differentiation to produce pollen-like structures (described as pseudopollen). Pseudopollen developed inside a separate sac situated between the true pollen sacs and development was concomitant with the normal pollen development. At maturity they migrated into pollen sacs and mixed with the normal pollen.

When cultured *in vitro*, immature pollen or microspores can be triggered to undergo repeated divisions leading to the formation of haploid embryos and later haploid plants. The response of cultured microspores is determined to a large extent by the genotype of the donor plants, stage of microspore development, pre-treatments, culture media composition, growth regulators and the culture conditions.

Anthers cultured at mid to late uninucleate stage resulted in high anther response (82%) and highest mean embryos per responded anther (37). Presence of kinetin in 1.0 mg/L concentration favored microspore embryogenesis and post-induction embryo development.

In this study, a novel pre-treatment of temperature-shock was studied. Anthers were subjected to a temperature gradient of high and low temperatures in quick succession. This simple technique had a significant impact on pollen embryogenesis and there was an apparent relationship between the temperature gradient and the embryo yield. When the temperature gradient was large ($45^{\circ}+10^{\circ}$ C and $40^{\circ}+10^{\circ}$ C) more embryos were produced while at smaller gradients ($40^{\circ}+15^{\circ}$ C and $35^{\circ}+10^{\circ}$ C) embryo production was also reduced.

Selected solanaceous species were screened for the ability of androgenesis. Haploids were obtained with *Solanum pseudocapsicum* in this study and this could be the first report of successful induction of haploids in this species.

Since haploids have only a single set of chromosomes there is a high possibility of mutants and recessives to be expressed. Some of these mutants will result in severe abnormalities in the basic body plan of the embryo. This study surveyed such abnormalities in microspore-derived-embryo progeny. Results suggested that, embryo/seedling development in higher plants follows two patterns: apical-basal and radial. Two superimposing processes apparently establish these two patterns in the early stages of embryo development. Four pattern deletions, apical, basal, central and terminal were found affecting the elements of the apical-basal patterning of the embryo. Deletion of shoot apical meristem, cotyledons, hypocotyl and root apical meristem resulted in abnormal embryo/seedling phenotypes. The defective embryonic pattern formations are substantiated by cytological sections of the embryos.

Spontaneous secondary embryogenesis was observed in the hypocotyl region of apical and terminal deleted pollen-derived embryos. These embryos emerged after the cessation of growth of the primary embryos. Cytological studies revealed that secondary embryos originated from sub-epidermal cells in the hypocotyl and followed a developmental sequence similar to zygotic embryogenesis. An enhanced production of secondary embryos was achieved when primary embryos were mechanically wounded to remove apical meristems. Absence of apical meristems and the stimulation caused by the injury during the removal of meristems seem to induce secondary embryos in primary embryo explants. Presence of light and kinetin favored induction and growth of secondary embryos. Terminal-cut + kinetin + light treatment combination resulted in the highest number of secondary embryos per responded explant.

7.40

A Study of the Physicochemical Characteristics of Banana and Response to Postharvest Acid and Calcium Treatment.

Perera, Antenette Niranjala

113p.

M.Phil. Degree, 2000.

Location No. 53

Abstract

Some physicochemical characteristics (peel thickness, firmness, peel to pulp ratio, pH, % titratable acidity, and soluble solids content) were determined in six local cultivars of banana; 'Ambon' (AAA), 'Embul' (AAB), 'Kolikuttu' (AAB), 'Seenikehel' (ABB) 'Puwalu' (AAB) and 'Anamalu' (AAA). These characteristics were comparable to those of some commercially important cultivars in other countries. A tendency to a positive correlation ($p \leq 0.1$) was observed between pairs of physical parameters (peel thickness, firmness and peel:pulp). The lowest peel thickness was observed in 'Kolikuttu' (1.27 mm) and highest in 'Anamalu' (2.73 mm). These cultivars also recorded the lowest, ('Kolikuttu' 0.91 kg cm^{-2}) and the highest ('Anamalu' 2.01 kg cm^{-2}) firmness values, determined by a hand held penetrometer. Anthracnose development was most rapid in 'Kolikuttu'. In 'Puwalu' anthracnose development and spreading of lesions were also comparatively slow. The correlation between lesion diameters and each physical parameter was negative without statistical significance.

In this study, the effects of alternatives to pesticide usage were tried out, to delay ripening and disease development. Pressure infiltration treatments with 0.2 % acetic acid and 0.05 % citric acids effectively reduced disease development although ripening process detected by peel colour change was , not affected. The bananas pressure infiltrated with 0.2 % acetic acid

showed a significantly ($p < 0.05$) higher firmness. A combined treatment of 0.1 % acetic acid, 0.025 % citric acid and 0.06% benlate . reduced both anthracnose induced by inoculating *Colletotrichum musae* and total disease. The results of this study suggested that the effect of acetic acid on fruit firmness was not affected by the ethylene controlled ripening physiology.

When compared with the effect of benlate, the individual actions of these acids was not as effective. However their combined effect with half the active strength of benlate significantly ($p < 0.01$) reduced total disease development and anthracnose development.

However dipping, pressure infiltration and vacuum infiltration of unripe bananas in 4 % CaCl_2 solutions enhanced ripening and disease development of bananas ruling out the use of CaCl_2 for extending their shelf life.

7.41

A Taxonomic Revision of Hymenophyllaceae of Sri Lanka.

Jayasekera, Palitha Wijaya Bandara

150p.

M. Phil. Degree, 1998.

Location No. 08

Abstract

The present study was based on field collections and on herbarium specimens deposited at British Museum (BM), Herbarium, Royal Botanic Gardens, Kew, England (K), Rijksherbarium, Leiden, the Netherlands (L), National Herbarium, Peradeniya, Sri Lanka (PDA). Morphological studies of taxa represented in Sri Lanka have been investigated. Morphological data and ecological studies were used in along with the revision of the family Hymenophyllaceae. Based on the outcome of the study, 18 species belonging to nine genera have been recognized as representatives of the family Hymenophyllaceae in Sri Lanka. Out of the 18 species recognized two species are endemic to Sri Lanka, namely, *Didymoglossum wallii* (Thwaites ex Trimen) Copel. and *Meringium macroglossum* (Bosch) Copel. *Hymenophyllum gardneri* Bosch and *Trichomanes plicatum* Bosch have been renamed as *Mecodium gardneri* (Bosch) Jayasekera and *Crepidomanes campanulatum* (Roxb) Jayasekera.

7.42

Vegetation, Structure and Floristic Composition in the Irrigation Extension Area of the Lower Walawe Basin, Sri Lanka.

Dilhan, M.A.A. Buddhika

146p.

M.Phil. Degree, 2005.

Location No. 511

Abstract

A survey on plant diversity was carried out to gather base line information, prior to irrigation development in the lower Walawe basin of Sri Lanka. Vegetation was investigated by plot sampling along transects. One hundred and six transects, each 50 m x 5 m, were enumerated. The plots were subjected to cluster analysis. Ten clusters in vegetation > 1 m in height (91 transects) and three clusters in vegetation < 1m height (15 transects) were recognized separately. These clusters were treated as "plant communities".

The following community types were distinguished: moderately degraded woodland, open rock outcrop vegetation, tall shrubland, dry zone woodland, dwarf shrubland, mixed vegetation, high density degraded forest, agricultural herbland, chena lands, mixed cropland,

Croton bonplandiamus/herbland, Black-eye-bean /vineland and Paddy /annual herbland. A detrended correspondence analysis (DCA) ordination was performed on the plot data. Studies on the structure and floristic composition of plant communities gave a total of 260 plant species belonging to 209 genera and 67 families, including two endemics (*Barleria nutans* and *Diplodiscus verrucosus*) in the vegetation greater than 1m in height. In the vegetation less than 1m in height 72 plant species belonging to 58 genera and 23 families were enumerated. Further, six timber species (2%), 107 (41 %) medicinal plant species, 60 (23%) food crop species and seven invasive alien species (3%) were recorded.

A total of 220 plant species, 157 genera representing 56 families were recorded during the dry season, whereas only 200 plant species, 153 genera belonging to 57 families were recorded during the wet season. The percentage cover values of species were significantly higher in the dry season compared to that in the wet season (Kruskal-Wallis test, $H = 4.66$, $d.f = 1$, $P < 0.05$; Mann-Whitney U test, $P < 0.05$).

The plant communities recognized in this study across the climatic gradient provide a preliminary scientific basis for delineating conservation areas and for monitoring the vegetational changes in them with time. The moderately degraded woodland, open rock outcrop vegetation, dry zone woodland and high density degraded forest should be prioritized for conservation.

M.Sc. Research Project Reports

BIODIVERSITY CONSERVATION MANAGEMENT

7.43

Assessment of Recreational Value of Minneriya National Park: Possibilities of Sharing Benefits with Stakeholder Community.

Sooriyabandara, M.G.C.

58p.

M.Sc. Degree, 2003.

Location No. 326

7.44

An Assessment on the Status of Natural Resources Exploitation by the Buffer Zone Communities of VRR Sanctuary.

Lalith Kumara, W.A.

42p.

M.Sc. Degree, 2004.

Location No. 350

7.45

Avifaunal Diversity Associated with Different Habitats in Wasgomuwa National Park.

Perera, B. V. Pushpakumara

74p.

M.Sc. Degree, 2003.

Location No. 293

7.46

Comparative Studies on Biodiversity of Logged and Unlogged Mahogany Plantations in Kumbalpola, Sri Lanka.

Samaradiwakara, R.M.W.S

83p.

M.Sc. Degree, 2003.

Location No. 294

7.47

Distribution, Ecology and Taxonomy of Apple Snails of the Genus Pomacea in the Wet Zone of Sri Lanka.

Dissanayake, K.M.D. Mahinda

50p.

M.Sc. Degree. 2004.

Location No. 327

7.48

Estimation of Population Density and Herd Composition of Elephants in Minneriya National Park, Sri Lanka.

Prasad, J.A. Tharaka

34p.

M.Sc. Degree, 2004.

Location No. 349

7.49

The Role of Cattle, Grey Langur and Elephant in Seed Dispersal of the Invasive Alien Plant *Prosopis juliflora* (Mesquite).

Sandanayake, A.

29p.

M.Sc. Degree, 2003.

Location No. 328

MEDICAL MICROBIOLOGY

7.50

Aetiological Agents of Human Dermatophytosis.

Shafiya, J.A.J.

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7.51

Anti-Candidal Activity of Some Plants in the Eastern Region of Sri Lanka.

Thanaraj, V.

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7.52

Application of PCR to Early Detection of Dengue Fever in Clinically Suspected Patients.

Rathnakumari, P.W.G.J.

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Location No. 1173

7.53

Application of Polymerase Chain Reaction for Diagnosis of *Dirofilaria repens* in Dogs.

Medis, S. D.

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Location No. 1044

7.54

Attitudes of Sri Lankans on 'Diyabath', its Physical Properties and Microbiology.

Nagasena, I.I.

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Location No. 1278

7.55

Comparison of Clinical and Laboratory Parameters in the Early Diagnosis of Dengue Fever.

Amunugama, M. B.

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7.56

Cryptosporidium Infection in Buffaloes and Cattle with Special Reference to Factors Contributing to Infection.

Jameel, A.B.S.H.

61p.

M.Sc. Degree. 2013.

Location No. 1046

7.57

Detection of *Legionella* Species and Other Microbiological and Physicochemical Properties in Natural and Man-Made Water Systems in the Colombo District.

Perera, W.V.S.M.

58p.

M.Sc. Degree. 2013.

Location No. 1276

7.58

Detection of W_{nt} Modulator in Surface Ectoderm (*Wise*) Gene in *Mycobacterium tuberculosis*.

Bandara, D.M.D.P.K.

38p.

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Location No. 1274

7.59

Establishing a Rapid Isolation Method for *Mycobacterium tuberculosis*.

Senaratne, T. N.

52p.

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Location No. 1043

7.60

Establishment of PCR Based Assay To Detect *Dirofilaria* Transmission in Mosquitoes.

Thahir, F.H.

33p.

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7.61

Genotyping of Hepatitis B Virus (HBV) Using Previously HBV Positive Serum Samples from Individuals Referred from the Surgical Clinic Teaching Hospital, Peradeniya.

Jayasuriya, D.G.D.

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M.Sc. Degree, 2013.

Location No. 1275

7.62

Group B Streptococcus Colonization in Pregnancy.

Herath, G.C.

46p.

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7.63

Identification of Pathogenic *Leptospira serovar* in Sri Lanka Using Polymerase Chain Reaction.

Rupasinghe, R. A. P.

63p.

M.Sc. Degree, 2010.

Location No. 1042

7.64

Isolation of *Listeria monocytogenes* from Ready to Eat Food Products.

Ranasinghe, E.H.R.K.

45p.

M.Sc. Degree, 2009.

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7.65

Laboratory Identification of *Pneumocystis jiroveci* in Clinically Suspected Pneumocystis.

Rathnapala, N.A.S.N.

43p.

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7.66

Molecular Identification of Methicillin Resistance and Virulence Marker in *Staphylococcus aureus*.

Gunawardena, N.D.

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7.67

Phenotypic Detection of Carbapenemase and Metallo β Lactamase Production among Carbapenem Resistant Gram Negative Bacilli.

Gamage, A.C.

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M.Sc. Degree, 2013.

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7.68

Preliminary Studies on Development of A PCR Based Technique for the Diagnosis of *Trichomonas vaginalis*.

Abeykoon, N.H.

49p.

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Location No. 836

7.69

Prevalence and Identification of *Cryptosporidium* Infection in Pediatric Patients.

Sirisena, U.V.

47p.

M.Sc. Degree, 2013.

Location No. 1389

7.70

Prevalence of *Naegleria* Species in Water Bodies of Maho and Nikaweratiya Divisional Secretariat Divisions.

Gunarathna, J.A.N.S.

76p.

M.Sc. Degree, 2009.

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7.71

Role of Brackish Water Breeding *Aedes aegypti* and *Aedes albopictus* in Transovarian Transmission of Dengue Virus.

Velupillai, T.

59p.

M.Sc. Degree, 2013.

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7.72

Situational Analysis of *Legionella pneumophila* and Some Physical and Chemical Properties of Cooling Tower Waters in Selected Hospitals and Tourist Hotels.

Surige, C.S.

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M.Sc. Degree, 2009.

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7.73

Viral Aetiology in Children Less than 3 Years with Acute Respiratory Tract Infection.

Muthulingam, A.

33p.

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PLANT SCIENCES

7.74

Activity of Two Medicinal Plants against Some Bacteria Causing Skin and Wound Infections in Humans.

Jayasinghe, P.K.D.E.

47p.

M.Sc. Degree, 2006.

Location No. 601

7.75

Antibacterial Activity of the Water Decoctions of the Constituent Plants of the Ayurvedic Drug Panchawalkala and the Medicinal Plant *Abutilon indicum*.

Perera, G.M.M.

55p.

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Location No. 717

7.76

Antimicrobial Activity Of Triphala: A Traditional Medicine Formulation.

Manoraj, A.

46p.

M.Sc. Degree, 2011.

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7.77

Antioxidant Activity and Antibacterial Activity of "Shaddharanayogaya" Prescribed for Hypertension.

Shanthilatha, H.H.

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7.78

A Case Study: Vegetation Study at the Meethirigala Forest Reserve.

Prematilleke, K.P.

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7.79

Comparison of Chemical Identities of Natural Plants and Callus Cultures of *Andrographis paniculata* and *Munronia pinnata*.

Hapuarachchi, Swarna D.

66p.

M.Sc. Degree, 2007.

Location No. 646

7.80

A Detailed Taxonomic Study on the Genus *Ilex* L., (Family Aquifoliaceae) in Sri Lanka.

Attanayake, A.M.A.S.

71p.

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Location No. 557

7.81

Effect of Bee Honey Treatment on Controlling the Lipid Level of Hyperlipidaemia Patients.

Fahumy, M.

57p.

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7.82

An Ethno Botanical Analysis of Montane Flora in the Ritigala Range.

Wijesinghe, W.W.R.

86p.

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Location No. 556

7.83

Four Medicinal Plants Used as 'Danti' in Ayurvedic Medicine in Sri Lanka: A Taxonomical, Anatomical and Phytochemical Study.

Shalika, A.R.R.

50p.

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7.84

Growth and Persistence of Biofilmed Biofertilizers in Liquid Media as Influenced by pH.

Lakmali, P.K.B.

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7.85

Impact of Weligama Coconut Leaf Wilt Disease (WCLWD) on Morphological, Physiological and Yield Aspects Coconut Palms.

Weerakkody, T.

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M. Sc. Degree, 2010.

Location No. 1060

7.86

Morphological and Anatomical Studies of Two Wild Rice Species: *Oryza eichingeri* Peter and *Oryza rhizomatis* Vaughan.

Dissanayake, G.K.P.

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M.Sc. Degree, 2007.

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7.87

Oral Hypoglycaemic Activity of the Traditional Native Drug Varipra Sadinadi and the Antioxidant Activity of the Drug and Its Constituents.

Perera, P.U. Muthumani

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7.88

Some Factors Affecting the Postharvest Longevity of Blue Water Lily (*Nymphaea* sp.) Flowers.

Rathnayake, R.M.G.K.

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7.89

Species Composition and Diversity of Mangroves in Madu Ganga Mangal.

Prasanna, M.G.M.

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7.90

A Study of Jurassic Plant Fossils in Tabbowa Sediments, Sri Lanka.

Edirisooriya, E.M.S.G.M.

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7.91

A Study on the Occurrence and Comparison of Trichomes in Selected Wild Rice Species and Hybrid Rice Varieties in Sri Lanka.

Premachandra, W.S.

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7.92

Wild Orchids in Upper Hantane Sri Lanka.

Pallewatta, S.K.

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M.Sc. Degree, 2006.

Location No. 602

POSTHARVEST TECHNOLOGY OF FRUITS AND VEGETABLES

7.93

Application of Calcium Chloride on Management of Internal Browning of Pineapple (*Ananas comosus* cv. Mauritius) Fertilized with Urea.

Champika, N.D.V.

50p.

M.Sc. Degree, 2010.

Location No. 937

7.94

Canker Disease of *Psidium guajava* L. Caused By *Pestalotiopsis psidii* and Host Defensive Responses.

Bandaranayake, B.M.R.P.

50p.

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7.95

Comparison of Glass and Polypropelene Jars for Canning of Some Selected Fruits and Vegetable Products.

Madugalla, M.A.S.R.K.

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M.Sc. Degree, 2009.

Location No. 840

7.96

Cross Inoculation Studies on Four *Colletotrichum* Isolates from Mango, Avocado, Banana and Rubber.

Senevirathna, A.M.W.K.

39p.

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7.97

***Cynometra cauliflora* L. (Ceasalpinioideae): Fruit Composition and Storage.**

Nalinie, K.A.C.

54p.

M. Sc. Degree, 1997.

Location No. 44

7.98

Development of a Processed Carrot Juice Drink and β -Carotene Retention During Storage.

Samansiri, T.M.

33p.

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Location No. 159

7.99

Development of Frozen "Pollos" (*Artocarpus heterophyllus*) for the Export Market.

Rathnabharathie, B. Varuna

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Location No. 331

7.100

Development of Fruit Leather from Locally Available Varieties of Banana.

Bandara, Lakshmi

56p.

M.Sc. Degree, 2001.

Location No. 164

7.101

The Effect of 1- Methylcyclopropene on the Ripening of Tomatoes (*Lycopersicon esculentum* mill cv. caraibo) During Postharvest Storage.

Nijamudeen, Abdul Majeed

50p.

M.Sc. Degree, 2004.

Location No. 392

7.102

Effect of *Bacillus macerans* on the Growth of Fungi on Copra During Storage, with Special Attention to Aflatoxin Levels in a Medium Scale Processing Unit.

Mallawaarachchi, S. Manjula

75p.

M.Sc. Degree, 2004.

Location No. 399

7.103

The Effect of Four Antagonists against *Fusarium oxysporum* Causing Fusarium Rot of Cucumber.

Bogamuwa, Srimathi Priyadarshani

67p.

M.Sc. Degree, 2001.

Location No. 165

7.104

Effect of Freckle Disease on Ripening Rate of Different Cultivars of Banana.

Liyanage, Sriyani

80p.

M.Sc. Degree, 2004.

Location No. 329

7.105

Effect of Hot Water, Papaya Latex and Bacterial Treatments to Extend Shelf Life of Papaya (*Carica papaya* L.).

Yalingasinghe, A.W.G.S.

30p.

M.Sc. Degree, 1997.

Location No. 39

7.106

Effect of Modified Atmosphere on Extending Storage Life of "Embon" Banana.

Priyadarshani, W.M. Deepika

43p.

M.Sc. Degree, 2001

Location No. 200

7.107

Effect of Nitrogen and Potassium Levels of Fruit Peel Tissue on Anthracnose Development and Postharvest Storage Quality of 'Embul' Bananas.

Gammanpila, Himani M.

60p.

M.Sc. Degree, 2004.

Location No. 332

7.108

Effect of Postharvest Calcium Chloride Treatment on Shelf Life and Quality of Tomato (cv. 'Thilina').

Senavirathna, N.K.

58p.

M.Sc. Degree, 2008.

Location No. 718

7.109

Effect of Postharvest Treatments on the Shelf Life of Mauritius Pineapple (*Ananas comosus* L. Merr.).

de Silva, P. H. J. Chandika

88p.

M.Sc. Degree, 2002.

Location Nos. 256 and 298

7.110

Effect of Transport Practices on Postharvest Disorders and Diseases of Cassava.

Jayasinghe, J.B.L.

50p.

M.Sc. Degree, 2010.

Location No. 936

7.111

The Effect of Two Antagonistic Bacterial Isolates on Three Major Postharvest Pathogens.

Nawas, N. Fahima

35p.

M. Sc. Degree, 1997.

Location No. 47

7.112

Effectiveness of Modified Atmosphere Packing (MAP) and the 'Hydrostore' Moist Bag in Extending the Storage Life of Lettuce (*Lactuca sativa* L.).

Edirisinghe, Kamani Rajika

89p.

M.Sc. Degree, 2001.

Location No. 160

7.113

Effectiveness of Some Essential Oils Alone or in Combination with Sodium Bicarbonate in the Control of Banana Crown Rot (*Musa acuminata* AAB).

Kularathna, L.P.

59p.

M.Sc. Degree, 2004.

Location No. 394

7.114

Effects of 1- Methylcyclopropene (1-MCP) on Postharvest Quality of Chilli (*Capsicum annum* L. var. MI-2).

Abusalihu, Salmathul Jaseela

62p.

M.Sc. Degree, 2004.

Location No. 398

7.115

Effects of Different Postharvest Treatments and Packing Materials on the Quality and Shelf Life of Carrots (*Daucus carota* var *sativus*).

Ratnarajah, Sutharsana

75p.

M.Sc. Degree, 2001

Location No. 198

7.116

Extending the Storage Life of Mukunuwenna (*Alternanthera sesilis*) in Simulated Air Freight Transportation System.

Piyasiri, S.S.

65p.

M.Sc. Degree, 2010.

Location No. 934

7.117

Extending the Storage Life of "Mukunuwenna" Using a Low Cost Evaporative Cooling System.

de Silva, A.S.K.

59p.

M.Sc. Degree, 2002.

Location No. 199

7.118

Factors Influencing Postharvest Longevity of Okra (*Hibiscus esculentus*).

Ranasinghe, R. A. D. D. Nilanthi

53p.

M.Sc. Degree, 1997.

Location No. 30

7.119

Harvesting Maturity and Postharvest Fungal Diseases in Ridged Gourd (*Luffa acutangula*) var. Indian 19.

Ali, M.A.A.A.

51p.

M.Sc. Degree, 2009.

Location No. 841

7.120

Investigation of Diurnal Variation and Impact of Stress on Titratable Acidity of Pineapple var. Mauritius as Causative Effect on Internal Browning.

Jayasundera, Upali

23p.

M.Sc. Degree, 1997.

Location No. 42

7.121

Manufacturing of Mushroom Incorporated Rice Biscuits and Its Quality as Affected by Packaging.

Premaratne, M.P.T.

34p.

M.Sc. Degree, 2008.

Location No. 786

7.122

Modified Atmosphere Packaging for Local Avocados (*Persea americana* Mill.).

Gunaratne, M.K.

55p.

M.Sc. Degree, 1997.

Location No. 40

7.123

Modified Atmosphere Storage of Type "Kolikuttu" Bananas.

Dasanayake, W.W.D.M.G.D.

39p.

M.Sc. Degree, 1997.

Location No. 38

7.124

Optimization of Technology to Control Development of Bitterness in Dehydrated Jak Fruit Flour.

Ranatungage, S.V.

46p.

M.Sc. Degree, 2010.

Location No. 935

7.125

Phytoalexin in Egg Plant (*Solanum melongena*) Infected with *Phomopsis vexan* and *Fusarium solani*.

Safeena, M.I.S.

47p.

M.Sc. Degree, 1997.

Location No. 41

7.126

Postharvest Longevity of Papaya (*Carica papaya* L) as Affected by Methods of Handling.

Balasoorya, Sajeewani Thushara

92p.

M.Sc. Degree, 2001.

Location No. 163

7.127

Product Development of Drumstick (*Moringa oleifera*) Using Pod Scrapings and Seeds.

Kumari, P.G.R. Hemanthi

42p.

M.Sc. Degree, 2004.

Location No. 396

7.128

Relationship between Varietal Characteristics of Melon (*Cucumis melo* L.) and the Infestation of Melon Fly (Diptera: Tephritidae).

Chandana, H.K.A. Sujith

68p.

M.Sc. Degree, 2001.

Location No. 189

7.129

Respiration and Ethylene Production in Relation to Anthracnose Development in Two Local Mango Cultivars.

Chandima, O.K.D.D.

70p.

M.Sc. Degree, 2004.

Location No. 395

7.130

Some Factors Underlying the Resistance of Banana Variety "Kahambala" to Anthracnose Disease.

de Silva, M.A.S.M.S.

45p.

M.Sc. Degree, 1997.

Location No. 43

7.131

Studies on Extending Postharvest Life of "Embul" Banana in Low Cost, Evaporative Cooling System.

Lokuliyana, M.D.

93p.

M.Sc. Degree, 2002.

Location No. 201

7.132

A Study of Physicochemical and Quality Aspects of Frozen ChowChow (*Sechium edule*).

Jayaratne, H.A.C.G.K.

72p.

M.Sc. Degree, 2004.

Location No. 393

7.133

A Study of Physico-Chemical Changes of Banana var. 'Kahambala' During Fruit Development and Ripening.

Manoja, U.G.Y.M.

28p.

M.Sc. Degree, 1997.

Location No. 45

7.134

A Study of Potato Dry Rot Caused by *Fusarium* Species.

Ratnayake, R.M.R.N.K.

69p.

M.Sc. Degree, 2001.

Location No. 161

7.135

A Study of the Casual Organisms and the Effect of Latex on Stem End Rot Development, Respiration and Ethylene Production in 'Karuthacolomban' Mangoes.

Attanayake, S.G. Sudarshi

64p.

M.Sc. Degree, 2004.

Location No. 397

7.136

A Study on Low Cost Preservation of Lime Juice.

Herath, H.M. Padmini Chandrani

52p.

M.Sc. Degree, 2001.

Location No. 162

7.137

Suitability Study on Different Maturity Stages of *Averrhoa carambola* L. Variety (Honey Sweet) in Fruit Juice.

Perera, Y.M.

63p.

M.Sc. Degree, 2010.

Location No. 1049

7.138

Utilization of Carambola (*Averrhoa carambola*) for the Formulation of Low Sugar Ready-To-Serve Drink.

Pathirana, Sandamali

49p.

M.Sc. Degree, 2001

Location No. 187

7.139

Utilization of Cassava through Freezing.

Wijesinghe, W.A.J.P.

57p.

M.Sc. Degree, 2008.

Location No. 744

7.140

Weight Loss and Storage Life of Lime in Relation to Fruit Size, Stage of Maturity and Storage Temperature.

Lekamge, Chandrika Subhashini

68p.

M.Sc. Degree, 2001.

Location No. 188

WILDLIFE ECOLOGY AND MANAGEMENT

7.141

Avifauna in the Illukkumbura Region of the Knuckles Range.

Esufali, Shameema Jafferjee

124p.

M.Sc. Degree, 1998.

Location No. 85

7.142

Biodiversity of Gannoruwa Forest and its Sustainable Management.

Basnayake, B.M.K.M.K.

67p.

M.Sc. Degree, 1998.

Location No. 76

7.143

Comparison of Streamside Vegetation in Different Land Use Types of Maha Oya in Hantana Campus Land.

Kariyawasam, Champika Shyamalie

45p.

M.Sc. Degree, 1998.

Location No. 84

7.144

Impact of Wild Elephants on Agricultural Communities in Victoria-Randenigala-Rantambe Sanctuary.

Jayaneththi, Salila Nalanthi J.K.D.

91p.

M.Sc. Degree, 1999.

Location No. 91

8 - SCIENCE EDUCATION

Ph.D. Dissertations, and M.Sc. Research Project Reports

Ph.D. Dissertations

8.1

Development of General Chemistry Concepts at School Level.

Menike, A.R.G.A.M. Abeykoon

320p.

Ph.D. Degree, 2006.

Location No. 551 (Thesis); 552 (Accompanying handbook titled 'Development of Demonstration Experiments for Teaching A/L Electricity and Magnetism: Activity Booklet for Primary Teachers and Handbook for A/L Chemistry Teachers')

Abstract

A good understanding of the general chemistry section in the chemistry syllabus for the General Certificate of Examination - Advanced Level, GCE (A/L) is essential for students as it provides the knowledge in basic concepts in chemistry that are helpful to understand the other sections in the chemistry syllabus. However, most advanced level chemistry teachers consider teaching general chemistry section of the GCE (A/L) chemistry syllabus poses many problems. The analysis of the content in the evaluation reports of the chemistry papers in the GCE (A/L) examination shows that students too experience difficulties in answering the questions that are focused to evaluate their knowledge in general chemistry concepts. This study aimed at identifying problems of the learners and assisting them in learning the concepts in general chemistry. In the Sri Lankan context the knowledge of some basic concepts in general chemistry is introduced at the junior secondary level of the school system. Therefore this study focused on identifying the problems in the teaching learning process in this section from junior secondary stage of education to senior secondary stage (General Certificate of Examination - Ordinary Level) of education too. The purpose of this was to find out ways of developing concepts in general chemistry effectively in students.

To understand how general chemistry concepts are taught at junior and senior secondary levels, three questionnaires were administered among O/L and A/L science teachers. 25% of them were interviewed. The answer scripts in term test papers of the GCE (O/L) students were also analyzed. Two diagnostic tests were conducted to A/L students to identify problematic topics in a selected unit (The unit on 'Chemical bond') in the general chemistry section of the A/L syllabus. Six classrooms were observed to identify problems in teaching and learning chemical bonds at GCE (A/L.) By doing a content analysis of the general chemistry sections in the O/L and A/L syllabuses, it was found out that the content in the teacher guides and textbooks had created some problems in learning. According to O/L teachers it is too much for the tenth graders to learn concepts involved in writing symbols, valence and writing formulae in the same year. It was also found that the content related to general chemistry in the O/L syllabus has to be reorganized to ensure smooth flow of facts from lower grades to upper grades.

The students had difficulties in writing formulae, balancing chemical equations and drawing dot-cross diagrams and, understanding molecular geometry, intermolecular forces, polar and non-polar molecules. In writing chemical formulae most of O/L students made mistakes. Fifty percent of the teachers stated that it is difficult to teach balancing equations for O/L students as well as A/L students. In teaching chemical bonds, several defects of the teachers such as presenting incomplete or irrelevant facts, making incorrect and incomplete explanations,

problems in introducing lessons and managing time were identified. To overcome the identified difficulties and to facilitate teaching learning process, a handbook was prepared on the unit on 'Chemical bond' in the GCE (A/L) chemistry syllabus and it was tried out in four classes. The analysis of students' answer sheets showed that students in the classes of the trying out sessions had comprehended the content better than the students who learned the unit in the traditional manner. It is suggested to reorganise the content in general chemistry from junior to senior secondary level and to introduce new methodologies of teaching to assist students in their learning. In addition preparation of handbook for each unit in general chemistry section of the GCE (A/L) chemistry syllabus is recommended.

In Sri Lanka students have the opportunities to develop science process skills in primary classes through the subject 'Environment Related activities (ERA.)' The content in this subject was analysed in order to find out whether some activities that are related to general chemistry sections can be introduced in these grades.

Two grade two classrooms were observed to understand the ways of introducing ERA subject in the primary classes. Subject experts were interviewed. It was found out that there are several themes in the ERA syllabuses in primary stage in which some activities related to general chemistry can be introduced. It was also found out that even though there are opportunities; teachers do not introduce activities that are directed to improve scientific process skills in students. A booklet of activities was prepared in which some activities related to general chemistry concepts are introduced -that are related to the content in the ERA syllabuses. This book also provides opportunities to develop process skills in students. Some of the activities in this booklet were tried out in primary teacher training programmes and the primary teachers were very satisfied with the outcome of these activities.

8.2

Teaching 'Environment Related Activities' at Key Stage One to Help Children in Developing Science Process Skills to Attain Scientific Literacy in Future.

Vitharana, P.R.K.A.

256p.

Ph.D. Degree, 2006.

Location No. 554

Abstract

Today we live in a world filled with scientific innovations due to the advancement of science and technology. Therefore society is complex and rapidly changing than ever before. In order to face the dynamic nature of the 21st century, an individual should possess multiple skills. The developed countries like USA are aiming to produce scientifically literate citizens to succeed challenging situations in the world.

Although we are a developing nation we have to face the global society. However, this cannot be achieved within one or two years and it should start from primary level. According to the primary education reforms introduced in 1997, the primary cycle of education has been divided into three key stages as key stage one - grades 1 and 2, key stage two - grades 3 and 4 and key stage three - grade five. Primary curriculum consists of four main subjects and science is integrated in Environment Related Activities (ERA.) The aim of this study was to help children in key stage one to develop science process skills through the subject ERA, that are required to be a scientifically literate adult in future.

In order to achieve the aim of the study it was conducted in three phases. In the first phase data were collected relating to ERA using classroom observation, interviews and diagnostic

questionnaire. In the classroom observation twelve teachers from three schools were observed while teaching ERA and detailed fieldnotes were prepared for each lesson. With the help of the fieldnotes detailed transcripts were made with the objective of understanding the real situation in the classrooms. During the second phase, activities were planned in different themes of ERA to develop process skills of children. In the third phase those activities were piloted in three selected classrooms. Classroom observation was conducted and fieldnotes were prepared. The necessary improvements were made with the data obtained from observation and the feedback obtained from teachers. Data obtained from different sources were analysed and identified the weaknesses in teaching ERA, the types of activities suitable for developing process skills and how children developed process skills through suggested activities.

It was evident from the study that many teachers had difficulties in teaching science related components of ERA due to the lack of subject matter knowledge and it led children to develop misconceptions. The students' active participation, which is expected in the student-centred teaching, was not observed in most of the classrooms. Almost all the teachers had weaknesses in the area of professional skills.

Among the most prominent of those were the introducing lessons, questioning, planning lessons, organizing groupwork and use of teaching aids. 85% of teachers were not competent in developing process skills of children especially due to the weaknesses in professional skills.

Children enjoyed and actively participated in introduced activities. Children developed process skills when they engaged in simple activities with the proper guidance of the teacher. Teachers' responses towards suggested activities indicated that children were very interested in learning through such activities and teachers motivated children to be inquisitive and investigative.

Children in key stage one developed misconceptions due to the limited science background of teachers. Although there were number of opportunities in the ERA syllabus to develop science process skills of students, they were rarely given proper guidance for that which is required to be a scientifically literate adult in future. The subject matter knowledge as well as the professional skills of primary teachers should be strengthened through workshops, allowing them to actively involve in activities where they could understand their own misconceptions and weaknesses.

M.Sc. Research Project Reports

8.3

Active Instruction Techniques for Teaching Science in Lower Secondary Classes.

Hanee, J.A.J.

127p.

M.Sc. Degree, 2006.

Location No. 606

8.4

Addressing Students' Misconceptions in Some Selected Topics in G.C.E. Advanced Level Chemistry Syllabus.

Anoma, H.U.K.

69p.

M.Sc. Degree, 2012.

Location No. 1299

8.5

Alternative Ways of Teaching Basic Concepts of Environmental Chemistry for Advanced Level Students.

Lenora, R. Prabha P.

79p.

M.Sc. Degree, 2006.

Location No. 648

8.6

An Analysis of Misconceptions in Electricity among G.C.E. (A/L) Students.

Tennakoon, S.N.K.K.

78p.

M.Sc. Degree, 2011.

Location No. 1102

8.7

The Analysis of Problems in the G.C.E. (A/L) Chemistry Practical Work in Some Selected Schools in Batticaloa District.

Segar, S.

67p.

M.Sc. Degree, 2008.

Location No. 729

8.8

Analysis of Problems of G.C.E. A/L Science Students and Teachers in Conducting Projects and Suggestions for Overcoming.

Alahakoon, S.W.K.

67p.

M.Sc. Degree, 2004.

Location No. 563

8.9

Analysis of Water Quality in Tsunami Affected Areas: a Case Study to Enhance G.C.E. (A/L) Practical Skills.

Kariyawasam, L.M.

48p.

M.Sc. Degree, 2007.

Location No. 675

8.10

Analysis of Water Quality Using Bioindicators and Effective Usage of this Knowledge in the Teaching and Learning Process of A/L Biology Course.

Ratnayake, R.M.G.K.

116p.

M.Sc. Degree, 2006.

Location No. 604

8.11

Application of Active Teaching Learning Approaches in Science (ATLAS) for the Unit on "Man and Environment" in G.C.E. Advanced Level Chemistry Syllabus.

Yatigamma, S. Kumari

106p.

M.Sc. Degree, 2004.

Location No. 406

8.12

Application of Concepts of Equilibrium in Everyday Life.

Rupasinghe, R.A. Apsara

24p.

M.Sc. Degree, 2006.

Location No. 561

8.13

Application of Contemporary Education Strategies to Motivate Students' Interests in Studying Electrode Equilibria and to Develop Lifelong Learning Skills.

Dematage, N.

22p.

M. Sc. Degree, 2009.

Location No. 843

8.14

Application of Physico Chemical Principles in Industrial Chemistry.

Mukarram, M.L.M.

51p.

M.Sc. Degree, 2008.

Location No. 708

8.15

Assessing G.C.E. (A/L) Biology Students' Understanding of Environmental Issues Using a Two-Tier Diagnostic Test.

Vageesan, H.

165p.

M.Sc. Degree, 2011.

Location No. 1134

8.16

Assessing the Diversity of Woody Plant Species in Gannoruwa Forest and Preparation of Simple Teaching Aids for Teaching Ecological Diversity.

Weerasekara, W.M.N.

49p.

M.Sc. Degree, 1999.

Location No. 77

8.17

Assessment of a Modified Approach to Teach the Unit on 'Engages in Prevention of Diseases Associated with the Main System of the Human Body' of the G.C.E. (O/L) Syllabus.

Khan, S.K.M.A.

65p.

M.Sc. Degree, 2011.

Location No. 1197

8.18

Assessment of Conceptual Knowledge of G.C.E. Advanced Level Students Using the Force Motion Concept Inventory.

Jeganmohan, Nagarajah

69p.

M.Sc. Degree, 2004.

Location No. 440

8.19

Assessment of Practical Work in G.C.E. (A/L) Physics in Sri Lankan Schools.

Indralingam, Arumugam

46p.

M.Sc. Degree, 1999.

Location No. 117

8.20

An Attempt to Introduce Simple Experiment-Based Projects for A/L Agriculture Students.

Abeykoon, I.

45p.

M.Sc. Degree, 2005.

Location No. 562

8.21

Barriers of Teachers in Using Student-Centred Approach to Teach Seventh Grade Science.

Rajaguru, R.M.C.K.

61p.

M.Sc. Degree, 2012.

Location No. 1213

8.22

Bilingual Education in Sri Lanka: Perspectives of Stakeholders with Special Reference to Prospective Teachers in Science Education.

Polgampala, A.S.V.

51p.

M.Sc. Degree, 2011.

Location No. 1130

8.23

"BIOSTAT", a Computer Programme for Biostatistics Module for the G.C.E. (A/L) Biology

Bandara, R. M. P.

186p.

M.Sc. Degree, 2003.

Location No. 314

8.24

Building Students' Interest in Chemistry through Simple Experiments Using Household Chemicals.

Dissanayake, D.M.T.

54p.

M.Sc. Degree, 2010.

Location No. 1112

8.25

A Case Study of Strengths and Weaknesses of Advanced Level Science Education in Sri Lanka.

Saluwadana, S.M.

43p.

M. Sc. Degree, 2010.

Location No. 960

8.26

A Case Study on Feasibility of School Projects of the G.C.E. Advanced Level (Science Stream) Curriculum: Views of Teacher Community.

Vathanie, M.S.

62p.

M.Sc. Degree, 2009.

Location No. 850

8.27

A Case Study on Learning Physics through Problem Based Learning Approach.

Gunawardhane, V.D.K.

85p.

M. Sc. Degree, 2009.

Location No. 824

8.28

Case Study on School-Based Assessment in Physics in Learning Teaching Process in North Western Province.

Ranasinghe, J.I.

60p.

M. Sc. Degree, 2008.

Location No. 808

8.29

A Case Study on School Projects of the G.C.E. (A/L) Curriculum (Science Stream): Views and Constraints of Students.

Shiyana, M.Z.S.

67p.

M.Sc. Degree, 2009.

Location No. 849

8.30

A Colour Picture Guide on Fish and Fishing Gear Required for G.C.E. (A/L) Biology Students.

Dhanasekera, Deepika Prithini

118p.

M.Sc. Degree, 2003.

Location No. 269

8.31

Community Participation in Mosquito Control through Awareness Programmes.

Wimalawardhane, H.

42p.

M.Sc. Degree, 2001.

Location No. 157

8.32

A Comparative Study of Amylase Activity of Germinating Seeds of Mung Bean (*Vigna radiata L.*), Cowpea (*Vigna unguiculata L.*) and Soya Bean (*Glycine max L.*).

Bokalamulla, A. Ajantha Kumari

48p.

M.Sc. Degree, 1999.

Location No. 61

8.33

A Comparative Study of Student Performance on Theoretical and Practical Teaching Methodology Adopted in the Lesson on Traditional Food Preservation Techniques of G.C.E. (O/L).

Amaratunga, V.T.

44p.

M.Sc. Degree, 2013.

Location No. 1347

8.34

A Comparative Study of the Knowledge on Biodiversity in Town Schools and Village Schools in Kandy.

Manoharan, Subramaniam

59p.

M.Sc. Degree, 2004.

Location No. 315

8.35

A Comparison of Mathematical Skills and Numerical Problem Solving Skills of G.C.E. (A/L) Students Offering Chemistry.

Wijeratne, W.D.H.M.

108p.

M.Sc. Degree, 2005.

Location No. 444

8.36

Comparison of Performance at Solving Conventional and Conceptual Problems in Physics of G.C.E. (A/L) Students.

Sathar, A.L.S. Abthus

82p.

M.Sc. Degree, 2004.

Location No. 400

8.37

Computer Aided Learning (CAL): Multimedia Lesson for Electronics Unit in G.C.E. A/L Physics.

Perera, K.S.J.P.

30p.

M.Sc. Degree, 2004.

Location No. 445

8.38

Computer Aided Study Package for Effective Teaching of the Unit 2-Biodiversity in A/L Biology Syllabus.

Pushpika, A.

50p.

M.Sc. Degree, 2012.

Location No. 1212

8.39

Computer Assisted Programmes for Teaching Selected Topics in A-Level Chemistry.

Chandrasekera, M.

98p.

M.Sc. Degree, 2001.

Location No. 193

8.40

Computer Assisted Programmes for Teaching Selected Topics in A-Level Chemistry.

Wijethilaka, M.W.S.K.

62p.

M.Sc. Degree, 1999.

Location No. 58

8.41

Computer Assisted Teaching in Physical Chemistry Concepts for G.C.E. (A/L) Students.

Sahampath, J.A.A.

68p.

M.Sc. Degree, 2008.

Location No. 732

8.42

Computer Based Complementary-Learning Package in Rotational Motion for G.C.E. (Advanced Level) Physics Students.

Uruththiramoorthy, S.

109p. (Accompanying CD ROM available).

M. Sc. Degree, 2009.

Location No. 855

8.43

A Computer Based Self Learning Study Package for Understanding Orbital Behaviour in Chemical Bonding.

Kumanan, K.

29p. (Accompanying CD ROM available).

M. Sc. Degree, 2008.

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8.44

The Concept of Function in the Secondary School Mathematics Education in Sri Lanka.

Ranasinghe, R.A.A.S. Rohitha

68p.

M.Sc. Degree, 2005.

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8.45

Construction and Testing of a Supplementary Guide on Leafy Vegetables for Advanced Level Biology Teachers.

Fernando, S.P.

24p.

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Location No. 560

8.46

Construction of a Dual Purpose Digital Meter to Use in Physics Experiments.

Premalal, L.R.

41p.

M. Sc. Degree, 2008.

Location No. 828

8.47

Construction of a Low Cost Colorimeter and its Application in Teaching Colorimetry to A/L Students.

Waduge, Lalitha Kamal

62p.

M.Sc. Degree, 2001.

Location No. 190

8.48

Construction of a Low Cost Colorimeter and its Use for the Study of Equilibrium Phenomena.

Seneviratne, P. Champika

66p.

M.Sc. Degree, 2001.

Location No. 143

8.49

Construction of a Supplement Guide on Biodiversity (Unit II) for G.C.E. (A/L) Biology Students.

Kirupalamoorthy, Suganthy

38p.

M.Sc. Degree, 2001.

Location No. 146a (Research Report); 146b (Activity Guide)

8.50

Contribution to Mathematics Teaching at Senior Secondary Level via Error Analysis of Problem Solving in Mathematics.

Thiagarajah, T.

120p.

M.Sc. Degree, 2005.

Location No. 568

8.51

A Critical Analysis on Ancient Numerals.

Iqbal, S.S.J.M.

61p.

M.Sc. Degree. 2011.

Location No. 1109

8.52

A Critical Review of G.C.E. (A.L.) Physics Question Paper Administered in the Kandy Education Circuit at Grade 13 Level by the Provincial Education Department.

Rajakaruna, Padmini

62p.

M.Sc. Degree, 1999.

Location No. 56

8.53

A Critical Study on the Physics Question Papers Administered for the General Certificate Education (Advanced Level) Examination with a View to Making Recommendations for Quality Development.

Ratnasamy, M.S.C.

133p.

M.Sc. Degree, 2001.

Location No. 155

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Delivering Advanced Level Chemistry Curriculum (Unit One and Two) Using Information and Communication Technology: A More Effective Method of Teaching.

Kandekumbura, R.M.N.S.

59p.

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A Demonstration Experiment on Bernoulli's Principle for Advanced Level Physics.

Rajkumar, T.

32p.

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8.56

Demonstration Experiments for Teaching Magnetic Phenomena for G.C.E. (Advanced Level) Students.

Premakumara, V.S.

80p.

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Location No. 705

8.57

Demonstration Experiments with the Oscilloscope.

Karunaratne, K. B. J.

65p.

M.Sc. Degree, 1999.

Location No. 64

8.58

Designing a Teaching Methodology for the G.C.E. Advanced Level Biology Curriculum Based on a Section Evaluated as Disliked by Students.

Bandara, Sakunthala D.P.

56p.

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8.59

Designing Simple Activities in Fluid Mechanics for Easy Learning for G.C.E. A/L Students.

Balakrishnan, M.

80p.

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8.60

Determination of Factors Affecting the Performance of Students on the Subject Science at G.C.E. (O/L) Examination in Batticaloa District.

Jayakumar, Seenithamby

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8.61

Determination of the Relative Positions of Elements in the Electrochemical Series.

Chandrasena, W.D.

55p.

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8.62

Developing a Computer-Based Study Package for G.C.E. A/L Students on Matter and Radiation in Physics.

Arasakesari, Velauthar

93p. (Accompanying CD-ROM available).

M.Sc. Degree, 2005.

Location No. 450; 558

8.63

Developing a Novel Study Package for Learning Cell Biology (at the G.C.E. Advanced Level).

Amaratunga, A.A.D.D.

83p.

M.Sc. Degree, 1999.

Location No. 115

8.64

Developing a Supplementary Study Guide in Physics Application in Biology and Medicine for Intermediate Level Physics.

Prabaharan, D.

79p.

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8.65

Developing and Testing the Influence of Demonstrations in Teaching Electrostatic Unit for G.C.E. A/L Students.

Kumara, B.A.S.

69p.

M. Sc. Degree, 2010.

Location No. 1024

8.66

Development of a Computer Based Study Package: States of Matter for G.C.E. A/L Chemistry.

Laggoda, Saman Kumari

69p.

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8.67

Development of a Conceptual and Numerical Question Bank for the Testing of Students understanding in Physics.

Malavipathirana, P.

95p.

M.Sc. Degree, 2003.

Location No. 261

8.68

Development of a Study Package for Astronomy Education.

Koralagama, Priyanka Kumudinee

185p.

M.Sc. Degree, 2003.

Location No. 260

8.69

Development of an Experimental Package in Electrostatics for G.C.E. Advanced Level Students.

Wickramasooriya, D.T.

71p.

M.Sc. Degree, 2006.

Location No. 559

8.70

Development of Demonstration Experiment and Computer Based Test to Teach Rotational and Circular Motion.

Ariyasinghe, A.R.

61p.

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8.71

Development of Demonstration Experiments for Teaching Advanced Level Electricity and Magnetism.

Jayasekera, C.N

83p.

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Location No. 259

8.72

Development of Guidebook to Assist Successful Implementation of Advanced Level Projects.

Gamage, M.C.

43p.

M.Sc. Degree, 2005.

Location No. 566

8.73

Development of Human Resources in Science and Technology: Role of Universities.

Priyanthi, H.M.R.K.N.

93p.

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Location No. 650

8.74

Development of New Approaches in Teaching Thermochemistry.

Rasheed, Naseera Beevi Abdul

103p.

M.Sc. Degree, 1999.

Location No. 59

8.75

Development of Rapid and Cost Effective Propagation Techniques for Two Medicinal Plants *Cyperus rotundus* (Kalanduru) and *Phyllanthus debilis* (Ela Pitawakka).

Bodiabadu, D.C.

71p.

M.Sc. Degree, 2002.

Location No. 227

8.76

Development of Simple and Rapid Propagation Techniques for the Medicinal Plants (*Kaempferia galanga* L. and *Asparagus racemosus* Wild).

Senani, P.L.K.M.

54p.

M.Sc. Degree, 2001.

Location No. 192

8.77 Development of Some Demonstration Experiments to Teach Projectile Motion.

Ratnayake, P.L.N.A.
38p.
M.Sc. Degree, 2009.
Location No. 844

8.78 Differences in Knowledge Representation about Newton's Laws of Motion Between Two Groups of Physics Students.

Skantharajah, P.S.
345p.
M.Sc. Degree, 1999.
Location No. 57

8.79 Differential Effects Achieved Genderwise in Teaching Chemistry Using Macroscopic Method.

Salgadoe, A.V.C.
63p.
M.Sc. Degree. 2011.
Location No. 1105

8.80 Difficulties Encountered by Key Stage 3 Pupils of Akurana (Central Province) in Solving Numerical Division Problems with Special Reference to an Intervention Relating to Primary Mathematics Textbooks.

Nazeem, Mohamed
65p.
M.Sc. Degree, 2008.
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8.81 Difficulties in Learning Agriculture Science as a Subject in G.C.E. Advanced Level Class.

Senthilkumaran, Kanapathipillai
76p.
M.Sc. Degree, 2003.
Location No. 313

8.82 Diversity of Ferns at Upper Hantana: a Sample Ecological Study for A/L Biology Students.

Withanachchi, Indra
110p.
M.Sc. Degree, 2001.
Location No. 141

8.83

An Ecological Study of Grasslands at Horton Plains National Park.

Pushpalatha, W.R.D.M.U.

58p.

M.Sc. Degree, 2003.

Location No. 263

8.84

Ecology and Diversity of Woody Vegetation in Oruppreella Rain Forest, Kegalle District, Sri Lanka: a Preliminary Study.

Vitharana, P.R.K.A.

54p.

M.Sc. Degree, 1999.

Location No. 75

8.85

The Effect of Organic Fertilizers on the Growth of the Azolla Plant.

Upali, I.M.S.

52p.

M.Sc. Degree, 2001.

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8.86

The Effect of Student Centered Learning Including Criterion Based Assessment on the Performance of Students.

Yaparatne, Y.M.C.D.

56p.

M.Sc. Degree, 2006.

Location No. 605

8.87

The Effect of Wind Speed and Wind Directions on the Ventilation through Ridge Vent and Net Covered Side Vents in Single-Span Venlo-Type Greenhouses.

Warnakulasuriya, Sarath

62p.

M.Sc. Degree, 2003.

Location No. 317

8.88

An Effective Method for Teaching Organic Synthesis for G.C.E. A/L Students.

Vigneswaran, Nadarajah

120p.

M.Sc. Degree, 2007.

Location No. 691

8.89

An Effective Method of Teaching Thermochemistry.

Nawfal, Mohamed Mihlar Mohamed

90p.

M.Sc. Degree, 2001.

Location No. 134

8.90

Effective Ways of Teaching Periodicity, Patterns and the Properties of Some Elements.

Rajapakse, R.M.N. Wasantha

59p. (CD –ROM available in the office).

M.Sc. Degree, 2006.

Location No. 574

8.91

Effectiveness of Activity Based Learning in Teaching Biological Concepts to Primary Students.

Ravishankar, N.T.N.

103p.

M.Sc. Degree, 2012.

Location No. 1304

8.92

Effectiveness of Bilingual Education in Kandy District.

Athapattu, A.M.L.

37p.

M.Sc. Degree, 2013.

Location No. 1307

8.93

Effectiveness of 5E Instructional Method in Teaching and Learning Agriculture and Food Technology, G.C.E. (O/L).

Dharmadasa, H.K.D.L.

58p.

M.Sc. Degree, 2012.

Location No. 1220

8.94

Effectiveness of Information and Communication Technology Applications for Advanced Level Science Education.

Olagama, K.R.K.S.

106p.

M.Sc. Degree, 2008.

Location No. 709

8.95

Effectiveness of In-Service Teacher Training on Development of Secondary School Level Physics Education.

Wijayasiri, D.R.

87p.

M.Sc. Degree, 2013.

Location No. 1371

8.96

Effectiveness of Understanding Chemistry Concepts of Eighth Graders through Problem-Based Learning.

Wathurakumbura, S.K.

100p.

M.Sc. Degree, 2012.

Location No. 1300

8.97

Employment Status of G.C.E. A/L Biological Science Stream Students in Selected Provinces of Sri Lanka.

Amarasinghe, A.P.G.P.

76p.

M.Sc. Degree, 2008.

Location No. 707

8.98

The Enhancement of Experimental Aspects in Specified Practicals in G.C.E. (A/L) Chemistry.

Balachandran, T.

55p.

M. Sc. Degree, 2008.

Location No. 826

8.99

Enhancement of Learning through Problem-Based Learning.

Wattuhewa, Indra Sriyani

80p.

M.Sc. Degree, 2003.

Location No. 265

8.100

Enhancing Attitudes towards Conservation of Biodiversity among G.C.E. (A/L) Biology Students through Problem Based Learning.

Kandiah, T.

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Wijegunaratne, D.S.N.

177p. (CD-ROM available in the office).

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M.Phil. Theses

9.1

Analyzing the Ridge Regression Techniques Introduced for Solving the Problems of Multicollinearity.

Jahufer, Aboobacker

170p.

M.Phil. Degree, 2004.

Location No. 380

Abstract

Regression Analysis is one of the most widely used statistical techniques for analyzing multifactor data. Its broad appeal results from the conceptually simple process of using an equation to express the relationship between a set of variables. Regression analysis is also interesting theoretically because of the elegant underlying mathematics. Successful use of regression analysis requires an appreciation of both the theory and the practical problems that often arise when the technique is employed with real world data.

In the model fitting process the most frequently applied and most popular estimation procedure is the Ordinary Least Square Estimation (OLSE). The significant advantage of OLSE is that it provides minimum variance unbiased linear estimates for the parameters in the linear regression model.

In many situations both experimental and non-experimental, the independent variables tend to be correlated among themselves. Then inter-correlation or multicollinearity among the independent variables is said to exist. A variety of interrelated problems are created when multicollinearity exists. Specially, in the model building process, multicollinearity among the independent variables causes high variance (if OLSE is used) even though the estimator is still the minimum variance unbiased estimator in the class of linear unbiased estimators.

The main objective of this study is to show that the unbiased estimation does not mean good estimation when the regressors are correlated among themselves or multicollinearity exists. Instead, it is tried to motivate the use of biased estimation allowing small bias and having a low variance, which together can give a low mean square error.

In literature several biased estimation procedures were introduced for solving the problem of multicollinearity. Among them the biased regression technique namely, Ridge Regression Estimation, was first introduced by Hoerl (1964), and further developed by Hoerl and Kennard (1970a, b). Restricted Ridge Regression Estimation introduced by Sarkar (1992), Modified Ridge Regression Estimation introduced by Swindel (1976), Liu Estimation introduced by Liu Kejian (1993) and Restricted Liu Estimation introduced by S. Kaciranlar, G.P.H. Styan and H.J. Werner (1999) were frequently used biased estimation methods. These methods were rapidly developed in the recent years.

In this research work, five independent and one dependent standard normal pseudo-random (numbers) variables of multicollinearity-data were generated by using *Monte Carlo Simulation Study* with the correlation ($\rho = 0.9, 0.95$ and 0.99) between the independent variables. For the analysis 100 observations for each variable are generated and fit the model by using the above unbiased and biased estimation methods. The stochastic properties of these methods were

analyzed. The superiority of the biased estimation method is suggested and recommended to use and fit the model for the multicollinear real data.

9.2

Brain Computer Interface (BCI) Based on Electroencephalographic (EEG) Patterns due to New Cognitive Tasks.

Zahmeeth, S.S.

129p.

M.Phil. Degree, 2010.

Location No. 996

Abstract

Several new mental tasks were investigated to find their suitability in Brain Computer Interface (BCI). Electroencephalography (EEG) signals were collected after amplification while subjects were performing certain mental tasks. Later, collected EEG signals were analyzed to identify changes in EEG due to these mental tasks. Recordings were carried out using an electro-cap containing 20 EEG electrodes which were placed according to the standard 10-20 system.

Microsoft windows based software with user friendly features was developed for analyzing and classifying recorded EEG data. With this software, unnecessary frequencies were filtered out with Bandpass filtering. In order to identify the best feature vector construction for a given mental task, feature vectors were constructed using Bandpower, Principal Component Analysis, and Downsampling separately. These feature vectors were then classified with Linear Discriminant Analysis, Linear Support Vector Machines, Critical Distance Classifier, Nearest Neighbor Classifiers and their Non-Linear counter parts to find the best performing classifier.

For comparison purposes, performances of already well known mental tasks in BCI community were computed along with that of new mental tasks introduced in this thesis. In the preliminary studies it was found that most promising new mental tasks which could be identified by a BCI system is *imagination of hitting a given square by an imaginary arrow from above (or below) and right. (or left) to the screen.* The group of these mental tasks was named as "Hit Series" (HS). A detail investigation of HS was carried out and compared it with the performance of Motor Imagery (MI) events which are the most heavily used mental tasks in EEG based BCI systems.

One subject achieved the maximum average performance for HS, 100% in the binary classifications while 99% in overall combined performance. The best average performances of other two subjects for the same mental tasks were 93% and 87% with the over all performance of 89% and 78%. Performances of same three subjects for mental tasks in MI were relatively poor. The average performances were 92%, 78% and 92% while over all performances were 87%, 69% and 88%.

9.3

Improved Estimation of Parameters in Probability Distributions with Known Prior Information.

Laheetharan, A.

217p.

M.Phil. Degree, 2010.

Location No. 997

Abstract

In this thesis a study of the theoretical and practical aspects of the optimal shrunken

estimation for unknown parameters with known prior information, introduced by Searls in 1964 is undertaken. And consequently several authors Khan (1968), Gleser and Healy (1976), Arnholt and Hebert (1995) and recently Wencheke and Wijekoon (2005) have shown that a uniformly better (in the mean square error sense) estimator than the usual unbiased estimator can be constructed by considering the mean square error (MSE) of a constant multiple of the unbiased estimator when coefficient of variation is known.

This work mainly concerns with the results presented by Gleser and Healy (1976) as well as Arnholt and Hebert (2001), whose results have been generalized in this study to the problem of estimating an unknown parametric function or vector, through certain criterion. The classical problem of estimating an unknown parameter is generally solved by using the minimum mean squared error (MMSE) estimator, and this research also adopts this approach, and demonstrates analytically since the found techniques perform the optimum method in terms of mean square error (MSE). Then the methods for finding these estimators are discussed and it is demonstrated that the proposed estimators outperform the optimum approach in many cases.

A shrinkage framework to perform optimal estimators of parameter estimation is presented in the literature. The formulation allows the incorporation of existing prior information on the probabilistic models in a consistent way. The method is based on the classical approach that allows a straightforward utilization of the prior information. This resulted in an extension of the shrinkage technique which forms the main body of this work. This novel technique is referred as *optimal shrinkage estimation (OSE)*.

It is shown that mean square error optimal shrinkage estimation (MSE-OSE) method is a simple, flexible, and attractive OSE-method. The MSE-OSE method is simple because it is based on the well-known principle of parameter estimation. In this MSE-OSE method, the estimation of the parameters is based on sufficient statistic of parametric (probability) models. The method is flexible as it works with a user-defined known constant (k). Different scalar classes can be considered but they all automatically lead to a unique OSE of parameters. Using this method, the uniformly minimum mean square error (UMMSE) estimator $k(k^2 + \tau^2)^{-1} \phi(T(X))$ of parameter $g(\theta)$ can be obtained by choosing the complete sufficient statistic $T(X)$ as the estimator class of the parameter θ , when the ratio known as "WJLA" ratio, $\tau^2 = [g(\theta)]^2 \text{Var}[\phi(T(X))]$, is independent of θ . Further, the result of combining estimators for $g(\theta)$ is presented when θ has more than one sufficient statistic.

Using these results the OSE in a certain class for both population mean and variance of some probability distributions can be obtained when additional information such as coefficient of variation, kurtosis or skewness is known. It is proposed that a general OSE for natural exponential families with quadratic variance functions covers the binomial, Poisson, negative binomial, gamma, and generalized hyperbolic secant distributions. The mean square errors of these estimators were compared, and a numerical illustration has been done using the scaled mean square error loss as used by Kanfuji and Iwase (1998) to understand the efficiency of the estimators with increasing sample size. Finally, an estimation of parameter vector as an extension of the estimators in the univariate parametric model is derived by applying the ideas mentioned above to estimators in the multivariate parametric model. Therefore, by using this result, the OSE for mean vector of some probability models is found when multivariate coefficient of variation is available.

9.4

Improved Methods of Mixed Estimation in Linear Regression Model.

Hubert, Mariathas H.

143p.

M.Phil. Degree, 2006.

Location No. 536

Abstract

In this research work the estimation of coefficient vector and the superiority of the derived estimators in a multiple linear regression model under several circumstances are discussed. If only the sample information of the 'standard multiple linear regression model is available, then the estimator due to GAUSS or AITKEN is most favorable, that is, Ordinary Least Square Estimator (OLSE) is the best linear unbiased estimator of the parameter vector, when the regressor matrix is assumed to be full column rank matrix. However, in many estimation problems, often one can give auxiliary information or prior information in addition to the sample, which can be either exact or stochastic, about the unknown parameter via the routes of postulation, experimentation or past sample data which improves the linear models. Therefore, in the presence of stochastic prior information in addition to the sample, Thiel and Goldberger (1961) introduce a Mixed Regression Estimator (MRE) procedure for the parameter vector in the linear regression model. Several statisticians compared these two estimators MRE and OLSE and showed the superiority of the MRE over the OLSE under certain conditions.

Apart from this, recently, Liu Kejian (1993) introduced an alternative ridge type biased estimator to combat near multicollinearity, which is called Liu Estimator of the parameter vector, based on OLSE. Selahattin Kaciranlar, Saullah Sakallioglu, Fikiri Akdenz, George Styan and Werner (1999) introduced another new biased estimator called Restricted Liu Estimator (RLE) by augmenting the Restricted Least Squares Estimator (RLSE) and showed the superiority of the Restricted Liu Estimator (RLE) over the OLSE and Liu Estimator (LE).

In this research a new biased estimator called Stochastic Restricted Liu Estimator (SRLE) for the parameter vector was introduced and consequently its efficiency was discussed. In particular, stochastic properties of the newly introduced Stochastic Restricted Liu estimator were discussed and also the necessary and sufficient conditions for the superiority of the Stochastic restricted Liu estimator (SRLE) over the other alternatives were derived in the mean squared error matrix sense as well as scalar mean squared error sense by considering the two cases; correctly specified stochastic restrictions and incorrectly specified stochastic restrictions.

Generally, it is possible to divide every, stochastic prior information, which consists of more than one row, into two or more subsets of information. On this regard attention was also focused on the Stochastic Restricted Liu Estimators based on competing stochastic restrictions which outperform Liu estimator with respect to the mean squared error matrix criterion. Two estimators were proposed and efficiency properties of this estimation procedure were analyzed. Conditions for superiority of one Stochastic Restricted Liu Estimator over another were derived with respect to the mean squared error matrix criterion.

Special attention was also given to the use of correct and incorrect prior information in the estimation of regression coefficients when the regression model is misspecified due to exclusion of some relevant explanatory variables. Analysis of misspecification was extended to Liu estimator, and the superiority of Liu Estimator over Ordinary Least square Estimator was discussed. The results were further extended to the Stochastic Restricted Liu Estimator based on correct and incorrect prior information, and the resulting estimator was compared with that Liu estimator. It demonstrated that the stochastic restricted Liu estimator is still superior to the Liu estimator with respect to the mean squared error matrix criterion under certain conditions.

When collecting data, one is confronted with the problem of incomplete data sets. In such cases missing data may have a strong influence on the statistical analysis of the remaining data set. Several methods have been developed for handling missing values in the regression matrix, and the efficiency of the corresponding estimators has been investigated. In this study Stochastic Restricted Liu Estimator (SLRE) was applied under the complete case analysis for analyzing incomplete data sets, and the resulting estimators were compared.

Prediction of a study variable is an important aspect of regression analysis. As far as linear regression as the underlying model is concerned, the monograph of Bibby and Toutenburg (1978) was devoted to the problem of best predictors as well as to investigation of regions where one predictor improves another. One of the main aims of this research work was to examine the superiority of the Stochastic Restricted Liu Predictor (SRLP) over the Liu predictor (LP), and concluded that there were situations where the Stochastic Restricted Liu predictor outperforms the Liu predictor with respect to the mean squared error matrix criterion even the model was misspecified.

Finally, MATLAB software package for windows was used to analyze some theoretical results obtained in this study using the data set on Portland cement considered by Woods, Steinour and Starke (1932).

9.5

An Intelligent Weather Forecasting System for Sri Lanka.

Kalupahana, Sumudu S.

93p.: Accompanying CD-ROM available.

M.Phil. Degree, 2007.

Location No. 636

Abstract

Over the past two decades, there has been a substantial increase of understanding how satellite meteorological data can be used to estimate rainfall, Nevertheless, despite the use of interactive computer systems, the time required to produce rainfall estimates typically exceeds half an hour. Moreover, the average error for rainfall events is about 30%. Considering these facts, learning capabilities of neural network models and the state-of-the-art technology, force to investigate applications of neural network models in weather forecasting. There have been numerous research done on the related theme, but the approach taken here is new.

Proposed intelligent weather forecasting system is based on artificial neural networks (ANN), the inputs and outputs are the past experience (daily real rainfall figures in previous years and corresponding daily radiosonde data collected from the weather balloons). More explicitly, daily input data for the proposed ANN are an array of height, temperature and dew points at certain pressure levels while the output being the rainfall estimates and the error within the certain period of analysis. During the learning, it is necessary to store as much previous experience as possible in order to predict the actual weather forecast with the available data or partially available data.

There are free analytical software tools to train and manage such neural networks but they are built by research institutes for research purposes therefore not specific for weather but with ability to cater for any general environment. Therefore we could still chose to use these tools with our proposed model or use the final product (LIWPAT) which is designed to handle the entire forecasting process including data management.

The ANN approach is applied for weather forecasting in order to achieve results faster than the conventional methods at the same time minimizing the error. The accuracy of the model will

grow in time as its self evolving, considering the present data as past experience, every day.

9.6

Ontology Driven Clinic Management for Sri Lankan General Hospitals.

Rathnayake, R.M.N.B.

115p.

M. Phil. Degree, 2013.

Location No. 1339

Abstract

In healthcare domain, there are many different healthcare providers who offer healthcare services to patients. When a patient attends a clinic, medical officer may need some of the other healthcare services from different healthcare and related service providers which results in several actor involvements in clinic processes. In an environment, where healthcare clinic management systems (HCMS) are operated, a complex multi-actor network could be noticed. As a result of these interactions within this multi-actor network, a complex, multi-party collaborations are needed to be considered in designing and developing. This thesis proposes a layered designing approach starting from Healthcare Activity, Healthcare Transactions and Healthcare Binary Collaboration to model Multiparty Healthcare Collaborations in the healthcare domain. The final multiparty collaboration was composed with several binary collaborations and governance by governing binary collaboration between Patient and Medical Officer. And another issue in the healthcare domain is that healthcare service providers utilize Information Communication Technology (ICT) applications developed on different technical platforms to deliver their services. Further, there are different legacy healthcare applications that operate in isolation. Most of these ICT applications are inter-dependent on the outcome of each other (legacy sub-systems) in the process of provisioning curing services towards patients, often resulting in interoperability issues between legacy applications.

This research work proposes one of the solutions for the above issue that is the development of a sharable, complete and sound healthcare ontology. This could be considered as a positive initiative in the healthcare domain to solve issues of existing ICT applications and to support the development of new applications for healthcare domain that ensures smoother interactions between all these application categories via shared domain ontology. Another contribution of this research is to facilitate the designing of healthcare collaborations. A set of pre-defined transaction patterns is proposed to assist developers in modeling healthcare collaborations.

The three fold classification schema developed in this research can identify all the actors, activities, documents and facility of future expansions in the healthcare clinic domain. Proposed phase-wise layered approach can capture bi-directional feasibility of the e-healthcare applications and can facilitate the adaptation of "separation of concerns" with any technological platform when developing e-healthcare system.

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Time Series Model for Traditional Export Income in Sri Lanka.

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An Automated Paddy Variety Identification System.

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Automatic Measurement of Average Length of Coconut Fiber.

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Avquick Meta Search Engine for Quick Audio Visual Searching.

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Biomechanical Movements of a Humanoid Robot and Force Analysis.

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Classification of Brain Computer Interface Data Using Formant Analysis.

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Construction and Performance Evaluation of Multicore Workstation Cluster Under Windows And Linux Operating Systems.

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Content Based Image Retrieval System.

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Content Based Image Retrieval System by Clustering.

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Counting Coconut Mites Using Digital Image Processing.

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Create an Efficient Keyboard Driver to Minimize Sinhala Typing Errors.

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Database Administration via Short Message Service.

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Decision Support System for the Management of Patients with Community Acquired Pneumonia.

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Design and Implementation of an Automatic People Identification System Using Fingerprints.

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Design and Implementation of Role-Based Access Control in Health Care System.

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Design of an Inventory Control System for Value Added Tea Industry.

Wanigasekara, W.M.C.B.B.

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Designing a Role Based Access Control System Using Design Patterns.

Wanigasekera, W.M.J. Priyalal

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Detecting Faces in Arbitratory Images Using a Sample Technique.

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Detection of Alveolar Crestal Bone Loss and Tooth Length from a Radiograph in Dental Practice Using Digital Image Processing.

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Determination of the Performance of a Beowulf Cluster by Modelling the Heat Transfer in Parallel through a Two-Dimensional Body.

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Developing a Web Based Student Information System for the University of Vocational Technology.

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Developing an Online Shopping Cart System for Saweena Beauty Centre.

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Development of Spatial Database for Coastal Resource Profile (CRP) of Sri Lanka.

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Development of Web Based Aptitude Test System for the Post Graduate Institute of Science (PGIS) University of Peradeniya.

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Facial Expression Recognition System.

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Feature Extraction and Classification of Sinhala Fonts.

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Fingerprint Image Enhancement Method Using Chain-Code Based Orientation Estimation and Directional Median Filter.

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Free and Open Source Spam and Virus Filtering Gateway for Remote Mail Transfer Agent.

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Generation of Visual Characteristics of Humonoid Robots Using a Graphics Animator.

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Global Position Tracking System for Public Transportation in Sri Lanka.

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Global System for Mobile Communications Short Message Service Based Automated Credit Information System.

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Graph Colouring Model for Timetabling Problem.

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"GRK_TXedt" - Tamil TEX Editor for Scientific Typesetting and for LAT_EX Output.

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Hand Written Character Recognition Using Image Processing and Artificial Neural Network Techniques.

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Hospital Management System.

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Identification of the Human Race Using Skin Color (HRI-System).

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Identity Authentication Based Keystroke Latencies.

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Image Classification of Paddy Field Insect Pests Using Gradient-Based Features.

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Image Processing Routines for an Automated Security System.

Perera, L. S. K.

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Image Steganographic Scheme Based on Reversible and Inverse Embedding Strategies.

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Implement a Model to Reserve Mobile Numbers in an Efficient Manner for a Telecom Service Provider.

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An Improved Steganographic System for PCs and Mobile Devices.

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Improving the User Friendliness of Tamil Web Browsing.

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Influence the Performance and Energy Consumption of Modern Storage Devices by Reevaluating Input/Output Architecture for Green IT.

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Information Management System for Energy Purchase in Ceylon Electricity Board.

Hemantha, J.B.M.

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Information Management System for Trincomalee Multipurpose Cooperative Society Sri Lanka.

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Information Management System for Universities.

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Information System of Payroll Management for Lankem Plantations Ltd.

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Integrated Solution to Monitor and Audit Network for IT & Non-IT Personnel (Development of a Friendly Prototype).

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Intelligent Chat Bot for Chatting with People Having Stress and Depression.

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Introducing Tamil Language in Computer Assisted Learning Software.

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A Keyboard Configuration for Tamil Unicode Characters.

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LANManager: A Concurrent Management of Computers in LANs.

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Library Management System in Tamil Using Barcode.

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9.196

Management Information System for Agricultural Product Export Company.

Karunarathne, S.H.R.V.

74p.

M.Sc. Degree, 2013.

Location No. 1364

9.197

Measuring Damages and Colour Regions in Tree Leaves Using Image Processing Techniques.

Wakkumbura, Mapa

39p.

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9.198

Medical Information Management System for Vavuniya General Hospital.

Selvarangini, A.

70p.

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9.199

MESH Network for Software Process Modeling (MNSM).

Priyadarshani, W. P. Eureka

28p.

M.Sc. Degree, 2002.

Location No. 255

9.200

Mobile Access Asset Control System.

Wijekoon, W.H.M.P.P.B.

39p.

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Location No. 1358

9.201

Mobile Application for Academic Library Services.

Adikari, A.B.

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9.202

Mobile Based System for Providing Road Traffic Information.

Satharasinghe, C.H.

80p.

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9.203

Multi Agent System for Cooperative Tasks.

Rathnayake, R.M.C.A.B.

57p.

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9.204

Natural Language Question Answering System for Locating Resources in an E-Library.

Jahan, M.A.C.A.

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9.205

Network Based Distributed Intelligent Intrusion Detecting System.

Kariapper, R.K.A.R.

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M.Sc. Degree, 2010.

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9.206

Network Enabled Energy Measuring System.

Perera, W.N.C.

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Location No. 1012

9.207

Neural Network Approach to Predict Milk Yield of Dairy Farm.

Gamlath, N.J.

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Neural Network Based Reverse Engineering Approach to Recognize Printed Sinhala Script.

Gunasena, S.L.

51p.

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9.209

Neural Network Model for Estimating the Emission of Greenhouse Gases in Ecosystem with Soil Factors.

Gunasinghe, E.S.A.

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A New Information Technology Approach to TELCO Revenue Assurance.

Walpola, Jayantha

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Objects Indexing and Cut-Out in a Sequence of Frames.

Aravinthan, S.

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9.212

Offline Sinhala Handwritten Character Recognition Using Matrix Matching Method.

De Silva, D.P.H.R.

81p.

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9.213

Online Bibliographic Database for Eastern University Library Sri Lanka.

Christopaul, B.

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Online Internal Verification System for EDEXCEL HND Programs.

Premakumar, P.P.

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Online Mail Tracking System.

Hettige, H.D.S.N.

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Online Orientation System for the Open University of Sri Lanka.

Halkewidana, H.D.A.W.

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Samarasinghe, S.M.N.

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Online Student Registration System with SMS Based Course Management.

Jayawardane, D.N.

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Online System for Exam Registration and Results Processing.

Deepani, P.A.C.

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An Online System to Analyse Production Faults by Using Process History Data.

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Online Vehicle Reservation and Monitoring System for the University of Peradeniya.

Wataketiya, W.W.C.N.

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Ontology Based Information Extraction for Disease Intelligence.

Abeywardana, P.C.

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Optical Character Recognition (OCR) System for Printed Tamil Text Using the Unicode Standard.

Uwais, M.M.M.

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9.224

Optical Character Recognition Using Image Processing and Artificial Neural Network Techniques.

Kodikaraarachchi, Jayantha Chandralal

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9.225

Optimum and Shortest Way Finder.

Jayasinghe, J.A.G.N.

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9.226

Performance Analysis of a Small Low Cost Beowulf Cluster with Mathematical Modeling in a Parallel Computing Environment.

Herath, H.M.A.K.B.

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9.227

Performance Analysis of Coda File Systems.

Ratnayake, R.M.N.B.

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Performance Analysis of Existing Public Key Cryptosystems.

Megasooriya, C.S.

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Performance Evaluation and Comparison of Java RMI, RMI-IIOP.

Ekanayake, E.W.M.G.W.S.G.B.

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Performance Study of Software Quality Management Techniques.

Uduwela, R.A.

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Physical Quality Estimation of Rice by Image Processing.

Sirisumana, D.P. Kanchana

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Plagiarism Detection on Electronic Submissions of Text Based Assignments.

Jiffriya, M.A.C.

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Platform Migration Project for Bio Foods (Pvt.) Ltd.

Subasinghe, S.A.S.S.

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9.234

Predicting a Suitable Path for Ordinary Level Students.

Priyadarshani, W.A.S.

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Location No. 1298

9.235

A Profiler for Testing Java Programmes (Profiler Agent and Graphical User Interface).

Palliyaguruge, P. S.

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9.236

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Weerakoon, Nishantha Sripali

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Querying Database in Natural Language.

Tharmaseelan, Sivapathasundram

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9.238

A Reference Model for Disease Surveillance System.

Fernando, Y.D.

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9.239

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Samarakoon, A.S.D.R.S.

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Regulatory Framework for Near Field Communication (NFC) Based Mobile Payments in Sri Lanka.

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9.242

Remote Monitoring Loan Management System.

Bandara, L.R.C.U.

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Results Management System for the Faculty of Science of the University of Peradeniya.

Somaratne, O.S.R.

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9.244

Role Model Design and Implementation using a Set Approach.

Rizath, M.H. Mohamed

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A Schema Driven Mapping: Managing XML in Object-Relational database.

Kanagasabapathy, P.

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School Information Management System.

Umakajan, S.

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9.247

Semi-Automatic Online Examination System with SMS Notification for Essay and Structured Type Questions.

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9.248

Semi - Intelligent SQL Querying System.

Jayasundara, J.M.G.I.C.

41p.

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Location No. 624

9.249

Solving Shortest Path Problem Using Genetic Algorithms.

Jayasooriya, C.I.E.

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Location No. 625

9.250

Source Code Generator to Invoke Apache AXIS2 Web Service.

Ranaweera, R.R.M.P.

50p.

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Location No. 1235

9.251

A Study of Security Weaknesses of IEEE 802.11b and a Solution to improve its Security.

Bandara, H.M. Anura

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Location No. 338

9.252

Subscriber Management System for Customizable Customer Relation Management.

Jayaweera, J.P.R.R.S.

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Location No. 1191

9.253

A Supporting Tool for Teaching Data Structures and Algorithms.

Warusavithana, R.C.

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Location No. 1224

9.254

Tamil Search Engine for Unicode Standard.

Mansoor, C.M.M.

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Location No. 879

9.255

Time Sheet and Human Resource Management System for "Bizycorp (Pvt.) Ltd".

Mafas, M.

134p.

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Location No. 1319

9.256

A Tool for Testing Java Programs.

Samarasinghe, Sisira J.B.

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Location No. 478

9.257

Tools Support for Design Pattern.

Wijekoon, Chandana P.K.

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9.258

Tracking Moving Objects and Reconstruction in 3D Space.

Peiris, P.S.R.

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Location No. 483

9.259

Transliteration Keyboard Configurations for Sinhala and Arabic.

Kidhumathullah, M.M.

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9.260

University Time Table System.

Wijayakoon, W.M.S.K.V.

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Location No. 484

9.261

A University Timetabling System Based on Graph Colouring and Constraint Manipulation.

Liyanage, P. Udayanganee

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Location No. 476

9.262

Usage of Shortest Path Algorithm to Find the Most Effective Path.

Karunaratne, G.C.

80p.

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Location No. 742

9.263

Use of Image Enhancement Techniques to Assist Diagnosis of Heart Enlargement.

Ranasinghe, Amal Kaushalya

42p.

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Location No. 279

9.264

User Dependant Speech Based Lip Synchronization.

Wickrama, S.M. Inosha

55p.

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Location No. 626

9.265

Utilization of Game Theory in Computer Security as Applied to Intrusion Detection System.

Zainudeen, N.H.

37p.

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Location No. 1205

9.266

Vehicle Navigation System Based on Shortest Path.

Weerasinghe, W.D.C.

44p.

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9.267

Visual Programming Language for Java.

Sumanasinghe, D.N.

48p.

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Location No. 793

9.268

Web Based Automated System for Nurse Scheduling.

Kumara, B.T.G.S.

53p.

M.Sc. Degree, 2010.

Location No. 980

9.269

Web Based Evaluation System for Department of Technical Education and Training.

Withanachchi, S.J.

52p.

M.Sc. Degree, 2011.

Location No. 1192

9.270

Web Based HR System and Payroll System for Green Apparel (Pvt.) Ltd.

Perera, M.N.S.

147p.

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Location No. 1350

9.271

Web Based Information Management System (IMS) for a Research Institute.

Thotawatthage, C.A.

56p.

M.Sc. Degree, 2013.

Location No. 1361

9.272

Web Based Information System for the Provincial, Zonal and Divisional Education Offices of Central Province.

Sirajudeen, H.L.

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Location No. 1089

9.273

Web Based Project Monitoring System.

Jeewantha, W.M.D.

46p.

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Location No. 978

9.274

Web Enabled Bandwidth Prioritizing in Squid Cache without Disturbing Existing Connections.

Amarakeerthi, H.K.S.

38p.

M.Sc. Degree, 2006.

Location No. 519

9.275

A Wheel-Based Side-View Car Detection Using Snake Algorithm.

Vinotharan, V.

36p.

M.Sc. Degree, 2013.

Location No. 1351

9.276

Windows Based Multi User Computerized Government Payroll Management.

Watagoda, R.I.

36p.

M. Sc. Degree, 2009.

Location No. 890

10 - ZOOLOGICAL SCIENCES

Ph.D. Dissertations, M.Phil. Theses and M.Sc. Project Reports

Ph.D. Dissertations

10.1

Aspects of the Ecology and Morphotaxonomy of Cattle Ticks (Acari: Ixodidae) in Sri Lanka.

Dilrukshi, P.R.M.P.

375p.

Ph.D. Degree, 2004.

Location No. 387

Abstract

A two year study was done on the ecology and morphotaxonomy of cattle ticks in different agro-climatic areas of Sri Lanka, encompassing localities at low elevation dry and wet zones, and mid country and montane wet zone. A total of 164,483 ticks were collected from 1,240 head of sampled cattle. The most abundant species was *Boophilus* sp. (Curtice, 1891), followed by *Haemaphysalis bispinosa* (Neumann, 1897), *Rhipicephalus haemaphysaloides* (Supino, 1897), *Haemaphysalis intermedia* (Warburton and Nuttal 1909), *Hyalomma brevipunctata* (Sharif, 1928), *Hyalomma marginatum isaaci* (Sharif, 1928), *Amblyomma integrum* (Karsch 1879), and *Haemaphysalis spinigera* (Neumann, 1897).

Hy. brevipunctata was recorded for the first time on neat cattle in Sri Lanka. Keys for identification of adult and immature stages of cattle ticks were produced. Multivariate analysis of metric and descriptive character sets showed overlapping geographic variability in *Boophilus* sp. and *R. haemaphysaloides*, whereas *H bispinosa* segregated into three disjunct populations indicative of the possibility of three distinct species. A protein profile study of *Boophilus* sp. and *R. haemaphysaloides* adult stages showed similar geographic variability as seen in the morphometric analysis. The overall tick load on the host was significantly negatively correlated with elevation, with greatest abundance at low elevation dry and wet zone localities.

Population peaks of varying periodicities and amplitudes were observed in the different species at different localities. Stepwise multiple regression analysis of tick abundance against 10 climatological variables indicated that daily temperature may have an important impact on seasonal abundance trends, appearing as a significant covariate for *Boophilus* sp., *H intermedia* and *R. haemaphysaloides*. Individual tick species aggregated preferentially on different body regions of the host, and significant positive and negative inter-species associations were seen on different body regions. Cattle tethering strategies, acaricide use and the presence of other peridomestic animals all had impacts on cattle tick loads.

Nymphs of *Amblyomma integrum* were primarily responsible for a human otoacariasis outbreak within a low country wet zone area, which resulted in infestations of more women than men, and more children (1-10 years age), and adults (>21 years age) than the intermediate age group (11-20 years).

 10.2

Aspects on Biology and Ecology of *Acavus* Species in Sri Lanka.

Krishnarajah, S. Rasiyah

306p.

Ph.D. Degree, 2005.

Location No. 553

Abstract

Super family Acavoidea has a Gondwanaland type geographic distribution, and is represented in Sri Lanka by a single genus *Acavus* with four or more arboreal species and three uncertain taxa. This study includes species differentiation based on shell morphology, morphometric analysis, ecological distribution and internal anatomy of the penial complex.

The detailed study regarding the Biology of *Acavus haemastoma* has shown that it is active mainly at night. This species is however active by day during moist and cool periods. During inactive periods, it is found in aggregates mainly on the trunk, and the under surface of the leaves of *Areca catechu* L., and on trunks of other tree species.

There is a relative correlation between the shell length and peristome diameter until the commencement of lip formation. Three phases are recognized in the development of the shell: a juvenile phase (approximately 6 months), sub-adult phase (6-7 months) and lip formation phase (four months).

Food generally comprises lichens, mosses, fungi and dead soft plant materials. In the laboratory soft succulent plant materials are preferred. Young snails on hatching are sometimes seen feeding on broken eggshells.

Reproductive period of hermaphroditic *A. haemastoma* begins with the onset of rainfall and lasts throughout the season with repeated mating activity. During the reproductive period a snail produces 2-4 eggs $10.5 \pm 0.5\text{mm}$ in length, weighing of $1.02 \pm 0.25\text{g}$. Eggs are laid on the soil at the base of trees. Incubating takes about 30 days. Newly hatched snails measuring shell length $5.54 \pm 0.75\text{mm}$ move on to the trees.

Acavids are found in a limited range of altitudes both in the intermediate and wet zones of Sri Lanka. *A. phoenix* has the broadest distribution in both climatic zones. *A. haemastoma*, is restricted to southern maritime areas and interior regions and is sympatric with other three Acavid taxa. Geographic ranges of the four Acavid taxa, are sympatric in lower Udugama in the Galle district.

The main anthropogenic threats to Acavids are the clearing of habitats, collection for limited use in unauthenticated traditional medicine, and collector's items. *A. prosperus*, *A. haemastoma concolor* and *A. haemastoma conus* are potentially endangered and require immediate conservation measures. The genus *Acavus* in Sri Lanka is an example of a paleoendemic and biogeographically significant mollusc, which is worthy of further study and conservation.

 10.3

Ecology and Biodiversity in an Irrigated Rice Field Ecosystem.

Bambaradeniya, Channa Nalin Bandara

503p.

Ph.D. Degree, 2000.

Location No. 55

Abstract

The study on the ecology and biodiversity of a rice field was carried out in two irrigated rice fields located at Bathalagoda in the Kurunegala District. The overall objective was to study the ecology and biodiversity associated with the irrigated rice field ecosystem, in order to understand their role in the conservation and sustenance of the rice agroecosystem. The two rice fields, designated "Research field" and "Farmer field", respectively, differed in agricultural practices. The rice field floodwater, soil and vegetation were sampled to document and quantify certain water quality parameters, aquatic and terrestrial fauna and flora. Field sampling was carried out at fortnightly intervals during five consecutive rice cultivation cycles. Detailed investigations on the floodwater chemistry, the species composition, abundance, diversity and seasonal variation of fauna and flora in the two rice fields were carried out. Temporal and spatial variations of rice field biodiversity were determined using terrestrial arthropods as a surrogate group. The impact of different agricultural practices on the rice field biota were also examined. The overall biodiversity documented during the study consisted of 494 species of invertebrates of which 82% were arthropods, 103 species of vertebrates of which most were visitors dominated by birds. Flora consisted of 89 species of macrophytes representing rice field weeds, 31 genera of microphytes and three genera of macrofungi. The aquatic/benthic invertebrates recorded included 179 species, belonging to five major communities, namely neuston, zooplankton, nekton, periphyton and benthos. Terrestrial arthropod fauna comprised 280 species of insects and 60 species of arachnids. The contribution of arthropod biodiversity towards natural biological control in the rice agroecosystem was evident from the rice pest to natural enemy species ratio of 1 : 3.5. The weed flora included 42 species of monocotyledons, 45 species of dicotyledons and 2 species of pteridophytes. The aquatic weeds together with the aquatic microflora constituted the photosynthetic aquatic biomass which contributed to a high primary production in rice fields. The fauna and flora in the rice field showed a uniform pattern of seasonal colonisation and succession during each rice cultivation cycle. The terrestrial arthropod diversity gradually increased with the progress of the crop cycle, in the rice as well as in the non-rice bund habitat, while fluctuations occurred in relation to pesticide applications and weed management practices. The arthropod diversity was not significantly different between two consecutive annual rice growing seasons, at each rice field. However, a significantly higher terrestrial arthropod diversity was observed at the Farmer field, where the pest and weed management practices were relatively less intense, in comparison to the Research field. Agronomic practices associated with rice cultivation effected different rice field biota in different ways. Biocides adversely affected rotifers, cladocerans, aquatic insects, benthic oligochaetes and terrestrial arthropod natural enemies. Nitrate fertiliser applications showed a stimulatory effect on rotifers, cladocerans, oligochaetes and adult aquatic insects, while the molluscs were adversely affected. Intense slashing of weeds in bunds was detrimental to the predatory spiders. Preparation of fields by tractor caused heavy mortality to aestivating amphibians. Physico-chemical parameters of water such as temperature, pH and DO showed marked fluctuations, both diurnally as well as seasonally, while nitrate, phosphate and conductivity levels fluctuated in relation to fertiliser inputs. The floodwater pH, DO, BOD and temperature decreased significantly with the progress of the crop cycle. The floodwater DO showed a significant increase with rainfall. The adult aquatic insects showed a significant increase with increasing nitrate levels, while the aquatic molluscs showed a negative relationship with floodwater pH. The rotiferans increased significantly with increased floodwater DO. The species richness of weeds in the rice as well as the non-rice bund habitats showed a significant increase with the progress of the season. Minimal use of pesticides, maintenance of refuges of natural enemies (especially the bunds covered with weeds), landscape planning and management aimed at harbouring a rich biodiversity, and the development of an efficient system of extension to educate rice farmers on integrated pest management (IPM) strategies with emphasis on

natural biological control of insect pests, can be recommended as means of conserving and sustaining the rice field agroecosystem through its rich biodiversity.

10.4

The Ecology and Social Biology of a Selected Population of the Western Purple-Faced Leaf Monkey (*Trachypithecus vetulus nestor* = *Presbytis senex Nestor*).

Dela, Jinie Dhanika Shirindra

473p.

Ph. D. Degree, 1998.

Location No. 05

Abstract

This study is based on field research on the ecology and social biology of a selected population of the western purple-faced leaf monkey (*Trachypithecus vetulus nestor* = *Presbytis senex nestor*) living in human modified environments carried out by Jinie Dhanika Shirindra Dela. This thesis is submitted in candidature for the degree of Doctor of Philosophy, through the Board of Study in Zoological Sciences, University of Peradeniya.

Data presented here were collected from February 1985 to October 1992, including a survey of seven sites to gather information on troop size and structure and a systematic investigation of feeding, ranging and social behaviour (connected with social organisation) of two troops at Panadura and Piliyandala from August 1985 to February 1987, during five-day monthly sample periods using the scan sampling method.

At both sites, trees ≥ 30 gbh were sampled using contiguous 0.25 ha quadrats and phenological data were collected monthly-during the behavioral study. Monkey-human interactions were investigated through direct observations and administering a questionnaire.

There were fine differences between the study sites in terms of land use, species richness and diversity, species composition, vegetational heterogeneity and temporal fluctuations in the production of seasonal plant parts. Over 98% of the diet of both troops was on plant matter, of which >50% was on fruit. Leaf intake was less than 40% and comprised mainly young leaves. Food selection was apparent, >80% of the overall diet comprised seasonal plant parts and both troops increased monthly diet diversity with declining use of preferred food.

Both troops used small home ranges, but home range size and travel strategies varied due to fine vegetational differences in the habitats; use of space was influenced by species richness and temporal variation in the availability of seasonally limited important food; range use maximised encounters with preferred seasonal food and was determined by food availability and use.

These monkeys lived in small reproductive troops (\bar{x} 11.1) with one or two adult males. Extra-troop males lived in male bands (\bar{x} 5.4), alone or as pairs. Social organisation was influenced mainly by adult male replacement while changes in composition and size of stable troops occurred due to births (occurring year round), deaths, female migration, and disappearances. Infanticide and territorial behaviour (mainly for mate defence) were observed.

Both study troops damaged human habitations and crops. Although humans were generally tolerant of monkeys, the future existence of these monkeys in non-forested habitats is threatened due to habitat destruction and hunting. Their survival depends on timely conservation measures for forest populations.

10.5

Nesting Behaviour, Reproductive Output, Genetic Structure and Nest Paternity of Green Turtles Nesting at Kosgoda Rookery in Sri Lanka.

Ekanayake, E.M.L.

119p.

Ph.D. Degree, 2012.

Location No. 1259

Abstract

Green turtles nesting in Kosgoda rookery in the south-western coast of Sri Lanka were studied for a five-year period from August 2003 to July 2008. Nesting took place year round, with a clear peak in March to June recording a mean of 298.4 annual nests. A single female laid an average of 289 eggs in a season and re-visited the same beach after 1-3 years showing high nest site fidelity. Although, the reproductive output of the females nesting at Kosgoda was much lower compared to the females nesting in other beaches, hatching success was high at Kosgoda rookery. The incubation duration was 50.3 days which was lower compared to other nesting beaches. Incubation duration depends on the temperature. Since sex of sea turtles depends on the temperature during the incubation Kosgoda green turtles may be producing more females. Nesting behaviour and reproductive biology of the green turtles at Kosgoda rookery were similar to those nesting at Rekawa, the largest rookery in Sri Lanka. Genetic diversity assessed using six microsatellites showed a mean heterozygosity of 0.75 and a very high allelic diversity (mean 24.7 per locus). Kosgoda green turtle population is small compared to other beaches. However, its high genetic diversity suggests that the population may not be undergoing a genetic bottleneck. Although sea turtles are promiscuous breeders, offspring of less than half of the female green turtles (47%) nesting at Kosgoda rookery was multiply sired by two or three males. Information about the prevalence or multiple paternity is important to comprehend the population structure which is of great significance to the management and conservation of an endangered species such as sea turtles. Findings of this study suggest that it is still not too late to prioritize the conservation need of the green turtle population nesting at Kosgoda rookery and highlight the importance of declaring it as a turtle sanctuary.

10.6

Some Aspects of the Biology and the Fishery of Exotic Cichlids in Victoria, a Deep Reservoir in Sri Lanka.

Nathanael, Evangeline Shirani

282p.

Ph.D. Degree, 2001.

Location No. 182

Abstract

A fishery has been established in Victoria, a large, deep, hydropower reservoir created under the Accelerated Mahaweli programme. Since cichlids constitute the mainstay of this fishery, the primary objective of this investigation was to determine some important aspects relating to the cichlid fishery, their biology (i.e. breeding and feeding) and spatial and temporal distribution in four different sectors of the reservoir, and the natural and anthropogenic determinants affecting their populations.

To achieve this objective, apart from bi-weekly monitoring of fish catches, laboratory examination of individuals to determine their feeding and breeding habits was necessary. A comparative study was also made regarding the nutritional quality of the flesh of these three species owing to their importance as a low-cost source of protein for people in the

vicinity. Since an acute decline in the annual fish production of this reservoir, with a corresponding decline in the cichlid catch was evident since the withdrawal of state patronage in July 1990, with many unwarranted anthropogenic activities, it was evident that a suitable management strategy was needed for conservation and management of this valuable resource.

The result revealed that *O. mossambicus* which is primarily a detritivore, with an intrinsic year round breeding potential, was the most successful colonizer of the three cichlid species inhabiting the reservoir. The other two cichlid species are more selective, with the larger individuals being confined to specific locations as in the case of *O. niloticus* or restricted in their establishment by the limitation of available food resources as in the case of *T. rendalli*. However, the progressive decline of *O. mossambicus* and the corresponding increase of *O. niloticus* during the study period suggests that *O. niloticus* could override *O. mossambicus* to become the dominant cichlid species in the near future.

The socio-economics of fishermen and traders operating in the vicinity of the reservoir and details of the fish marketing system were also analyzed. Fishermen have taken to this vocation secondarily and hence have no inherent fishing skills. Progressive decline in catches made some of the fishermen abandon fishing altogether. In the absence of alternative sources of income, traders are compelled to purchase small fish which are available in large quantities. Apart from the freshness of the fish, the socio-economic status of the consumer was identified as a key determinant of the type of fish (viz. marine/freshwater) purchased.

This study indicates the importance of developing an integrated management approach, taking into consideration the fishery resource as well as the social component affecting the resource, as well as the importance of encouraging greater user group participation for effective management of the fishery.

10.7

Status and Mechanisms of Insecticide Resistance in Anopheline Vectors of Malaria in Sri Lanka.

Perera, M.D. Bernadine

126p.

Ph. D. Degree, 2007.

Location No. 702

Abstract

Resistance to insecticides was studied in the major malaria vector *An. culicifacies*, and secondary vector *An. subpictus* in five districts (i.e. Anuradhapura, Kurunegala, Moneragala, Puttalam and Trincomalee) of Sri Lanka during January 2001 to January 2005. Adults were collected using cattle baited trap huts. Larvae were collected from natural breeding habitats. Adult bioassay experiments were carried out with World Health Organization (WHO) discriminative dosages of DDT, malathion, fenitrothion, propoxur, lambda-cyhalothrin, cyfluthrin, cypermethrin, deltamethrin, permethrin and etofenprox, according to WHO standards. Metabolic resistance by carboxylesterase, glutathione S-transferase (GST) and monooxygenase based mechanisms were determined by biochemical, synergist and metabolic techniques. Target site insensitivity was studied by biochemical assays and gene sequencing. Resistance in other potential malaria vectors from Anuradhapura was also studied.

Both species were highly resistant to DDT in all the collected places. Malathion and fenitrothion resistance was high in all the places except *An. culicifacies* in Kurunegala (susceptible to both) and Puttalam (susceptible to fenitrothion). Populations were highly resistant to permethrin in Anuradhapura and Trincomalee. All the populations were

susceptible to cypermethrin and cyfluthrin. *An. subpictus* from Anuradhapura, Kurunegala and Puttalam were resistance to lambda-cyhalothrin. All *An. subpictus* populations had low susceptibility to deltamethrin. Etofenprox tolerance was highest in Anuradhapura *An. subpictus*.

Carboxyl esterase activities were higher in *An. culicifacies*. Native PAGE resolved one elevated isozyme band from each species. Thin layer chromatography analysis of metabolized mosquito homogenates showed the presence of malathion carboxylesterase mechanism in all the populations except for Kurunegala *An. culicifacies*. AChE was more sensitive to insecticides in Kurunegala and Trincomalee *An. culicifacies* populations and highest insensitivity was observed from Trincomalee *An. subpictus* population.

High GST activities in both species explained their high resistance to DDT. Quantitative and qualitative changes of carboxylesterases, and insensitive target site AChE were found to be responsible for organophosphorus resistance in Anuradhapura, Moneragala, Puttalam and Trincomalee *An. culicifacies* populations. Synergist and biochemical studies revealed that monooxygenases provide pyrethroid resistance.

An. subpictus, *An. nigerrimus* and *An. peditaeniatus* showed resistance to propoxur showing the high exposure of their breeding sites to agricultural insecticides. *An. nigerrimus* and *An. peditaeniatus* have developed insecticide resistance mainly due to elevated monooxygenase activities.

Leucine to phenylalanine substitution (ITA to TTT) in sodium channel regulatory gene was detected from Anuradhapura *An. subpictus* and was almost identical to the mutation identified in *An. gambiae* s.s. of South Africa This indicates an independent origin of the same mutation in two geographically isolated species due to the constraints for evolving different mutations without interrupting the physiological role of the target site. It appears that pyrethroid resistance of Sri Lankan *An. culicifacies* is mainly caused by monooxygenases and that of *An. subpictus* is mainly by mutated sodium channel genes.

10.8

Taxonomy and Natural History of Bees in Selected Areas of Sri Lanka.

Karunaratne, Inoka

343p.

Ph.D. Degree, 2004.

Location No. 386

Abstract

Prior to this study, taxonomic work on bees of Sri Lanka had been conducted entirely by overseas scientists commencing in 1897 and leading to the Smithsonian Surveys (1975-1986). These studies have documented 137 bee species in 27 genera. Information on their natural history is completely lacking and only a few specimens have been deposited in Sri Lanka. In the present study (a) bees collected from several districts, agroecological regions and habitats were identified (b) their floral relationships and nesting habits were recorded, (c) the subfamily Nomiinae was reviewed, (d) and bees diversity was determined in selected sites.

A total of 137 bee species in 35 genera and 3 families were recorded. These included 20 previously unrecorded species and 5 genera and a species new to Science. Based on the location of the 29 collection sites, the Low Country Dry Zone, middle peneplain, and the agricultural habitats harboured the highest number of species. Floral hosts consisted of 167 species in 115 genera and 44 families. Weeds were the most preferred hosts (129 spp.) followed by crops and trees. Flowers of 6 naturalized plant species attracted an unusual

number (> 20 species) of bees. According to pollen relationships, 131 bee species are generalists and 7 species are pollen specialists. Twelve species of bees are buzz pollinators of crops whose pollen is concealed in anthers. Pollen from 69 floral hosts in 27 plant families when microscopically examined and grouped into 12 pollen classes.

Several stem nesting (16 spp.), ground nesting (13 spp.) and hive building (4 spp.) bees were recorded. Certain species were recorded only from their nests. Review of the subfamily Nomiinae resulted in 22 species in 11 genera. Sampling in different locations/habitats of the Knuckles Forest Reserve gave the highest Shannon Diversity Index for agricultural habitat in the Semi Evergreen Climatic Zone. Descriptions, identification keys, locality details and floral hosts are given for the 137 bee species recorded.

M.Phil. Theses

10.9

Aspects of the Foraging Ecology of Selected Bird Species in Udawattakele Forest Reserve, Sri Lanka.

Wijesundara, C.S.

103p.

M.Phil. Degree, 2008.

Location No. 757

Abstract

Several parameters of foraging ecology were studied in selected species of coexisting birds. The study was undertaken in Udawattakele Forest Reserve, Kandy, Sri Lanka, from July 2003 to July 2005. The selected species were Black Bulbul *Hypsipetes leucocephalus humii*, Yellow-browed Bulbul *Acritillas indica indica*, Yellow-fronted Barbet *Megalaima flavifrons*, Small Barbet *Megalaima rubricapillus rubricapillus*, Indian Hill Mynah *Gracula religiosa indica*, Red-backed Woodpecker *Dinopium benghalense psarodes*, Crimson-backed Woodpecker *Chrysocolaptes lucidus stricklandi*, Common Kingfisher *Alcedo atthis taprobana*, Stork-billed Kingfisher *Pelargopsis capensis capensis*, Layard's Parakeet *Psittacula calthorpae*, Sri Lanka Lorikeet *Loriculus beryllinus*, Brown-capped Babbler *Pellorneum fuscicapillus fuscicapillus*, and White-rumped Shama *Copsychus malabaricus leggei*.

It was hypothesized that ecologically similar species are able to coexist in the same habitat due to differences in various aspects of their foraging behavior and some aspects of their foraging ecology, such as food type consumed, foraging habitat, foraging site, and foraging height.

The study revealed that the sympatric species under study were able to coexist in the same habitat due to differences in various aspects of their foraging ecology. The black bulbul and the yellow-browed bulbul showed differences in the type of food consumed, foraging site, and foraging height. The yellow-fronted barbet, small barbet, and Indian hill mynah showed differences in foraging site and foraging height. The red-backed woodpecker and the crimson-backed woodpecker showed differences in the type of food consumed and foraging site. The common kingfisher and stork-billed kingfisher showed differences in the type of food consumed, foraging habitat, foraging site, and foraging height. Layard's parakeet and Sri Lanka lorikeet showed differences in the type of food consumed, whereas the brown-capped babbler and white-rumped shama showed differences in their foraging heights.

These parameters were considered as mechanisms of coexistence of the respective pairs (or more) of ecologically similar species. The results obtained from this study were generally similar to the results from a number of previous studies carried out elsewhere (outside Sri

Lanka).

10.10

Distribution and Ecology of Earthworms in Selected Habitats in Sri Lanka with Emphasis on Soil Fertility and Composting.

Samaranayaka, D.H.J.W.K.

216p.

M.Phil. Degree, 2008.

Location No. 695

Abstract

Earthworms (Annelida: Oligochaeta) contribute to soil fertility and play a key role in composting garbage. Very little is known about the earthworms of Sri Lanka apart from work done in the mid 1900. With a view to identify soil living earthworms in natural and man-made ecosystems, collections were made from several habitats in 22 sites located in different ecological regions. Based on adult and cocoon morphology, 22 morphospecies of earthworms in 9 families were recorded. These were identified to 16 genera and 15 species and the balance 7 morphospecies awaits formal identification. Six of the families and 9 genera are new records for Sri Lanka. Earthworm cocoons common in soil and leaf litter were easily identifiable to species level based on size, shape, colour and incubation period, than adults. Keys were constructed for the identification of collected species, based on observed external features of adults and cocoons. Distribution of earthworm species in the study sites was found to be determined by altitude (and the associated temperature) and rainfall than soil type. Of the ecologically different earthworm groups, endogeic forms were the most common and of them, *Pontoscolex corathrurus* was the dominant species in man-made and natural sites. The epigeic earthworms, *Periyonix excavatus*, *Eudrilus eugenia* and *Eisenia foetida*, used in vermicomposting world over were common in most of the study sites.

Earthworm casts recorded a higher level of available plant nutrients than surrounding soil. Furthermore, activity of *Pontoscolex corathrurus* significantly increased plant growth in *Zea maize*, in pot experiments. Bins and tanks specially prepared for vermicomposting yielded nutritively high compost with better particle size than composting without earthworms. The findings on earthworm diversity, improvement of soil fertility and composting using local earthworms have useful field applications that should be popularized.

10.11

Ecology, Diversity and Distribution of Freshwater Crabs (Decapoda: Parathelphusidae) in Knuckles and Nuwara Eliya Region of Sri Lanka.

Karunarathna, M.M.S.

102p.

M.Phil. Degree, 2007.

Location No. 632

Abstract

The present study was carried out in seven habitat types; primary forests, secondary forests, tea plantations, cardamom plantations, grasslands, paddy fields and marshy areas in Knuckles and selected areas in Nuwara Eliya region.

A total of 18 freshwater crab species belonging to a single family (Parathelphusidae) and four genera (*Ceylonthelphusa*, *Perbrinckia*, *Mahatha* and *Oziothelphusa*) were recorded. Out of the 18 species, three species remain unidentified. All the recorded 18 species are endemic to the island. Genera *Ceylonthelphusa*, *Perbrinckia* and *Mahatha* are endemic to the island. Genus

Oziothelphusa is not endemic. New locality data for eight freshwater crab species were recorded.

The results indicate that freshwater crabs have diversified into different ecological habitats with some morphological and behavioral adaptations. They occupy various freshwater and terrestrial habitats and show different degree of dependence on water and different pH preferences.

Most stream habitats sampled contain at least two species of freshwater crabs: one species in lowland and the other in higher altitudes. The altitudinal distribution of freshwater crabs in Knuckles and Nuwara Eliya region shows a unique pattern of sympatry within a narrow zone of 200 meters. Within this zone, lowland large bodied common species are found to be co-existing with common highland species.

Most freshwater crab species found within the study area show very restricted distribution while *C. rugosa* and *C. soror* show wide range of distribution within both study areas. Diversity indices indicate that primary forests have the highest freshwater crab species diversity followed by secondary forests and tea plantations respectively in both Knuckles and Nuwara Eliya regions. In Knuckles region, grasslands, paddy fields and marshy areas show the lowest freshwater crab species diversity where as in Nuwara Eliya region grasslands had the lowest crab species diversity. The Shannon Evenness indicated that the grasslands, paddy fields and marshy areas showed the highest species evenness (1.0). The primary and secondary forests showed the highest similarity in terms of freshwater crab diversity followed by tea plantations.

The species richness was higher in Knuckles region. This may be due to the presence of different habitat types. Less species richness in Nuwara Eliya region can be attributed to the extreme climatic conditions and less diversity of habitat types.

10.12

Effect of Pesticides and Trematode Infection on Survival, Growth and Development of Malformations in *Polypedates cruciger* and *Bufo melanostictus* (Amphibia: Anura).

Jayawardena, U.A.

87p.

M. Phil. Degree, 2008.

Location No. 864

Abstract

Recent reduction of amphibian populations and widespread occurrence of amphibian malformations are a global concern. Amphibian declines are a result of interactions between a number of highly context-dependent causal factors of natural and man-made changes to the ecosystem, including habitat loss and alterations, global warming, pathogens, chemical contaminants, predation, ultraviolet (UV) radiation, invasive species and synergism among these factors. Field and laboratory studies in identifying the culprit deforming the amphibians suggest that many complex causes are involved, the prime suspects being parasitic (trematode) infections, pesticides and UV radiation. I tested how exposure to pesticides and trematode infection affect the growth, survival and development of malformations in two common local anuran species; the common hourglass tree frog (*Polypedates cruciger*) and the common toad (*Bufo melanostictus*) under laboratory conditions. First, the tadpoles (Gosner stage 26) of both species were exposed to four widely used pesticides at low ecologically relevant doses. In a second set of experiments tadpoles of *B. melanostictus* were exposed to monostome type cercariae in a dose dependent manner. All the tadpoles were reared until metamorphosis. Survival was recorded weekly and the growth and malformations were

recorded at metamorphosis. Time required for the forelimb emergence of half the number of tadpoles in a given treatment (TE_{50}) was recorded to measure growth retardation. Pesticide and cercariae caused significant reduction in survival and growth retardation in both anuran species. Moreover, both these factors induced malformations in the limbs, spine and skin pigmentation of tadpoles and adults. Individual effects of pesticide and cercariae were enhanced when both were introduced synergistically. Further studies are required to ascertain the widespread occurrence of these malformations in other amphibian species and the prevalence of malformed amphibians in wild populations of Sri Lanka.

10.13

Effective Control of Dengue Fever Vectors: *Ae. aegypti* and *Ae. albopictus* in Sri Lanka.

Weeraratne, T.H.

136p.

M.Phil. Degree, 2012.

Location No. 1258

Abstract

Control of the vector mosquitoes *Aedes aegypti* and *Aedes albopictus* is the primary means of controlling dengue fever. Abundance (using ovitraps), breeding preference (by larval survey) of these vectors were done at four study sites in two districts (Kandy: Rajawatta and Gampola, Kurunegala: Wehera and Theliyagonna). *Ae. albopictus* was the dominate species in both these districts. Ovitrap indices and larval indices (House, Container and Breteau) showed that all four areas are at epidemic risk due to high abundance of *Ae. albopictus*. Miscellaneous containers were the most vulnerable dengue vector mosquito breeding sites. Attractiveness (by risk factors) of the all potential breeding sties was at risk level and elimination of them is essential for the success of any dengue vector control programme.

There is a high mortality rate during egg to larva transition. Decreased rate of egg hatching and high larval mortality due to flooding of breeding sites with excess rainy water, predation, infections by pathogens, change of pH in water, removal/ destruction of breeding sites by the residents etc. may be responsible for this.

Insecticide cross-resistance spectra and mechanisms of insecticide resistance of both these vectors from Kandy, Kurunegala, Ratnapura, Gampaha, Puttalam and Jaffna were evaluated. High resistance to DDT, susceptibility to propoxur and malathion (except Jaffna populations for malathion), and moderate resistance to permethrin were observed. Susceptibility to both malathion and propoxur in the presence of high activity of mosquito carboxylesterases and glutathione S-transferases indicates the failure of these enzymes to provide resistance in the absence of elevated monooxygenases. Propoxur sensitive acetylcholinesterases (target site of carbamates and organophosphates) could not be detected using the standard substrates used.

Thermal fogging of pyrethrum and malathion killed 100% mosquito adults at 10m distance. The effect is negligible when the mosquitoes are 75 m away from the origin of spraying. Malathion was more effective than pyrethrum in thermal fogging (space spraying). Larvicide temephos (1 ppm) was effective ten months under laboratory conditions. Use of temephos which is cheap and long lasting is highly recommended as a larvicide.

10.14

Effects of Anti- α -Galactosyl Antibodies on the Growth of the Malaria Parasite, *Plasmodium falciparum*.

Rajakaruna, Rupika S.

178p.

M. Phil. Degree, 1997.

Location No. 25

Abstract

Malaria due to *Plasmodium falciparum* has exerted selective pressure on human populations at the level of globin, Human Leucocyte antigens (HLA), glucose-6-phosphate dehydrogenase (G6PD) genes and few other red cell disorders. New World monkeys (NWM, platyrrhines) and non-primate mammals possess Gal α 1-3 Gal β 1-4GlcNAc-R structures (termed α -galactosyl epitopes) while humans, apes and Old World monkeys (OWM, catarrhines) lack these epitopes but produce the corresponding antibodies (termed anti-gal). Platyrrhines do not synthesise this antibody. Inactivation of a gene for the α 1-3 galactosyl transferase enzyme (α 1-3 GT) in the Golgi of catarrhines is responsible for the difference. A hypothesis which might explain this distribution pattern is that a pathogen carrying α -galactosyl epitopes like *P.falciparum* which was endemic in the Old World adapted to infect ancestral catarrhines and may have been the cause for the suppression of the activity of α 1,3 GT gene.

In this study the effects of anti-gal antibodies on *P. falciparum* growth were examined *in vitro*. Anti-gal antibodies were purified from humans, OWM and NWM sera by immunoaffinity chromatography on Gal α 1-3Gal β 1-4GlcNAc oligosaccharide attached to silica beads. Growth inhibition assays were carried out on parasite cultures to which antibodies were added, using [3 H] hypoxanthine incorporation and Giemsa stained smears of cultures. Results showed that anti-gal inhibit parasite growth in a concentration dependent manner, through complement mediated damage of merozoites.

Terminal α -galactose residues previously shown to be present on the 185kDa and 45kDa *P. falciparum* merozoite surface proteins as either O-linked oligosaccharides or glycoposphatidyl inositol (GPI) membrane anchors are potentially antigenic. The demonstrated binding of *Bandeiraea simplicifolia* IB4 lectin to parasite membranes suggests that the terminal galactose residues are present in α 1-3 linkages. It is therefore possible that during the early Miocene period, a *P.falciparum* like parasite adapted itself to infect OW monkeys leading to the inactivation of the α 1,3 GT gene. The driving force for inactivation would have been the ability to produce antibodies reactive with α -galactosyl epitopes of the parasite which then conferred significant protection against falciparum-like malaria without inducing autoimmunity.

Plasmodium falciparum proteins are being investigated as the basis of a vaccine against falciparum malaria. This study suggests that oligosaccharide moieties of the parasite may also be useful for this purpose.

10.15

Elephant Orphanage at Pinnawala, Sri Lanka: its Management and Aspects of Biology, Ecology and Behaviour of its Elephants.

Rajapaksa, R.C.

162p.

M.Phil. Degree, 2006.

Location No. 592

Abstract

The Elephant Orphanage at Pinnawala village (EOP) was established in 1975 in a 10.75 ha coconut land by the Government of Sri Lanka to care for at least some of the elephant calves that are orphaned when they are abandoned by the native herds. The Orphanage is situated about 88 km away from Colombo in the Kegalle District. In the orphanage, at present, there are 75 elephants of all ages including 14 adult males and 28 adult females.

Although the orphans are brought to the orphanage from all elephant-dwelling regions of Sri Lanka, these individuals form a cohesive unit led by an adult female (matriarch). The adult males are separated when they are about 8-10 years old and live solitary lives afterwards, but they also maintain a hierarchy, often according to the age. The males are trained for work, although the females are not. In fact, elephants in the main herd of EOP are not fully tamed or trained. They cannot be ridden; nor can they be made to work, but, keepers can lead them to the river for bathing, to the grassland for feeding, or chain them at their special places in the evening.

Mating behaviour, stereoscopic behaviour and sleep behaviour were studied. Reproductive activities mainly take place at the free grazing area of the coconut land or at the river. Real mating will last only 1-2 min. It is not possible to determine whether a particular male would select a particular female in heat, or *vice versa*, because mahouts determine which male should be led to a female in heat. But, almost always more than one male is brought to mate with the female to ensure mating success. Always unrelated males and females are mated to reduce inbreeding.

It appears that the stereoscopic behaviour is resorted to when the animal is in apparent distress or boredom. If the routine activities of the orphanage are proceeding without any disturbance, very little stereotypic behaviour was observed. The intensity of the stereotypic behaviour seems to depend on age, sex, availability of food or water, and severity of the cause of stress.

The main period of sleep of elephants at the orphanage is from 1200-0500 h. The number of hours of sleep reduces with age. Elephants sleep either standing or in recumbent position. The ratio between the period of standing sleep and recumbent sleep increases with increase in age. The EOP has a good captive breeding programme, and, so far (01 January 2006), 34 calves were born over 30 years, 31 of them living. Seventeen male calves and 17 female calves were born at the orphanage. Thus, the sex ratio at birth appears to be 1: 1. The programme has now proceeded to the 2nd generation. In 22 years, 15 females have given birth to 34 calves. The birth rate so far is 1.55 calves per year. The average length of the oestrus cycle is 3-3½ months. The period in which the female is in heat is 1-3 days. The average pregnancy period is about 22 months. The average age at first calving in EOP is 14.5 years and the average inter-calving interval is 4.8 years.

Several parasitic and bacterial diseases have been identified and treated at EOP. Round worm (nematode) infestations are common at the orphanage. The blood fluke *Bivitellobilharzia nairi* has been identified in the elephants at the orphanage. Any part of the colon of an elephant may get impacted with the fibrous food materials. Sometimes, elephants inadvertently swallow polythene bags along with food materials and obstruction of colon may result. Pododermatitis is very rare in EOP. Sometimes corneal opacity develops in one or both eyes. In severe conditions, eyesight becomes poor or absent.

The EOP provides a ready source for scientific study of biology, ecology and behaviour of elephants. Several researchers from local universities and foreign universities and institutions have engaged in research activities at the orphanage. The EOP veterinary surgeons, in

collaboration with foreign scientists, are planning to investigate the paternity of elephants born in Pinnawala using molecular genetic techniques, in order to develop a pedigree and future breeding programme.

The orphanage has a high ecotouristic potential, as it provides, directly or indirectly, employment and income to a substantial number of people in the vicinity, and as it attracts a large number of tourists. In 2005, 433,994 visitors (124,850 foreign and 558,844 local) visited EOP.

Management problems in EOP are more or less similar to those that are experienced in zoos in various parts of the world that keep Asian elephants. However, zoos keep many animal species besides Asian elephants, and lesser number of elephants than EOP does.

Short-comings of the management were studied and remedial measures are suggested. The main inadequacies appear to be in the areas of herd accommodation, grasslands and forest for natural feeding, available staff, and tourist amenities. The management, at present, is taking several important steps to improve these facilities.

10.16

Insecticidal Activity of *Euphorbia antiquorum* L. Latex against Agricultural Insect Pests.

de Silva, W.A.P.P.

94p.

M.Phil. Degree, 2006.

Location No. 540

Abstract

Insecticidal properties of *Euphorbia antiquorum* (Euphorbiaceae) (in Sinhala: Daluke) latex was studied using the plants collected from Eppawala (Anuradapura District), Ibbagala (Kurunagala District) and Haloluwa (Kandy District) during 1999-2002. Latex extractions (10%) were prepared in seven solvents *i.e.* dichloromethane, petroleum ether, acetone, methanol, n-hexane, distilled water and xylene.

Insecticidal components were best extracted by less polar solvents like xylene. Out of the four bioassay methods tested (*i.e.* Potters' sprayer, leaf-dip, hand sprayer and microapplicator), Potters' sprayer method gave the best performance. Xylene-latex extraction was tested against three species of vegetable infesting aphids, three species of rice insect pests, two species of predatory insects and one species of spider. Results revealed that the latex is an effective insecticidal agent but not effective against the insects with a thick cuticle cover. Significant differences of insecticidal activity was observed in the latex collected from dry (highest insecticidal activity), intermediate and wet (lowest activity) zones. Monthly collected latex samples showed that there is no significant seasonal variation of the activity. Field experiments showed that cheap and common detergents like soap could be used to prepare an effective spraying formulation using the crude extraction.

Only the xylene and methanol extractions gave clear spots in thin layer chromatography (TLC). Comparative TLCs showed that the xylene extraction had two additional spots. This extraction was subjected to florisil column chromatography (FCC) and eluted with n-hexane followed by petroleum ether and dichloromethane. Fourth n-hexane fraction had the highest insecticidal activity (53.25% mortality). Only the 4th n-hexane fraction gave a clear spot in TLC and a peak at 1.006 min in high performance liquid chromatography (HPLC).

However, these peaks were present in HPLC chromatogram of crude xylene-latex extraction

also and may represent the compound/s, which are responsible for the insecticidal activity of the *E. antiquorum* latex. Gas chromatography (GC) showed that the 4th n-hexane fraction of FCC comprise of several minor peaks with one major peak at 0.528 min.

On storage, both the xylene-latex extraction and the 4th n-hexane fraction of FCC were highly stable showing only a 3% decline of insecticidal activity after one year suggesting that stable commercial products can be formulated from these two.

10.17

Nest Site Fidelity and Nesting Behaviour of Marine Turtles in Rekawa Turtle Rookery.

Ekanayake, E.M.L.

120p.

M.Phil. Degree, 2003.

Location No. 306

Abstract

There are seven species of marine turtles living in the world and five of them come to nest in Sri Lanka. They are green turtle (*Chelonia mydas*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys coriacea*). This study was carried out in Rekawa turtle rookery, a two kilometer stretch of beach in, the southern Sri Lanka. All the turtle species nesting in Sri Lanka nested at Rekawa study site during the period of this study. Studies were carried out on all five species with more emphasis on the most frequent species, the green turtles.

The total time taken for the nesting process of all five species in Rekawa was similar to the observations made in other parts of the world while green turtles have taken the longest duration. The percentage time for the each activity was calculated. The average egg count, egg weight and egg diameter was calculated. The nesting was observed throughout the year with a peak season from March to July. Ninety six percent of the turtles nested at Rekawa beach were green turtles.

The turtles selected different locations for nesting on the beach. In some places there were several nesting, while in others only a few were observed. It was observed that the distance to the vegetation from the nests was also varied. The green turtles show a high degree of nest site fidelity and 75% of them came back to re-nest on the same site. The average number of nests in a single nesting season for the green turtles was 4.1 (SE = 0.1) with a minimum of one and a maximum of 12 nesting.

On the basis of temperature dependent sex determination (TSD) the sex ratio of the hatchling green turtle on the Rekawa beach was 71 % females and 29% males (7:3). This study revealed that there was no correlation between the number of nesting turtles and the lunar cycle as well as the tidal level.

10.18

Some Aspects of Farm-Rearing Of Post-Larvae and Fry of Commonly Cultured Carps (Pisces: Cyprinidae), and Development of Methodology Suitable for Rearing of Post-Larvae and Fry by Rural Communities of Sri Lanka.

Ariyaratne, M.H.S.

87p.

M.Phil. Degree, 2000.

Location No. 97

Abstract

The major constraint in stocking water bodies and aquaculture ponds at present is the lack of fingerlings. As a result of the discontinuation of the state patronage for inland fisheries development in 1990, the development of a community-based method of fry and fingerling rearing became necessary more than ever before.

In the present study the feasibility of producing fish fingerlings with community participation was investigated. Most of the raw materials and feed used in the study are cheap and available locally. Cement tanks were used as the rearing vessels. Such trials could be carried out in a suitable location where water is truly available.

Tanks were cleaned, dried, disinfected and filled with screened water, which was followed by fertilization with cow dung. The earlier seed production method has been modified by changing some steps and adding new steps in order to improve the survival and growth.

Cow dung was found to be a better organic manure for the rearing of post-larvae (PL), although chicken manure could also be used. Fry rearing could be done no manuring. In the rearing of *Cyprinus carpio* fry, a high stocking density (380 fry m⁻²) could be used in the first two weeks followed by a low stocking density (95 fry m⁻²) in the next four weeks. The suitable stocking density for the rearing of PL of *Aristichthys nobilis* and *Ctenopharyngodon idella* was found to be 600 PL m⁻², and that for the PL of *Labeo rohita* and *Cyprinus carpio* was found to be 500 PL m⁻². Higher stocking densities affected the growth and percentage survival of the PL and also increased the duration of rearing period.

Supplementary feeding was essential for the PL for better growth and survival. Rice bran showed better results than a locally formulated feed (C2) in the rearing of *Labeo rohita* PL but *Cyprinus carpio* PL showed better results with C2.

Fertilization with cow dung improved the population of rotifers in 7-10 days after the initial dosage. This period, therefore, is suitable for PL stocking. Subsequently application of fertilizer (cow dung) could be done on every 7th day.

In order to improve survival the following steps are recommended in PL- and fry-rearing.

- Tanks should be suitably prepared during each rearing cycle before stocking.
- Kerosene could be used to control the predatory insects and 0.5 ppm. Dipterex could be used to control macro zooplankton.
- A hand net with a diagonal mesh size of 3 mm made of knotless net material is suitable for fish handling.
- If algal blooms appear, the surface algal mat should be reduced manually, and water should be kept running in order to remove remaining algae.

The method proposed here is important because it can be used by the rural fish farming community to produce their own fish seed.

10.19

Status of Insecticide Resistance and Resistance Mechanisms in Some of the Rice Insect Pests and Four of their Predators.

Weerakoon, Krishni Chanika

116p.

M.Phil. Degree, 2003.

Location No. 307

Abstract

Insecticide resistance and the underlying resistance mechanisms were studied in five rice insect pests (brown planthopper *Nilaparvata lugens*; green leafhopper *Nephotettix virescens*; paddy bug *Leptocorisa oratorius*; white leafhopper *Cofana spectra* and white-backed planthopper *Sogatella furcifera*), and four of their predators (lady-bird beetle *Micraspis discolor*; ground beetle *Ophionea indica*; mired bug *Cyrtorhinus lividipennis* and spider *Tetragnatha* sp.). Insects were collected from the rice fields at Batalagoda, Kurunegala district (intermediate zone) and Angunakolapalassa, Hambanthota district (dry zone) of Sri Lanka from August 1999 to January 2002. Insects were subjected to insecticide bioassays with dimethoate and chlorpyrifos (organophosphates), permethrin (a pyrethroid) and carbosulfan and BPMC (carbamates). A fixed dosage of 3500µg/g DDT and 4400µg/g malathion was used to assess the DDT and malathion tolerance. Bioassays were carried out by topical application method. Log-probit mortality lines and LD₅₀/LD₉₀ values were obtained for each insecticide except for malathion and DDT, for all the species. For malathion and DDT percentage mortalities were recorded.

N. lugens collected from both sites showed high resistance to permethrin. *L. oratorius* population at Angunakolapalassa was resistant to carbosulfan compared to Batalagoda population. *L. oratorius*, *M. discolor* and *Tetragnatha* sp. populations at Angunakolapalassa were susceptible to permethrin compared to Batalagoda populations and *Tetragnatha* sp. population was susceptible to chlorpyrifos resistance at Angunakolapalassa. Others showed similar resistance levels at both study areas. In general, most of the species tested from Batalagoda and Angunakolapalassa had lower tolerance for malathion although some species showed higher tolerance for DDT. To measure the carboxylesterase activity two substrates α/βnaphthyl acetate and p-nitrophenyl acetate were used. Highest carboxylesterase activity with the substrate pNPA was present in *S. furcifera* (mean specific activity = 1.91 µmol/min/mg). Lowest activity was found in *L. oratorius* (mean specific activity = 0.02 µmol/min/mg). Native polyacrylamide gel electrophoresis was used to resolve carboxylesterase isoenzymes. No elevated carboxyl esterase bands were found in *O. indica*. The major mechanism of insecticide resistance of rice insect pests and predators was elevated carboxylesterases. Malathion metabolism studies showed the absence of malathion carboxylesterases in all the species. Glutathione S-transferase activities were high in *O. indica* (mean specific activity = 0.55 µmol/min/mg) and very low in *Teragnatha* sp. (mean specific activity = 0.11 µmol/min/mg). Presence of high oxidase concentrations were detected in *M discolor* (mean oxidase concentration = 3.82units) and *Tetragnatha* sp. (mean oxidase concentration = 8.75units). Inhibition of the organophosphate and carbamate targetsite acetylcholinesterase (AChE) with propoxur and paraoxon showed that AChEs of *S. furcifera*, *Tetragnatha* sp. and *C. lividipennis* populations are not sensitive to these insecticides. High activity of carboxylesterases and altered acetylcholinesterases were correlated with high resistance to organophosphates and carbamates. High levels of glutathione S-transferases activity had provided high resistance to organochlorines and high oxidase concentrations were correlated with pyrethroid resistance.

10.20**Taxonomy, Distribution and Host Plant Relationships of Thrips in Selected Sites in Sri Lanka.**

Tillekaratne, K.

235p.

M.Phil. Degree, 2011.

Location No. 1179

Abstract

Thrips (Insecta: Thysanoptera) are of economic importance as they cause much damage to plants feeding on the plant sap and as vectors that transmit plant viruses. In recent times thrips have become key pests of many economic crops such as rice, vegetables, cut flowers and foliage plants. However, in Sri Lanka, information on species present, host plant relationships and damage is lacking. At the commencement of this study, a survey of published literature on thrips in Sri Lanka, dating back to 1913 was carried out that resulted in the publication of a checklist of 78 species in 42 genera. The objectives of the study were to record the species of thrips and their host plants in selected sites of the country, to identify the part(s) of plant they infest and the damage caused. The vegetation in the selected sites was carefully examined for thrips infestations and thrips were hand collected for identification. From the 22 selected study sites in the country (that came under 6 provinces, 9 districts, 12 agroecological regions and 6 different habitats) over 1000 plants were examined for thrips. Of them, 324 plant species in 83 families harboured thrips. A total of 72 species of thrips in 45 genera were recorded. Of the taxa recorded, 19 genera and 24 species of thrips are new records for Sri Lanka. Among the recorded thrips were 42 species of pest thrips and 5 species of potential viral vectors. The thrips infested plants were grouped into 18 plant categories (based on their usage) and the most number of thrips species were found on non graminaceous weeds, followed by woody trees, fruit trees, vegetables, ornamental plants, cut flowers, and medicinal plants. Of the different parts of plants infested by thrips, damage was seen mostly in buds, flowers and leaves resulting in premature bud fall, streaking of flower petals, discolouration and bronzing in leaves, crumpling and gall formation in leaves. None of the thrips infested plants showed any symptoms of viral infection. Thrips infestations were found to be associated with the host plant species rather than with any particular habitat type. Cultivated and disturbed habitats included more of such plant species resulting in a higher thrips species composition. The largest number of thrips infested plants and thrips species were collected from Angunakolapellassa representing the Low Country Dry Zone. Certain thrips species, *Microcephalothrips abdominalis*, *Thrips palmi* and *Haplothrips gowdeyi* had a wide distribution with respect to study sites. Flower thrips, specially, species belonging to the Subfamily Thripinae were common on flowering plants grown in the Wet and Intermediate Zones. Thrips in the subfamily Panchaetothripinae were common in plants in the Dry Zone. With respect to distribution localities; *Thrips flavus* in particular was abundant in the Up Country Wet Zone. Furthermore, *Thrips simplex* was recorded only from flowers of plants in the Up country Wet Zone. Species identification keys, descriptions of species and their damage, host plant records and reference specimen collections resulting from the study are aids in the identification of thrips and their host plants. The information generated through this study would further the knowledge of this economically important insect order in the country.

M.Sc. Research Project Reports**FISH AND WILDLIFE MANAGEMENT**

10.21

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Wijesundara, W.M.C.S.

68p.

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Location No. 376

10.22

The Diversity and Distribution of the Herpetofauna in the Hakgala Range, Sri Lanka.

de Silva, I.H.S. Kumara

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Location No. 375

10.23

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Location No. 454

PARASITOLOGY

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47p.

M.Sc. Degree, 2000.

Location No. 111

Title Index

1

¹H NMR Study of the Role of Alumina Fillers in Conductivity Enhancement in the PEO Based Solid Polymer Electrolytes., 238

3

3D Reconstruction Tool for CT (Similar) Scanned Images., 368

A

- Abundance and Population Structure of the Paddy Bug in Non-Rice Habitats of a, 183
- Active Instruction Techniques for Teaching Science in Lower Secondary Classes., 307
- Activity of Two Medicinal Plants against Some Bacteria Causing Skin and Wound Infections in Humans., 292
- Addressing Students' Misconceptions in Some Selected Topics in G.C.E. Advanced Level Chemistry Syllabus., 307
- Adsorption and Desorption Behavior of Phosphate on Kaolinite., 111
- Adsorption of 2-Chlorophenol and 2,4-Dichloroaniline on Silica and Adsorption and Desorption of Phosphate on Kaolinite., 61
- Adsorption of Cadmium (II) by Kaolinite., 111
- Adsorption of Mercury (II) by Kaolinite., 111
- Adsorption of Thiram by Soil., 111
- Adsorption of Zinc on Kaolinite in the Presence of Calcium and Magnesium., 112
- Aetiological Agents of Human Dermatitis., 288
- Agent Application for World Wide Web Searching., 368
- Air Quality Trends in the City of Colombo., 178
- Alizarin Red S Impregnated Conducting Polymer as a Potential Ionic Sensor., 112
- Alkaloids of *Erythroxylum zeylanicum* O.E. Shulz (*Erythroxylaceae*)., 63
- Allelopathic Activity Studies of Sri Lankan Flora and Chemical Investigation of Endophytic Fungi and Terrestrial Streptomyces Species, 29
- Alternative Ways of Teaching Basic Concepts of Environmental Chemistry for Advanced Level Students., 308
- Analysis and Comparison of the Performances of Data Compression Algorithms for Text Files., 368
- Analysis and Recovery of Iodine from Brine in Solar Salt Manufacturing., 112
- Analysis of a Commercial Fertilizer., 129
- Analysis of Cadmium in Drinking Water in Padavi Sripura Area and Modification of Diphenyl Thiocarbazon., 112
- Analysis of Contingency Tables with Multiple Responses: Special Emphasis on Three-Way Tables., 355
- Analysis of Distribution of Butterfly Species in Sri Lanka., 355
- Analysis of Dosimetric Characteristics of Virtual Wedge., 233
- Analysis of Market "Chinese Roll" Samples in Kandy Municipality Area for Acrylamide: A Probable Carcinogen., 112
- Analysis of Measurement Error Model and the Stein Rule Estimator., 355
- Analysis of Misconceptions in Electricity among G.C.E. (A/L) Students., 308
- Analysis of Organochlorine and Organophosphorus Pesticide Residues in Sri Lankan Agricultural Export Commodities with Special Emphasis on Tea., 112
- Analysis of Paired Incidence Scores with Clustering., 355
- Analysis of Patient Integral Radiation Dose Using Ionization Chamber and Thermoluminescence Dosimeter for External Beam Radiation Therapy., 233
- Analysis of Pesticide Residues in Chilli (*Capsicum annum*)., 113
- Analysis of Prevalence of Dengue Fever in Vavuniya MOH Division., 355
- Analysis of Problems in the G.C.E. (A/L) Chemistry Practical Work in Some Selected Schools in Batticaloa District., 308
- Analysis of Problems of G.C.E. A/L Science Students and Teachers in Conducting Projects and Suggestions for Overcoming., 308

- Analysis of Proteins in Infant Milk Formulae., 113
- Analysis of Sludge, Soil, and Plants for Lead Contamination and Investigation of Suitable Methods for Removal of Lead., 113
- Analysis of the Perception of Eastern and South Eastern University Students on the Ongoing Peace Process., 355
- Analysis of the Quality of Water at School Level., 113
- Analysis of Water Quality in Tsunami Affected Areas: a Case Study to Enhance G.C.E. (A/L) Practical Skills., 308
- Analysis of Water Quality Using Bioindicators and Effective Usage of this Knowledge in the Teaching and Learning Process of A/L Biology Course., 308
- Analyzing the Ridge Regression Techniques Introduced for Solving the Problems of Multicollinearity., 349
- Anion Association and CO₂ Reduction Capacity of Some Selected Transition Metal Macrocyclic Complexes., 113
- Antibacterial Activity of the Water Decoctions of the Constituent Plants of the Ayurvedic Drug Panchawalkala and the Medicinal Plant *Abutilon indicum*., 292
- Anti-Candidal Activity of Some Plants in the Eastern Region of Sri Lanka., 288
- Antigenic Analysis of Bovine *Sarcocystis* spp. in Sri Lanka., 23
- Antimicrobial Activity Of Triphala: A Traditional Medicine Formulation., 293
- Antimicrobial Efficacy of Nano-Zinc Oxide-Coated Cross-Linked Cotton., 132
- Antimicrobial Natural Products against Oral Pathogens., 114
- Antioxidant Activity and Antibacterial Activity of "Shaddharanayogaya" Prescribed for Hypertension., 293
- Anti-Oxidant and Anti-Tyrosinase Natural Products of *Nymphaea stellata*., 113
- Antioxidant Capacity of Spices in Retarding Oxidation of Lipids during Storage of Cooked Herring., 63
- Application of Active Teaching Learning Approaches in Science (ATLAS) for the Unit on "Man and Environment" in G.C.E. Advanced Level Chemistry Syllabus., 309
- Application of Aeromagnetic and Remote Sensing Data to Map Ranna Rock Unit., 165
- Application of Branch and Bound Algorithm to Minimize the Product Cost., 356
- Application of Calcium Chloride on Management of Internal Browning of Pineapple (*Ananas comosus* cv. Mauritius) Fertilized with Urea., 295
- Application of Concepts of Equilibrium in Everyday Life., 309
- Application of Contemporary Education Strategies to Motivate Students' Interests in Studying Electrode Equilibria and to Develop Lifelong Learning Skills., 309
- Application of Dynamic Light Scattering to Probe Molecular Dynamics in Polymer Gels., 238
- Application of Floating Wetlands for Water Quality Improvement., 183
- Application of Floating Wetlands to Improve Water Quality in Kandy Lake., 183
- Application of GIS to Mitigate Soil Erosion in Upper Kotmale Area., 165
- Application of Hydrocyclone in Industrial Wastewater Treatment., 129
- Application of PCR to Early Detection of Dengue Fever in Clinically Suspected Patients., 289
- Application of Physico Chemical Principles in Industrial Chemistry., 309
- Application of Polymerase Chain Reaction for Diagnosis of *Dirofilaria repens* in Dogs., 289
- Application of Principal Component Analysis in Response of *Shorea* Seedlings in Sri Lanka, 356
- Application of Role Base Access Control in Health Care Organization., 368
- Application of Rotational Residuals for Normal Diagnostics in Regression Analysis: A Simulation Study., 356
- Application of Spatial Data Infrastructure Technology and Mobile GIS for Disaster Management in Sri Lanka., 138
- Application of Statistical Techniques in the Interpretation of Stream Sediments Data of Some Rivers in Sri Lanka., 356
- Application of the Principal Component Regression Model to Investigate All Share Price Index., 356

- Application of Zero Valent Iron for the Treatment of Landfill Leachate Generated from Gohagoda Municipal Solid Waste Dumpsite., 179
- Applications of Graph Colouring., 203
- Applications of Neural Networks in Electromagnetics: A Survey., 369
- Applications of Red Clays of Sri Lanka for High Quality Ceramic Products., 137
- Applying Role Based Access Control for Intranet Security., 369
- Appraisal of Nitrate Contamination of Groundwater by Intensive Use of Fertilizer around Kandy Area in Maha Season., 183
- Approximate First Integrals of Perturbed Ordinary Differential Equations., 203
- Aquifer Identification, and Groundwater Development in NuwaraEliya Basin., 160
- Arsenic Determination and Removal from Drinking Water., 114
- Artificial Muscles Using Polypyrrole Conducting Polymer., 238
- Aspects of Diversity and Ecology of Butterflies in Minneriya National Park of Sri Lanka., 184
- Aspects of the Ecology and Morphotaxonomy of Cattle Ticks (Acari: Ixodidae) in Sri Lanka., 397
- Aspects of the Foraging Ecology of Selected Bird Species in Udawattakele Forest Reserve, Sri Lanka., 404
- Aspects on Biology and Ecology of *Acavus* Species in Sri Lanka., 398
- Assessing G.C.E. (A/L) Biology Students' Understanding of Environmental Issues Using a Two-Tier Diagnostic Test., 309
- Assessing Salinity Level of Soils in Area near the Batticaloa Lagoon., 114
- Assessing Spatial and Social Vulnerability for Natural and other Hazards in the Ampara District of Sri Lanka., 165
- Assessing the Diversity of Woody Plant Species in Gannoruwa Forest and Preparation of Simple Teaching Aids for Teaching Ecological Diversity., 309
- Assessment of a Modified Approach to Teach the Unit on 'Engages in Prevention of Diseases Associated with the Main System of the Human Body' of the G.C.E. (O/L) Syllabus., 310
- Assessment of a Risk from Exposed Acid Sulfate Soils in the Southern Highway from Kottawa to Dodangoda., 184
- Assessment of Conceptual Knowledge of G.C.E. Advanced Level Students Using the Force Motion Concept Inventory., 310
- Assessment of Data Quality and Map Accuracy of Topographic Maps., 165
- Assessment of Disaster and Emergency Preparedness Level in the Primary Health Care Centers in IDP Villages, Menik Farm, Vavuniya District, Sri Lanka., 153
- Assessment of Disaster Management Practices in Sri Lanka : Lessons from 2003 Flood and Landslide., 153
- Assessment of Drinking Water Quality of Selected Dug- Wells within the Vavuniya Urban Council of Sri Lanka., 184
- Assessment of Emergency Preparedness of Secondary and Tertiary Care Institutions of Sri Lanka., 153
- Assessment of Geographical Risk and Vulnerability of Coastal Communities of the Galle Municipal Council Area for Tsunami., 166
- Assessment of Glycaemic Control in a Sample of Diabetic Patients with Cataract and Retinopathy., 19
- Assessment of Heavy Metal Contamination in the Marine Sediments of Galle Harbour., 114
- Assessment of Land Subsidence Susceptibility within Industrial Estate at Achchuvily in Jaffna., 154
- Assessment of Nitrate Pollution of Well Water in Relation to Distance of Toilet Pit in Vavuniya., 184
- Assessment of Pollution Sources of the Vavuniya Tank and Proposing Remedial Measures., 184
- Assessment of Practical Work in G.C.E. (A/L) Physics in Sri Lankan Schools., 310
- Assessment of Recreational Value of Minneriya National Park: Possibilities of Sharing Benefits with Stakeholder Community., 287
- Assessment of Temporal Variation of Water Quality in Boralessgamuwa Lake., 174
- Assessment of the Effects of Selected Pre-Analytical and Analytical Factors on the

- Optimal Immunohistochemical Staining for ER and HER-2 in Breast Cancer., 19
- Assessment of the Ground Water Quality for Aquaculture, Agriculture and Drinking Purposes in Selected Areas of North Western Province., 184
- Assessment of the Iron Status of Patients with Chronic Renal Failure., 20
- Assessment of the Mammographic Image Quality Using a Test Object., 233
- Assessment of the Potential Threat to Ground and Surface Water due to Agricultural Practices in Kala Oya Basin., 139
- Assessment on the Status of Natural Resources Exploitation by the Buffer Zone Communities of VRR Sanctuary., 287
- Attempt to Introduce Simple Experiment-Based Projects for A/L Agriculture Students., 310
- Attitudes of Sri Lankans on 'Diyabath', its Physical Properties and Microbiology., 289
- Automated Diagnose of Anemia and Malaria Using Image Processing., 369
- Automated Exam Marking System., 369
- Automated Identification System for Sri Lankan Anopheline Mosquito Species by Spot Analysis., 369
- Automated Paddy Variety Identification System., 369
- Automated System to Construct Higher Order Steiner Triple System., 369
- Automatic Font Detection in Tamil Document., 370
- Automatic Measurement of Average Length of Coconut Fiber., 370
- Automobile Spare Parts Distribution System Design., 203
- Availability of Water Resources within the Attanagalla Oya Basin : a Review., 175
- Avifauna in the Illukkumbura Region of the Knuckles Range., 303
- Avifaunal Diversity Associated with Different Habitats in Wasgomuwa National Park., 287
- Avquick Meta Search Engine for Quick Audio Visual Searching., 370
-
- B**
- Barriers of Teachers in Using Student-Centred Approach to Teach Seventh Grade Science., 310
- Behaviour of the Parasitoid *Diglyphus isaea* (Hymenoptera: Eulophidae) of the Potato Leafminer *Iriomyza huidobrensis* (Diptera: Agromyzidae)., 185
- Bilayers and Multilayers of Polypyrrole and Poly(3, 4-Ethylenedioxythiophene) for Conducting Polymer Actuators., 206
- Bilingual Education in Sri Lanka: Perspectives of Stakeholders with Special Reference to Prospective Teachers in Science Education., 310
- Binary-Integer Programming Method for Optimal Control of Water Distribution Systems., 201
- Bioaccumulation of Heavy Metals in Selected Freshwater Macrophytes., 185
- Bioactivities of *Alpinia calcarata* Rosc. Rhizome., 3
- Bioactivity of *Pongamia sp.* and Effect of Saponins on the Fungal Symbiote of Shot-Hole Borer Beetle., 64
- Bioactivity Studies of Some Sri Lankan Flora and Bioactive Xanthenes from *Calophyllum thwaitesii*., 65
- Biochemical Interactions in Shot-Hole Borer Infestation of Tea and Studies of three Microbial Polysaccharides, 30
- Biochemical Studies in Shot-Hole Borer Infestation of Tea., 66
- Biodiversity of Ecological Communities and the Biogeography of Their Species in Three Isolated Hills in Sri Lanka., 245
- Biodiversity of Gannoruwa Forest and its Sustainable Management., 304
- Biofilms with Nitrogen Fixing Bacteria and Fungi: A Novel Biofertilizer Technology for Sustainable Maize (*Zea mays* L.) Cultivation., 260
- Biological and Chemical Elicitors of Banana Fruit Defence., 246
- Biological Aspects of the Development of Some Selected Soil Profiles in the Central Highlands of Sri Lanka., 185
- Biological Monitoring of Sulfur Dioxide in Ambient Air Using Bryophytes., 185
- Biomechanical Movements of a Humanoid Robot and Force Analysis., 370
- Biomonitoring of Tropospheric Ozone Pollution in Kandy District Area., 185

- BIOSTAT, a Computer Programme for Biostatistics Module for the G.C.E. (A/L) Biology, 311
- Bird Diversity in Kumana Marsh in the Kumana National Park, Sri Lanka., 185
- Blue Green Algal Populations of Some Irrigation Tanks in Anuradhapura District., 185
- Brain Computer Interface (BCI) Based on Electroencephalographic (EEG) Patterns due to New Cognitive Tasks., 350
- Building Students' Interest in Chemistry through Simple Experiments Using Household Chemicals., 311

C

- Cab Management System Using Genetic Algorithms., 370
- Cadastral Index Mapping of Temple Lands Udunuwara Divisional Secretary Division., 166
- Cadmium Levels of Paddy Field Soils and Drinking Water in Kebithigollewa Area., 186
- Call Capturing and Billing System., 370
- Callus Induction, Plant Regeneration and Agrobacterium-Mediated Transformation of Rice Variety BG – 250., 23
- Canker Disease of *Psidium guajava* L. Caused By *Pestalotiopsis psidii* and Host Defensive Responses., 296
- Case Study of Strengths and Weaknesses of Advanced Level Science Education in Sri Lanka., 311
- Case Study on Feasibility of School Projects of the G.C.E. Advanced Level (Science Stream) Curriculum: Views of Teacher Community., 311
- Case Study on Learning Physics through Problem Based Learning Approach., 311
- Case Study on School Projects of the G.C.E. (A/L) Curriculum (Science Stream): Views and Constraints of Students., 312
- Case Study on School-Based Assessment in Physics in Learning Teaching Process in North Western Province., 311
- Case Study: Vegetation Study at the Meethirigala Forest Reserve., 293
- Catastrophes and Stabilization Policies in Economic Dynamics., 203
- Cathodic Electrodeposition of ZnO Thin Films for Solar Energy Conversion., 238
- Changes in Consumption of Rice in Sri Lanka and the Rest of the South Asia., 356
- Characterization and Nutritional Effect of Cell Wall Polysaccharides from Coconut Kernel., 31
- Characterization of Accessions and Reproductive Biology of *Elettaria cardamomum* L. Maton in Sri Lanka., 261
- Characterization of Acid Proteinases of Porcine Ovaries and Analysis of their Expression., 114
- Characterization of Deoxyribonucleases from Pitcher Juice of *Nepenthes distillatoria*., 114
- Characterization of Germline Mutations in the Breast Cancer Gene 1 - Exon 15., 23
- Characterization of Molecular Diversity and Physiological Properties of Rhizobial Populations in *Crotalaria juncea*., 24
- Characterization of Road Dust in the Kandy Urban Area., 186
- Characterization of Thunderstorms over Sri Lanka Using Weather Data in GIS., 166
- Chemical and Biochemical Modifications of Electrode Surfaces for Sensor Applications., 67
- Chemical and Biological Activity of Selected Varieties of Spring Canola (*Brassica napus*) and Mustard (*Brassica juncea*) and Introduction of a High Content of Favourable Fatty Acids to Mustard., 115
- Chemical Characteristics of Industrial Effluents after Treatment with Brick Particles., 115
- Chemical Characterization of Road Dust in Greater Colombo Area., 186
- Chemical Investigation and Biological Activity of *Gliricidia sepium*., 68
- Chemical Investigation of *Goniothalamus gardneri* (Annonaceae)., 69
- Chemical Investigation of *Litsea ovalifolia*., 128
- Chemical Investigation of *Myristica ceylanica* and *Xylopiia nigricans* and Synthetic Studies on (2S, 3R, 1'R)-Stegobinone., 33
- Chemical Substances Produced by Selected Microorganisms and their Biofilms., 115
- Chemistry and Activity of *Acronychia pedunculata* Fruits., 69
- Chemistry and Antiviral/Anti-HIV Activity Studies of Family Clusiaceae., 70

- Chemistry and Bioactivity of *Diploclisia glaucescens* and *Elaeocarpus serratus*., 128
- Chemistry and Bioactivity of some Sri Lankan Buxaceae and Rubiaceae., 70
- Chemistry and Bioactivity of Some Sri Lankan Menispermaceae and Rubiaceae., 71
- Chemistry and Bioactivity of the Fruits of *Artocarpus altilis* and *Flacourtia indica*., 72
- Chemistry and Bioactivity of the Fruits of *Averrhoa carambola*., 73
- Chemistry and Bioactivity Studies of *Garcinia mangostana* L., 74
- Chemistry and Biological Activity Studies of some Marine Algae and their Endophytic Fungi., 34
- Chemistry of Five Lichens of Sri Lanka and Sequestration of Lichen Compounds by a Lycaenid Butterfly *Talicauda nyseus*., 36
- Chemistry of some Annonaceae Plants., 75
- Chemistry of the Genus *Hortonia*., 36
- Chilli Colour Analysis Using Digital Image Processing., 370
- Classification Method for Optical Phenomena of Cat's-Eyes and Stars in Minerals., 136
- Classification of Brain Computer Interface Data Using Formant Analysis., 371
- Classification of State Schools in Sri Lanka: Multivariate Approach., 357
- Clay Polymer Nanocomposites: Investigation of Mechanical, Thermal and Optical Properties of Selected Nanocomposites., 219
- Clay Polymer Nanocomposites: Investigation of their Electrical Properties for Industrial and Technological Applications., 77
- Climate and Flowering Phenology of Eight *Shorea* Species in Sinharaja Rain Forest, Sri Lanka., 262
- Clinical Dosimetry of Transmission Factors for Hard Wedges and Shielding Trays Used in T 780 E Telecobalt Machines and its Features., 234
- Clinical Significance and Diagnostic Value of Urinary Protein Analysis of Chronic Kidney Disease Patients by Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis., 20
- Code of Practice for the Shrimp Farmers in Sri Lanka., 186
- Colour Enhancement of Sri Lankan Gem-Quality Quartz by Gamma-Ray and Neutron-Beam Irradiation., 163
- Colour Picture Guide on Fish and Fishing Gear Required for G.C.E. (A/L) Biology Students., 312
- Combined Test for the Median and the Effects of Five Normality Tests on the Combined Test., 357
- Community Disaster Response Teams for Malawenna Village., 154
- Community Participation in Mosquito Control through Awareness Programmes., 312
- Comparative Antioxidant Activity and Quantification of Gymnemic Acid from Sri Lankan *Gymnema* sp., 115
- Comparative Phylogenetic Analysis of Selected Species of *Exacum* of Sri Lanka with *Osbeckia octandra*., 24
- Comparative Studies on Biodiversity of Logged and Unlogged Mahogany Plantations in Kumbalpola, Sri Lanka., 288
- Comparative Study of Amylase Activity of Germinating Seeds of Mung Bean (*Vigna radiata* L.), Cowpea (*Vigna unguiculata* L.) and Soya Bean (*Glycine max* L.), 312
- Comparative Study of Butterfly Fauna in Three Different Habitats of the Knuckles Region, Sri Lanka., 186
- Comparative Study of Student Performance on Theoretical and Practical Teaching Methodology Adopted in the Lesson on Traditional Food Preservation Techniques of G.C.E. (O/L)., 312
- Comparative Study of the Knowledge on Biodiversity in Town Schools and Village Schools in Kandy., 312
- Comparative Study on Avifauna Associated with Two Selected Seasonal Reservoirs at Kurunegala District., 182
- Comparative Survey of Bioaccumulation of Some Metallic Ions Such as Cu(II) , Cr(VI)O_4^{2-} by the Aquatic Fern - *Azolla pinnata*., 115
- Comparison between Conventional Clustering Methods Using *Abelmoschus esculentus* (L.) Moench (Okra)., 357
- Comparison of Bacteriological Methods for Detecting Total Coliforms and *Escherichia coli* in Water., 247

- Comparison of BOD Methodology for Waste Water Samples., 186
- Comparison of Chemical Identities of Natural Plants and Callus Cultures of *Andrographis paniculata* and *Munronia pinnata*., 293
- Comparison of Clinical and Laboratory Parameters in the Early Diagnosis of Dengue Fever., 289
- Comparison of Embryo Quality Between Intracytoplasmic Sperm Injection and In Vitro Fertilization in Couples with Unexplained Sub Fertility., 20
- Comparison of Glass and Polypropelene Jars for Canning of Some Selected Fruits and Vegetable Products., 296
- Comparison of Mathematical Skills and Numerical Problem Solving Skills of G.C.E. (A/L) Students Offering Chemistry., 313
- Comparison of Minimum Spanning Tree Algorithms for a Telecommunication Network., 204
- Comparison of Performance at Solving Conventional and Conceptual Problems in Physics of G.C.E. (A/L) Students., 313
- Comparison of Ripening Methods for "Kolikuttu" (*Musa sapientum* L. AAB Group) Banana., 115
- Comparison of Stochastic and Mathematical Programming Approaches Used in Measuring Technical Efficiency: Illustrated by an Efficiency Analysis of Cattle Farming Systems in Up Country Wet Zone of Sri Lanka., 357
- Comparison of Streamside Vegetation in Different Land Use Types of Maha Oya in Hantana Campus Land., 304
- Comparisons of Indicators Availability for Detecting Multicollinearity., 357
- Computer Aided Learning (CAL): Multimedia Lesson for Electronics Unit in G.C.E. A/L Physics., 313
- Computer Aided Study Package for Effective Teaching of the Unit 2-Biodiversity in A/L Biology Syllabus., 313
- Computer Assisted Programmes for Teaching Selected Topics in A-Level Chemistry., 313
- Computer Assisted Teaching in Physical Chemistry Concepts for G.C.E. (A/L) Students., 314
- Computer Based Complementary-Learning Package In Rotational Motion for G.C.E. (Advanced Level) Physics Students., 314
- Computer Based Self Learning Study Package for Understanding Orbital Behaviour in Chemical Bonding., 314
- Computerizing the Monitoring and Evaluation of Teaching Performance., 371
- Concept of Function in the Secondary School Mathematics Education in Sri Lanka., 314
- Concept of Non-Parametric Procedure for Testing Homogeneity of Variance and a Non-Parametric Approach in Testing Higher Order Interactions., 357
- Conceptual model for Evaluation of Ecological Impacts in Environmentally Sensitive Areas., 186
- Conservation Importance of Semi-Evergreen Seasonal Forests of Galamuduna Area in the Knuckles Region., 182
- Construction and Performance Evaluation of Multicore Workstation Cluster Under Windows And Linux Operating Systems., 371
- Construction and Testing of a Supplementary Guide on Leafy Vegetables for Advanced Level Biology Teachers., 314
- Construction and Testing of an Apparatus for Thermal Conductivity Measurement., 238
- Construction of a Dual Purpose Digital Meter to Use in Physics Experiments., 314
- Construction of a Low Cost Colorimeter and its Application in Teaching Colorimetry to A/L Students., 315
- Construction of a Low Cost Colorimeter and its Use for the Study of Equilibrium Phenomena., 315
- Construction of a Supplement Guide on Biodiversity (Unit II) for G.C.E. (A/L) Biology Students., 315
- Construction of a Vibrating Sample Magnetometer to Measure Magnetization of Some Ferromagnetic Materials., 239
- Construction of Super Capacitors Based on Activated Carbon., 239
- Contamination of Menik Ganga in Buttala-Pelwatte Area Due to Anthropological Activities., 187

- Contamination of Shallow Groundwater in the Sinnauppodai Coastal Area, Batticaloa, Sri Lanka., 187
- Contamination of Stream Water and Sediments of the Kandy Urban Area., 187
- Content Based Image Retrieval System by Clustering., 371
- Content Based Image Retrieval System., 371
- Contribution to Mathematics Teaching at Senior Secondary Level via Error Analysis of Problem Solving in Mathematics., 315
- Controlling Odour in Tobacco Processing., 129
- Convenient Method to Measure Distance for School Admission., 166
- Coordinate Transformation Tool for Android Mobile Devices., 166
- Copolymerization of 8-Hydroxyquinoline with Aniline and Intercalation of 8-Hydroxyquinoline into Montmorillonite Clay., 132
- Copper Kaolinite Interactions: An Application of Diffuse Layer Surface Complexation Model., 116
- Correlation Study on Student Achievements at Grade Five Scholarship Examination and G.C.E. Ordinary Level Examination., 358
- Counting Coconut Mites Using Digital Image Processing., 371
- Create an Efficient Keyboard Driver to Minimize Sinhala Typing Errors., 371
- Crime Mapping and Spatial Analysis of Kirulapane Police Division: A Pilot Project for Colombo City., 166
- Critical Analysis on Ancient Numerals., 315
- Critical Review of G.C.E. (A.L.) Physics Question Paper Administered in the Kandy Education Circuit at Grade 13 Level by the Provincial Education Department., 315
- Critical Study on the Physics Question Papers Administered for the General Certificate Education (Advanced Level) Examination with a View to Making Recommendations for Quality Development., 316
- Crop Damages by Asian Elephants in Ekgaloya and Dewalahinda Areas in Ampara District, Eastern Province - Sri Lanka., 187
- Cross Inoculation Studies on Four *Colletotrichum* Isolates from Mango, Avocado, Banana and Rubber., 296
- Crown Rot of Banana and Its Possible Control Using Papaya Latex., 263
- Cryptographic Techniques with Artificial Intelligence., 372
- Cryptosporidium Infection in Buffaloes and Cattle with Special Reference to Factors Contributing to Infection., 289
- Current Pollution Status of Valaichenai Lagoon., 116
- Cynometra cauliflora* L. (Ceasalpinioideae): Fruit Composition and Storage., 296
-
- D**
- Data Migration in Software Implementation Projects., 372
- Database Administration via Short Message Service., 372
- Database to Support University Course Timetabling., 372
- Decision Support System for the Management of Patients with Community Acquired Pneumonia., 372
- Decontamination of Cadmium Containing Aqueous Solutions using Feldspar., 116
- Deep Groundwater Hydrology in the Bogala Graphite Mine., 160
- Defluoridation of Water., 116
- Delivering Advanced Level Chemistry Curriculum (Unit One and Two) Using Information and Communication Technology: A More Effective Method of Teaching., 316
- Demining Before Resettlement a Prerequisite: A Case Study - Mannar Sri Lanka., 154
- Demonstration Experiment on Bernoulli's Principle for Advanced Level Physics., 316
- Demonstration Experiments for Teaching Magnetic Phenomena for G.C.E. (Advanced Level) Students., 316
- Demonstration Experiments with the Oscilloscope., 316
- Dengue Incidence in Mawanella Area : a Case Study., 166
- Design and Construction of a Testing Machine to Study the Impact Behaviour of Materials., 239
- Design and Development of a Digital Library., 372

- Design and Development of a Virtual Academy., 372
- Design and Development of an Electronic Voting System., 373
- Design and Development of an Online Student Information and Management System for College of Technology, Kandy., 373
- Design and Implementation of a Chat Application with the Observer Pattern and the Net Remoting., 373
- Design and Implementation of an Automatic People Identification System Using Fingerprints., 373
- Design and Implementation of Role-Based Access Control in Health Care System., 374
- Design and Implementing an Online System for Advertising Management., 374
- Design Backup and Restore Add-on for Moodle., 374
- Design of an Inventory Control System for Value Added Tea Industry., 374
- Design, Development and Evaluation of Experimental Biofilm Leachate Treatment Systems., 187
- Design, Manufacture and Implantation of Custom-Made Orthopedic Bioprotheses for Needy Patients: Nano-Range Hydroxyapatite Coating on Roughened Stainless Steel Surfaces., 133
- Designing a Role Based Access Control System Using Design Patterns., 374
- Designing a Teaching Methodology for the G.C.E. Advanced Level Biology Curriculum Based on a Section Evaluated as Disliked by Students., 316
- Designing of Scalable Map Symbol Library for Digital Topographic Mapping., 167
- Designing Simple Activities in Fluid Mechanics for Easy Learning for G.C.E. A/L Students., 317
- Designing the Sanitary Land Fill Site in the Upper Kotmale Hydropower Project Area at Talawakele., 187
- Detailed Taxonomic Study on the Genus *Ilex* L., (Family Aquifoliaceae) in Sri Lanka., 293
- Detecting Faces in Arbitratory Images Using a Sample Technique., 374
- Detection of Alveolar Crestal Bone Loss and Tooth Length from a Radiograph in Dental Practice Using Digital Image Processing., 374
- Detection of *Legionella* Species and Other Microbiological and Physicochemical Properties in Natural and Man-Made Water Systems in the Colombo District., 289
- Detection of Marek's Disease Virus in Poultry Using a Polymerase Chain Reaction Based Molecular Diagnostic Assay., 24
- Detection of W_{nt} Modulator in Surface Ectoderm (*Wise*) Gene in *Mycobacterium tuberculosis*., 290
- Deterioration of Coastal Water Quality from Land Based Activities: Western Province, Sri Lanka., 188
- Determination of Allethrin in Mosquito Coils Comparison of Test Methods Specified in Sri Lankan and Indian Standards., 188
- Determination of Factors Affecting the Performance of Students on the Subject Science at G.C.E. (O/L) Examination in Batticaloa District., 317
- Determination of Mercury Content in Marine Fish Marketed in Sri Lanka., 116
- Determination of Neutral Sugar Composition of Tea Clones TRI-3015, TRI-3019 and TRI-4078., 128
- Determination of Optimum Population Size for Higher Accuracy in Mapping Quantitative Trait Loci., 24
- Determination of the Performance of a Beowulf Cluster by Modelling the Heat Transfer in Parallel through a Two-Dimensional Body., 375
- Determination of the Relative Positions of Elements in the Electrochemical Series., 317
- Determination of the Sensitivity of Pcr Based Non-Radiolabeled Hybridization for the Detection of *Mycobacterium tuberculosis*., 24
- Developing a Biocontrol Method Against, *Botryodiplodia theobromae* and *Colletotricum musae* Causing Crown Rot of 'Embul' Banana., 264
- Developing a Computer-Based Study Package for G.C.E. A/L Students on Matter and Radiation in Physics., 317

- Developing a GIS Based Tourism Information System for Hambantota District., 167
- Developing a Novel Study Package for Learning Cell Biology (at the G.C.E. Advanced Level), 317
- Developing a Passive Sampler Method for Monitoring the Air Quality in Kandy., 188
- Developing a Supplementary Study Guide in Physics Application in Biology and Medicine for Intermediate Level Physics., 317
- Developing a Web Based Student Information System for the University of Vocational Technology., 375
- Developing an Information System for Analysis of Morbidity and Mortality Statistics for a Government Hospital., 375
- Developing an Online Shopping Cart System for Saweena Beauty Centre., 375
- Developing and Testing the Influence of Demonstrations in Teaching Electrostatic Unit for G.C.E. A/L Students., 318
- Developing Grass Root Level Multi Hazard Contingency And Disaster Response Plan for Biyagama Area., 154
- Developing Java Applets to Illustrate the Basic Concepts in Simple Linear Regression Analysis., 358
- Development and Characterization of Macroporous Ceramic Structures., 239
- Development of a Community Based Disaster Management Plan for Coastal Line of Negombo District Secretary Division., 154
- Development of a Computer Based Study Package: States of Matter for G.C.E. A/L Chemistry., 318
- Development of a Computer Model Representing Bulk Diffusion in Semiconductors., 239
- Development of a Computer Model Representing Low Temperature Thin Film Growth., 358
- Development of a Conceptual and Numerical Question Bank for the Testing of Students understanding in Physics., 318
- Development of a Distributed Collaborative Student Group Project Management System., 375
- Development of a Hydrological Model to Predict Kaluganga Flow at Ratnapura., 175
- Development of a Low Cost, Multiflex Pcr Based Diagnostic Assay for Down Syndrome., 24
- Development of a Processed Carrot Juice Drink and β -Carotene Retention During Storage., 296
- Development of a Reporting Module for Pay Phone System., 375
- Development of a Secure E-Voting System for Election., 376
- Development of a Sensor to Detect Lead (II) in Water Using Ammonium Salt of Di Ethanoldithiocarbamate., 116
- Development of a SMS Based Library Management System., 376
- Development of a Software Infrastructure for a Fuzzy Logic Based Decision Support System for Critical Care., 376
- Development of a Student Information Management System for Schools., 376
- Development of a Study Package for Astronomy Education., 318
- Development of a Video Programme on Dry Zone Forests of Sri Lanka., 188
- Development of Amperometric Sensors for Detection of Cyhalothrin and Propanil., 78
- Development of an Animal Model to Study Oral Submucous Fibrosis Using Aqueous Arecanut (*Areca catechu*) Extract., 5
- Development of an Electrochemical Sensor for Copper (II) Analysis., 116
- Development of an Electronic Time Sheet., 376
- Development of an Experimental Package in Electrostatics for G.C.E. Advanced Level Students., 318
- Development of an Online Examination System., 376
- Development of an Opto-Chemical Sensor for the Investigation of Metal Cations., 117
- Development of Clays or Minerals as Backfill Materials in Lightning Conductors., 239
- Development of Demonstration Experiment and Computer Based Test to Teach Rotational and Circular Motion., 318
- Development of Demonstration Experiments for Teaching Advanced Level Electricity and Magnetism., 319
- Development of Dye-sensitized Solar Cells Using Atomized Spray Pyrolysis Technique., 79

- Development of Electroanalytical Detection Schemes for Some Selected Pesticides., 38
- Development of Environmentally Friendly Methodologies for Control of Industrial Pollution., 117
- Development of Frozen "Pollos" (*Artocarpus heterophyllus*) for the Export Market., 296
- Development of Fruit Leather from Locally Available Varieties of Banana., 297
- Development of General Chemistry Concepts at School Level., 305
- Development of Guidebook to Assist Successful Implementation of Advanced Level Projects., 319
- Development of Human Resources in Science and Technology: Role of Universities., 319
- Development of Image Processing and Analyzing Workbench for an Electronic Document Authenticator., 376
- Development of Low Cost Method for the Monitoring of Ambient Air Quality., 117
- Development of New Approaches in Teaching Thermochemistry., 319
- Development of Novel Methods to Prepare Montmorillonite-Polyaniline Nanocomposites., 117
- Development of Organic/Inorganic Composite Electrolyte Materials based on Poly (Ethylene Oxide) and Montmorillonite (PEO/MMT) for Applications in Electrochemical Devices., 80
- Development of Polyaniline Conducting Polymer Systems for Sensor Applications., 81
- Development of Propagation Techniques and Agronomic Practices of Two Medicinal Plants: *Asparagus racemosus* Willd. and *Cyperus rotundus* L., 265
- Development of Rapid and Cost Effective Propagation Techniques for Two Medicinal Plants *Cyperus rotundus* (Kalanduru) and *Phyllanthus debilis* (Ela Pitawakka)., 319
- Development of Self-Cleaning and Anti-Microbial Textile Material., 82
- Development of Self-Cleaning Textiles by Incorporating Photo Chemically Active TiO₂ Nano-Particles., 117
- Development of Semi Automated System for Work Piece Localization on Computer Numeric Control Machines., 377
- Development of Simple and Rapid Propagation Techniques for the Medicinal Plants (*Kaempferia galanga* L. and *Asparagus racemosus* Wild)., 319
- Development of Single Step Reverse Transcriptase Polymerase Chain Reaction (RT- PCT) Assay to Detect Chikungunya Virus in Clinical Samples., 25
- Development of Solar Cells Based on Dye-Sensitized Titanium Dioxide with Solid-State Electrolyte., 83
- Development of Some Demonstration Experiments to Teach Projectile Motion., 320
- Development of Spatial Database for Coastal Resource Profile (CRP) of Sri Lanka., 377
- Development of Standard Operational Procedures for the Special Response Unit., 154
- Development of Web Based Aptitude Test System for the Post Graduate Institute of Science (PGIS) University of Peradeniya., 377
- Dielectric and Thermal Properties of Polymer Electrolytes Based on Poly (Acrylonitrile) and Poly (Propylene Glycol)., 220
- Differences in Knowledge Representation about Newton's Laws of Motion Between Two Groups of Physics Students., 320
- Differential Effects Achieved Genderwise in Teaching Chemistry Using Macroscopic Method., 320
- Difficulties Encountered by Key Stage 3 Pupils of Akurana (Central Province) in Solving Numerical Division Problems with Special Reference to an Intervention Relating to Primary Mathematics Textbooks., 320
- Difficulties in Learning Agriculture Science as a Subject in G.C.E. Advanced Level Class., 320
- Digital Image Compression with Wavelet Transforms., 377
- Disaster Preparedness of Sri Lankan Businesses: A Case Study of Five Companies., 155
- Dispersion and Water Exchange in Strongly Restricted Inlet Lagoon: ARekawa Lagoon, South Coast of Sri Lanka., 173
- Distributed Sales Application., 377
- Distribution and Ecology of Earthworms in Selected Habitats in Sri Lanka with Emphasis on Soil Fertility and Composting., 405

- Distribution of Endemic Goitre in Kalutara District., 188
- Distribution of Stray Dogs and Their Antirabies Vaccination Status in Hanthana Residence Area in Kandy., 155
- Distribution of Stray Dogs in Three Selected Locations In Kandy: Possible Outbreak of Rabies., 155
- Distribution, Ecology and Taxonomy of Apple Snails of the Genus Pomacea in the Wet Zone of Sri Lanka., 288
- Diversity and Aspects of the Ecology of Birds in Nuwara Eliya and Adjacent Areas of Sri Lanka., 414
- Diversity and Distribution of the Herpetofauna in the Hakgala Range, Sri Lanka., 415
- Diversity and Resource Partitioning of Avifauna in Forest and Agricultural Ecosystems, 189
- Diversity and Taxonomy of Lichens in the Areas Affected by Forest Die Back at Horton Plains National Park, with a View to Biomonitor the Ecosystem Health., 248
- Diversity of Aquatic Plants in Three Selected Tanks and Utilization of Aquatic Plants by the Community in the Anuradhapura District., 182
- Diversity of Ferns at Upper Hantana: a Sample Ecological Study for A/L Biology Students., 320
- Diversity of the Ground Living Amphibian Fauna in the Campus of the University of Peradeniya, Sri Lanka., 415
- Dose Response Relationship of *Salmonella* Enteritidis Infection in Guinea Pigs., 20
- Dosimetric Characteristics and Optimization for a Multislice Computed Tomography, 234
- Drought Identification and Monitoring in Kurunegala District Using Standardized Precipitation Index., 155
- Drying Behavior of Few Commercially Available Paint Samples Using Dynamic Light Scattering., 240
- Dye Sensitization of Nanoporous TiO₂ with Solid Polymer Electrolyte for Solar Energy Conversion., 83
- Dye Sensitized Photo Electro Chemical (PEC) Solar Cells Using PEO Based Solid Polymer Electrolyte., 240
- Dye Sensitized Solar Cell Based on Hydrothermally Synthesized TiO₂ Nanotubes., 133
- Dye-Sensitized Photoelectrochemical Cells Based on TiO₂ Films with Polymer Electrolytes for Solar Energy Conversion., 85
- Dynamic Detection of Land Use Changes Using GIS in Thambuththegama Area., 167
- Dynamics of Market Models with Inventory., 204
-
- E**
- E-Bookstore with Distributed Database Approach., 377
- Ecological Study of Grasslands at Horton Plains National Park., 321
- Ecology and Biodiversity in an Irrigated Rice Field Ecosystem., 398
- Ecology and Diversity of Woody Vegetation in Oruppreella Rain Forest, Kegalle District, Sri Lanka: a Preliminary Study., 321
- Ecology and Social Biology of a Selected Population of the Western Purple-Faced Leaf Monkey (*Trachypithecus vetulus nestor* = *Presbytis senex Nestor*)., 400
- Ecology, Diversity and Distribution of Freshwater Crabs (Decapoda: Parathelphusidae) in Knuckles and Nuwara Eliya Region of Sri Lanka., 405
- Economic Design of Fraction Non-Conforming Quality Control Chart., 358
- Edaphic Characteristics at the Ussangoda Serpentinite Deposit., 266
- Education Management Information System for the Ministry of Education -Sri Lanka., 378
- Effect of 1- Methylcyclopropene on the Ripening of Tomatoes (*Lycopersicon esculentum* mill cv. caraibo) During Postharvest Storage., 297
- Effect of *Bacillus macerans* on the Growth of Fungi on Copra During Storage, with Special Attention to Aflatoxin Levels in a Medium Scale Processing Unit., 297
- Effect of Bee Honey Treatment on Controlling the Lipid Level of Hyperlipidaemia Patients., 293
- Effect of Carbon Filler on Conductivity of (Peo)₉ LiCF₃SO₃ Polymer Electrolyte., 238

- Effect of Coconut Fat on Serum and Aortic Tissue Lipids, and Endothelial Dependent Relaxation of Blood Vessels: A Study in Guinea Pig., 1
- Effect of Dietary Fat on Blood Lipids., 6
- Effect of Different Industrial Effluents on the Water Quality of Valaichchenai Lagoon., 189
- Effect of Four Antagonists against *Fusarium oxysporum* Causing Fusarium Rot of Cucumber., 297
- Effect of Freckle Disease on Ripening Rate of Different Cultivars of Banana., 297
- Effect of High Energy Radiation on Poly (Ethylene Oxide) Complexed with Copper Thiocyanate., 240
- Effect of Hot Water, Papaya Latex and Bacterial Treatments to Extend Shelf Life of Papaya (*Carica papaya* L.), 297
- Effect of Inclusion of *Setaria italica* (L.) P. Beauv Seeds on the Level of *cis-9, trans-11* Isomer of Conjugated Linoleic Acid Content in Goat Milk., 7
- Effect of Incorporating Sulphate of Potash Magnesia (SPM) and Kieserite to a Recommended NPK Mature Tea Fertiliser Mixture (U709) on Soil Nitrogen Availability., 118
- Effect of *Lactobacillus bulgaricus* and *Streptococcus thermophiles* on Serum Lipid Profile and Total Protein Concentration in Guinea Pigs., 20
- Effect of *Mannan oligosaccharides* on Some Nutritional and Biochemical Parameters of Mice., 25
- Effect of Modified Atmosphere on Extending Storage Life of "Embon" Banana., 298
- Effect of Nitrogen and Potassium Levels of Fruit Peel Tissue on Anthracnose Development and Postharvest Storage Quality of 'Embul' Bananas., 298
- Effect of Nucleotides on Some Nutritional Parameters of Mice., 25
- Effect of Organic Fertilizers on the Growth of the Azolla Plant., 321
- Effect of Pesticides and Trematode Infection on Survival, Growth and Development of Malformations in *Polypedates cruciger* and *Bufo melanostictus* (Amphibia: Anura)., 406
- Effect of Postharvest Calcium Chloride Treatment on Shelf Life and Quality of Tomato (cv. 'Thilina')., 298
- Effect of Postharvest Treatments on the Shelf Life of Mauritius Pineapple (*Ananas comosus* L. Merr.), 298
- Effect of Potential Biocontrol Agents Isolated from Food Sources on Fungal Contamination of Copra and Fresh Coconut and on Quality of Coconut Oil., 269
- Effect of Pre and Postharvest Treatments on Postharvest Quality of Selected Varieties of Decorative Cut Foliage., 267
- Effect of Preharvest Treatments with Gibberellic Acid and Bagging, on Quality and Shelf-Life of Banana (CV. 'EMBUL')., 268
- Effect of Root Polyphenols and Amino Acids on Nematodes in Tea., 128
- Effect of Selenium on Some Nutritional Parameters of Mice., 25
- Effect of Soil Organic Matter on Nutrient Availability under Different Land Use Patterns with Special Emphasis on the Role of Carbohydrates., 249
- Effect of Soil Salinity in the Paddy Cultivation in Vavuniya District., 155
- Effect of Soil-Related Factors on Habitat Specialization in the 25 ha. Forest Dynamics Plot at Sinharaja Rain Forest, Sri Lanka., 270
- Effect of some Carbon Substrate Supplementation, on Associative Dinitrogen of Rice., 271
- Effect of Student Centered Learning Including Criterion Based Assessment on the Performance of Students., 321
- Effect of Sunlight and Rain on the Colour of Coloured Asbestos Sheet., 129
- Effect of Sunlight, Soil Nutrient Status and Original Establishment on the Chemical Composition of *P. longum*., 128
- Effect of Tea Metabolites on Development and Behaviour of Selected Insects and the Transformation of Steroids by *Monacrosporium ambrosium*., 40
- Effect of Transport Practices on Postharvest Disorders and Diseases of Cassava., 298
- Effect of Two Antagonistic Bacterial Isolates on Three Major Postharvest Pathogens., 298

- Effect of Using Microwave Energy for Withering on Quality of Made Tea., 129
- Effect of Wind Speed and Wind Directions on the Ventilation through Ridge Vent and Net Covered Side Vents in Single-Span Venlo-Type Greenhouses., 321
- Effective Control of Dengue Fever Vectors: *Ae. aegypti* and *Ae. albopictus* in Sri Lanka., 407
- Effective Half Life of ^{131}I in Thyroid Cancer Patients., 235
- Effective Method for Teaching Organic Synthesis for G.C.E. A/L Students., 321
- Effective Method of Teaching Thermochemistry., 322
- Effective Ways of Teaching Periodicity, Patterns and the Properties of Some Elements., 322
- Effectiveness of 5E Instructional Method in Teaching and Learning Agriculture and Food Technology, G.C.E. (O/L)., 322
- Effectiveness of Activity Based Learning in Teaching Biological Concepts to Primary Students., 322
- Effectiveness of Bilingual Education in Kandy District., 322
- Effectiveness of Information and Communication Technology Applications for Advanced Level Science Education., 322
- Effectiveness of In-Service Teacher Training on Development of Secondary School Level Physics Education., 323
- Effectiveness of Modified Atmosphere Packing (MAP) and the 'Hydrostore' Moist Bag in Extending the Storage Life of Lettuce (*Lactuca sativa* L.)., 299
- Effectiveness of Some Essential Oils Alone or in Combination with Sodium Bicarbonate in the Control of Banana Crown Rot (*Musa acuminata* AAB)., 299
- Effectiveness of Understanding Chemistry Concepts of Eighth Graders through Problem-Based Learning., 323
- Effects of 1- Methylcyclopropene (1-MCP) on Postharvest Quality of Chilli (*Capsicum annum* L. var. MI-2)., 299
- Effects of Anti- α -Galactosyl Antibodies on the Growth of the Malaria Parasite, *Plasmodium falciparum*., 408
- Effects of Different Postharvest Treatments and Packing Materials on the Quality and Shelf Life of Carrots (*Daucus carota* var *sativus*)., 299
- Effects of Fertilizer Application in Up-Country Tea Lands on Downstream Pollution., 180
- Efficiency of Removing Arsenic from Drinking Water Using Aluminum Oxide and Ferric Oxide., 118
- Efficient Algorithm for Locally Fitted 3D Mesh Generation., 378
- Efficient Transfer Scheme for School Teachers in Sri Lanka., 204
- Elaeocarpus serratus*: Anti-Oxidant Activity and Cosmetic Applications., 118
- Electrical Conductivity and Optical Absorption Studies of Polyaniline Conducting Polymer., 221
- Electrical Conductivity of Synthesized Zircon Ceramics Doped with Different Dopants., 240
- Electrical Properties of Zircon (ZrSiO_4) Ceramics Doped with Different Dopants Prepared via Solid State Sintering Route., 207
- Electrochemical Analysis of Pesticides in Water., 189
- Electrochemical and Electromechanical Behaviour of Polypyrrole Films., 221
- Electrochemical Behaviour of Polypyrrole/Dodecyl Benzene Sulphonate Films in Highly Concentrated Electrolytes., 240
- Electrochemical Detection of Chromium (VI)., 118
- Electrochemical Studies of Electronically Conducting Polymers and their Possible Applications., 88
- Electrochemical, Gas Chromatographic and Spectroscopic Methods for Investigation of the Fate of some Commonly used Pesticides in Sri Lanka., 86
- Electrolytic Treatment of Oil-Based Effluent., 189
- Elephant Orphanage at Pinnawala, Sri Lanka: its Management and Aspects of Biology, Ecology and Behaviour of its Elephants., 408
- Emergency Response Plan for Teaching Hospital Anuradhapura Sri Lanka., 155
- Employment Status of G.C.E. A/L Biological Science Stream Students in Selected Provinces of Sri Lanka., 323

- Enhance the Mechanical Strength of Bricks and Construction Materials., 160
- Enhanced Biodegradation of Photodegradable Polyethylene from Developed Microbial Biofilms., 25
- Enhanced Computer Based Counting System for Coconut Mites in Microscopic Images., 378
- Enhancement of Experimental Aspects in Specified Practicals in G.C.E. (A/L) Chemistry., 323
- Enhancement of Learning through Problem-Based Learning., 323
- Enhancing Attitudes towards Conservation of Biodiversity among G.C.E. (A/L) Biology Students through Problem Based Learning., 323
- Enhancing Electronics Concepts through Life Related Experiments for G.C.E. Advanced Level Physics Students., 324
- Enhancing Student Achievement on Major Biological Processes in Living Organisms through Problem Based Learning., 324
- Enhancing Student Understanding of Unit 4: Diseases Associated with the Main Systems of the Human Body by Introducing Worksheets., 324
- Enrichment of Iron in the Gannoruwa Well Field: Causes and Pathways., 161
- Environment Friendly Options for the Control of Sesame Leaf Webber and Pod Borer: *Antigastra catalaunalis duponchel* (LEPIDOPTERA: PYRALIDAE), 189
- Environmental Parameters and Fish Abundance in Negombo Lagoon., 174
- Environmental Problems and their Management in Three Selected Hospitals in the Kurunegala District., 189
- Epidemiological Risk Factors of Chronic Kidney Disease of Unknown Origin in, 358
- Equilibrium Studies on Toxic Metal Ion-Mixed Ligand Systems under Physiological Conditions., 89
- Establishing a Rapid Isolation Method for *Mycobacterium tuberculosis*., 290
- Establishing Haematological Reference Ranges Using a Selected Population of Blood Donors, 20
- Establishment and Validation of an Immunofluorescence Antibody Test (IFAT) to Diagnose Sarcosystis Infection in Cattle., 26
- Establishment of a Molecular Diagnostic System for Detecting Human Papilloma Viruses in Clinical Samples., 26
- Establishment of a Molecular Diagnostic System for Detecting Y - Chromosomal Microdeletions Which Cause Male Infertility., 26
- Establishment of GIS Based Land Bank., 167
- Establishment of Health Services for Internally Displaced Persons in Vavuniya, Sri Lanka 2009., 156
- Establishment of PCR Based Assay To Detect *Dirofilaria* Transmission in Mosquitoes., 290
- Establishment of Pre-Hospital Emergency Medical System in the Municipality of Anurdhapura., 156
- Estimating Fluoride Exposure in Rural Communities in Sri Lanka: A Case Study from Irakamam Village in Ampara District., 190
- Estimation of Absorbed Dose to Thyroid Carcinoma Patients who are Treated with Radioactive Nuclide Iodine - ¹³¹I., 235
- Estimation of Parameters from Gaussian-Beta Hierarchical Model., 358
- Estimation of Population Density and Herd Composition of Elephants in Minneriya National Park, Sri Lanka., 288
- Estimation of the Effective Population Size for Coconut Genome Mapping Using Computer Simulation., 26
- E-Tendering System for Government Procurement Process., 378
- Ethno Botanical Analysis of Montane Flora in the Ritigala Range., 294
- Evaluating and Enhancing Grade Eleven Science Teachers' Teaching of Physics Concepts in Nuwara-Eliya Zone., 324
- Evaluating the impact of Capture and Translocation of Trouble Making Toque Monkey (*Macacasinica*) Troops in Mahakanda Village, as a Tool of Mitigating the Human-Macaque Conflict., 156
- Evaluating the Success of Translocating Problem Creating Elephants to Mitigate Human-Elephant Conflict in North-Western Wildlife Region in Sri Lanka., 190

- Evaluation and Enhancement of Weaknesses of the IEEE 802.11b WEP Protocol with Dynamic Key., 378
- Evaluation of Chemical Properties of Tea in Different Regions of Sri Lanka., 118
- Evaluation of Communication Technologies for Smart Grid Applications., 378
- Evaluation of Computer-Based Conceptual Simulations: A Case with Reproduction in Flowering Plants., 324
- Evaluation of Groundwater Quality and Soil Pollution in Urban Solid Waste Dump Site, Kegalle., 190
- Evaluation of Ion Removal Capacity of Low Cost Naturally Available Murunkan Clay for Desalination of Water., 118
- Evaluation of Laws Regulating Lakes and Reservoirs of Sri Lanka, 190
- Evaluation of Mass and Energy Balances of Landfill Bioreactor "Test Cell" at Peradeniya., 190
- Evaluation of Microbiological and Chemical Quality of Commercially Available Bottled Drinking Water in Sri Lanka., 250
- Evaluation of the Presence of some Selected Metals in Commercial Bottled Drinking Water in Sri Lanka., 119
- Evaluation of Water Quality of Girandurukotte where Chronic Kidney Disease is Prevalent., 119
- Evaluation of Water Quality of Kelani River with Emphasis on Chrome Leather Tanning Industrial Effluents., 119
- Evaluation of Water Quality of Maa Oya with Emphasis on Total Organic Carbon and Carbofuran Residues., 119
- Evaluation of Water Quality of Pinga-Oya with Emphasis to Heavy Metal Pollution., 190
- Evaluation Procedure for Chemical Kinetics., 325
- Development of a Specific Molecular Marker to Identify the Coconut Form Bodiri., 25
- Evolution of Organic Chemistry Content in Sri Lankan Schools with Special Reference to Advanced Level Syllabus., 325
- Exercise in Teaching the Topics "Equilibrium of a Rigid Body under the Action of Coplanar Forces" and "Complex Numbers" of the GCE (A/L) Syllabus by the Guided Discovery Method., 325
- Experimental Correlation among Some Mechanical Properties of uPVC Pipes., 240
- Exploring Conversion of Perthite to Moonstone by Heat Treatment., 163
- Extending the Storage Life of "Mukunuwenna" Using a Low Cost Evaporative Cooling System., 299
- Extending the Storage Life of Mukunuwenna (*Alternanthera sesilis*) in Simulated, 299
- Extraction and Characterization of Bixin from the Annatto Seeds and its possible use in the Colour Enhancement of Gold Fish., 129
- Extraction of Topological Properties from a 2D Contour Map and Reconstruction of the 3D Terrain., 379
-
- F**
- Fabrication and Characterisation of $\text{Bi}_{1.6}\text{Pb}_{0.4}\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ Superconductors Prepared by Solid State Reaction Technique., 241
- Fabrication and Characterization of Some Polymer and Pigment-Based Devices for Solar Cell and Electrochromic Applications., 222
- Fabrication of Dye-Sensitized Solid-State Solar Cells: use of Triethylamine Hydrothiocyanate as Crystal Growth Inhibitor., 133
- Fabrication of Grinding Wheels Using Locally Available Minerals., 241
- Fabrication of Low Cost Clay Bricks for Building Industry., 223
- Fabrication Use of Biology Practicals to Enhance Learning of Grade Eleven Students., 325
- Face Recognition Based on Eigenfaces., 379
- Facial Expression Recognition System., 379
- Factors Affecting on Decision Making and Achievements in Educational Pursuits of Students in Selecting Careers., 325
- Factors Affecting on Physical Dormancy Break of *Ipomeea hederacea* Seeds., 359
- Factors Influencing Postharvest Longevity of Okra (*Hibiscus esculentus*)., 300
- Feasibility Studies on Underplanting Multiple Use Species in Buffer Zone Pine Plantations of the Sinharaja MAB Reserve., 272

- Feasibility Study of Bio Diesel Production from Locally available Non Edible Oils., 130
- Feature Extraction and Classification of Sinhala Fonts., 379
- Feldspar-Fluoride Interactions: Examination of Interfacial Processes by Potentiometry., 119
- Field Study, Preparation and Evaluation of a Study Guide on Insect Pests in a Rice Field: (for G.C.E. A/L Biology Syllabus)., 325
- Fingerprint Image Enhancement Method Using Chain-Code Based Orientation Estimation and Directional Median Filter., 379
- Fingerprint Matching Based Crime Detection System., 379
- Fitting Beta-Binomial Distribution to Overdispersed Binomial Data., 359
- Flood Risk and Vulnerability Assessment along Kelani River in Biyagama., 167
- Flood Risk Identification and Management in the Horowpathana Urban Environment., 182
- Floristic Structure and Aspects of Regeneration of Tree Species in the Kahalla Forest Reserve., 273
- Floristics and Soil Nutrient Status of Hantana Forests, Sri Lanka., 274
- Fluctuations in Physico-Chemical Parameters and Dipteran Larval Density in Household Composting Units., 191
- Forecasting Accidents due to Liquor in Sri Lanka., 359
- Forecasting Cow and Buffalo Milk Production in Sri Lanka., 359
- Forecasting Currency in Circulation in Sri Lanka., 359
- Forecasting Sri Lankan Black Tea Prices., 359
- Forest Die-Back at Rajawaka Forest Reserve., 191
- Formulation of a Groundwater Potential Index in Sri Lanka., 161
- Four Medicinal Plants Used as 'Danti' in Ayurvedic Medicine in Sri Lanka: A Taxonomical, Anatomical and Phytochemical Study., 294
- Fractal Based Automated Pattern Design., 380
- Fracture Toughness and Craze Behaviour of Virgin and Filler Added Polystyrene Films., 224
- Freckle Disease Caused by *Phyllosticta musarum* in Banana: Biology, Control and Host Defense Responses., 252
- Free and Open Source Spam and Virus Filtering Gateway for Remote Mail Transfer Agent., 380
- Fruit Volume Estimation by Digital Image Processing., 380
- Functional and Financial Feasibility Analysis of GIS Software., 167
-
- G**
- Gelatinolytic Activity in Human Whole Saliva., 119
- Gem Mineral Distribution in the Area Around Uggalkaltota off Balangoda., 163
- Gemmological Investigation of Corundum and Spinel in the Embilipitiya and Ratnapura Areas of Sri Lanka., 164
- Gender Difference in Learning Electricity., 326
- Generation of Visual Characteristics of Humonoid Robots Using a Graphics Animator., 380
- Genesis of Pegmatites and use of Pegmatite Mine Waste as Fertilizer, Matale District, Sri Lanka., 140
- Genetic Diversity and Population Structure of Wild Banana (*Musa balbisiana*) Populations in Sri Lanka., 26
- Genotyping of Hepatitis B Virus (HBV) Using Previously HBV Positive Serum Samples from Individuals Referred from the Surgical Clinic Teaching Hospital, Peradeniya., 290
- Geochemical Etiology of Chronic Kidney Disease Unidentified (CKDU): Case Study from Mahamailankulam, Vavuniya., 156
- Geochemistry of the Serpentinite Deposit at Ussangoda and Possible Environmental Impacts., 191
- Geoenvironmental and Engineering Geological Study of Cut Slope Failures in Kandy Area., 191
- Geological and Geotechnical Interpretation of Some Quaternary Formations of Colombo., 161
- Geology, Microstructure and Chemistry of some Vein Graphite Deposits of Sri Lanka., 141

- Geotechnical Back Analysis as an Economical Method of Slope Stabilization: A Case Study at Thalathu Oya Metal Quarry., 161
- GIS Application for Weather Analysis and Forecasting., 380
- GIS Based Archaeological Data Management System for Anuradhapura., 167
- GIS Based Decision Making System for Agriculture., 168
- GIS Based Gem Potential Map: A Case Study from Moragahakanda Reservoir Area, Naula., 168
- GIS Based Model for Potential Locations of Mini Hydropower Projects., 168
- GIS Based Slope Stability Models for Rain Triggered Landslide Hazard Mapping: Case Study - Rathnapura, Sri Lanka., 168
- GIS Based Solid Waster Management of Matale Municipal Council Area., 168
- GIS for Effective Land Use Management in Plantation Sector., 168
- GIS for Land Use Zoning in Urban Development Plans Case Study: Hambantota Municipal Council Area., 169
- GIS for Rural Planning in Hambantota District., 169
- GIS Guided Land Suitability Analysis for Urban Development Activities in Trincomalee Urban Council (TUC) Area., 169
- GIS Model to Identify Soil Erosion Potential Areas of a Watershed (a Case Study of Kukule Ganga, Sri Lanka)., 169
- GIS-Based Decision Support System for Matara Divisional Secretariat Division., 168
- Global Position Tracking System for Public Transportation in Sri Lanka., 380
- Global System for Mobile Communications Short Message Service Based Automated Credit Information System., 381
- Gold Mineralization in Sri Lanka with Special Emphasis on Walawe Basin and Ramboda Areas., 142
- Gonadal Dose of Radiation in Patients Undergoing Chest Radiography., 235
- Graph Colouring Model for Timetabling Problem., 381
- Grass Competition and Herbivores Competition on Survivals and Growths of Transplant Seedlings on Degraded Grassland Areas., 359
- GRK_EXedt - Tamil TEX Editor for Scientific Typesetting and for L^AT_EX Output., 381
- Ground Water Pollution in Batticaloa., 120
- Groundwater Condition in Monaragala District., 175
- Groundwater Development in NuwaraEliya Area: Hydrogeological Drawbacks and Remedial Measures., 161
- Groundwater Potential Mapping in Hard Rock Areas Using GIS and RS., 169
- Groundwater Quality and Chronic Kidney Disease in the North Western Province of Sri Lanka
A Case Study., 191
- Groundwater Resources for Community Water Supply Schemes : a Case Study from Minipe-Muttettutenna in the Kandy District of Sri Lanka., 175
- Group B Streptococcus Colonization in Pregnancy., 290
- Growth and Persistence of Biofilmed Biofertilizers in Liquid Media as Influenced by pH., 294
- Growth Curve Analysis of Goat Breeds in Sri Lanka., 360
- Guide to Identify Marine Food Fishes Available at Some Selected Markets: Landing Sites in South Western and Southern Coasts of Sri Lanka., 326
- Guidelines for Setting Standards for the Nomenclature, Description, Grading and Appraisal of Sri Lankan Gems., 164
-
- H**
- Hand Written Character Recognition Using Image Processing and Artificial Neural Network Techniques., 381
- Harvesting Maturity and Postharvest Fungal Diseases in Ridged Gourd (*Luffa acutangula*) var. Indian 19., 300
- Heat Treatment of Gueda Stones and Enhancement of their Blue Colour., 164
- Heat Treatment of Oil Based Sludge., 191
- Heat Treatment of Yellow Geuda., 164
- High-Speed Counter-Current Chromatographic Separation and Antibacterial Activity of Proanthocyanidins from Tea Leaves., 89

- Histopathological Effects of Crude Venom and Purified Phospholipase A2 from Russell's Viper (*Daboia russelii russelii*) in Mice., 21
- Hospital Management System., 381
- How Successful is the Newly Introduced Biology Curriculum in Schools to Date?, 326
- Hydrogen Peroxide in Milk: Its Estimation and Possible Effects on the Quality of Milk., 120
- Hydrogeochemistry of Areas with Endemic Chronic Kidney Disease with Uncertain Etiology in Vavuniya District., 120
- Hydrogeochemistry of Groundwater from Two Dry Zone Regions of Sri Lanka., 175
- Hydrogeological Assessment of the Hard Rock Aquifers in Proposed Biyagama Export Processing Zone., 161
- Hydrogeological Assessment of the Precambrian Basement in the Area Around Vavuniya Town as Revealed from Existing Tube Well and Dug Well Data., 162
- Hydrogeology at a Boundary Between Sedimentary and Hard Rock Aquifer Units: A Case Study from Palavi in the Puttalam District., 162
- Hydrography, Coastal Water Circulation and Classification of Sri Lankan Lagoons., 209
- Hydrothermal Synthesis of Hydroxyapatite Nanopowders., 241
-
- I**
- Identification and Mapping of Spatial Distribution of Floating Aquatic Plants in Tanks Using Remote Sensing and GIS., 169
- Identification of a Microsatellite Marker Linked to Thrips (*Stenchaetothrips biformis*) Resistance in Rice Using Bulk Segregant Analysis., 26
- Identification of Difficulties in Teaching and Learning G.C.E. A/L Biology: Sub Unit, "Reproduction in Plants", 326
- Identification of Learning Difficulties in Phase Equilibria in Chemistry among G.C.E. (A/L) Students and Some Suggestions to Overcome Difficulties Identified., 326
- Identification of Pathogenic *Leptospira serovar* in Sri Lanka Using Polymerase Chain Reaction., 290
- Identification of Some Learning Difficulties of Physics Concepts on Fields Among G.C.E. (A/L) Students and Suggested Recommendations to Teachers., 326
- Identification of Standard Local Sand for Cement Testing., 226
- Identification of the Human Race Using Skin Color (HRI-System), 381
- Identification of the Ssr Marker Rm261 for Brown Plant Hopper Resistant Gene BPH 12 (T) in *O. officinalis* Line Ir 54751-2-34-10-6-2 and Its Validations., 27
- Identifying the Effect of Information Technology on Total Quality Management: A Study of Manufacturing Organizations in the Greater Colombo Region., 360
- Identifying the Flowering and Fruiting Pattern of Eight *Shorea* Species in Sri Lanka Using Directional Statistics., 360
- Identity Authentication Based Keystroke Latencies., 381
- Image Classification of Paddy Field Insect Pests Using Gradient-Based Features., 382
- Image Processing Routines for an Automated Security System., 382
- Image Steganographic Scheme Based on Reversible and Inverse Embedding Strategies., 382
- Impact of 2007 Education Reforms on G.C.E. (O/L) Mathematics Results., 327
- Impact of Seasonal Flooding on Livelihoods in Two Selected Urban Low Income Communities in Colombo District., 156
- Impact of Simple Biological Projects in Learning Biology., 327
- Impact of Teacher Qualities on Mathematics Performance of Junior Secondary Level Students., 327
- Impact of the Internally Displaced Persons from the North and East on the Local Population in Alankuda., 156
- Impact of the Performance of G.C.E. (O/L) Mathematics on the Subject Combined Mathematics at the G.C.E. (A/L) Examination in the Batticaloa District., 327
- Impact of Tsunami Rehabilitation Assistance (Special Reference to Town and Gravets Divisional Secretariat Division of Trincomalee District), 157

- Impact of Weligama Coconut Leaf Wilt Disease (WCLWD) on Morphological, Physiological and Yield Aspects Coconut Palms., 294
- Impact of Wetland Filling in Urban Area on Flood Detention Capacity: case Study from Muthurajawela Marsh., 175
- Impact of Wild Elephants on Agricultural Communities in Victoria-Randenigala-Rantambe Sanctuary., 304
- Impacts of Dam Construction of Upper Kotmale Hydropower Project in Kotmale Oya, Talawakelle on Vertebrate Fauna and Possible Mitigation Measures., 192
- Impacts of Gem Mining on the Environment in Pelmadulla Area., 327
- Impacts of Soil Biological and Chemical Properties on Forest Dieback at Horton Plains National Park, Sri Lanka: Influence of Arbuscular Mycorrhizal Fungi on the Growth of *Syzygium rotunfolium* Arn., 275
- Implement a Model to Reserve Mobile Numbers in an Efficient Manner for a Telecom Service Provider., 382
- Implementation of Kruskal's Algorithm., 204
- Implementing a Unit Plan with School-Based Assessment (SBA) Modalities for Tenth Grade Mathematics., 327
- Improve the Learning Skills of Students on "Water Quality" in G.C.E. (A/L) Chemistry Syllabus., 328
- Improved Estimation of Parameters in Probability Distributions with Known Prior Information., 350
- Improved Methods of Mixed Estimation in Linear Regression Model., 352
- Improved Steganographic System for PCs and Mobile Devices., 382
- Improvement of Performance of Students through an Activity Oriented Approach to Teach Enzymes for G.C.E. Advanced Level Biology Students., 328
- Improvement of Secondary Permeability in Hard Rocks Using Hydro Fracturing Techniques: A Case Study from Hard Rock Terrain of Sri Lanka., 162
- Improvement of Students' Achievement in Learning Section 6.5: Pollution of the Environment of A/L Biology Syllabus through Activity Based Learning., 328
- Improvement of Understanding of a Biology Unit for Tenth Graders Using School-Based Assessment (SBA)., 328
- Improving Student Understanding of Introductory Level Physics-Mechanics through Computer-Based Interactive Methods., 328
- Improving the Production Efficiency in Hirdaramani (Industries) Limited at Kahathuduwa Using Statistical Process Control., 360
- Improving the Quality of a Soft Drink Production Process Using Statistical Process Control., 360
- Improving the Quality of Cement Manufacturing Process by using Statistical Techniques, 130
- Improving the User Friendliness of Tamil Web Browsing., 382
- Impurities Adulterants and Diluents of Illicit Heroin in Sri Lanka., 120
- Inculcating Good Attitudes Regarding the Environment in Students of Grade Seven through the Story Telling Methods., 328
- Inflorescence Diseases and Natural Disease Resistance in Mango (*Mangifera Indica* L.) in Relation to Anthracnose Development., 253
- Influence of Land Based Pollutants to the Quality of Water at the Kaluganga Bay Area., 329
- Influence of Language Factor on Student Performance on Solving Word Problems among Bilingual Learners in Junior Secondary Level., 329
- Influence of Performance at the Grade 5 Scholarship Examination on the Follow-On Education: A Case Study in the Batticaloa District., 360
- Influence of Seasonal Sea Level Variability on Salt-Water Intrusion in Kelani River Basin., 174
- Influence of Students' Mathematics Knowledge in Learning Advanced Level Physics., 329
- Influence of the Particle Size of CaCO₃ Coating Layer on the Efficiency Enhancement of SnO₂-Based Dye Sensitized Solar Cells., 133
- Influence of Unplanned Human Settlements on Urban Land: A Case Study of Colombo Municipal Council., 170

- Influence the Performance and Energy Consumption of Modern Storage Devices by Reevaluating Input/Output Architecture for Green It., 383
- Information Management System for Energy Purchase in Ceylon Electricity Board., 383
- Information Management System for Trincomalee Multipurpose Cooperative Society Sri Lanka., 383
- Information Management System for Universities., 383
- Information System of Payroll Management for Lankem Plantations Ltd., 383
- Insecticidal Activity of *Euphorbia antiquorum* L. Latex against Agricultural Insect Pests, 410
- Insecticidal Compounds from some Sri Lankan Plants., 41
- Insecticide Tolerance in the Bruchid *Callosobruchus maculatus*., 128
- In-Situ Corundum Occurrences in Kegalle District, Sri Lanka., 164
- Instrument and Software Development for Measuring Size of Nanoparticles Using Dynamic Light Scattering., 133
- Integrated Method in Teaching Postharvest Technology for Advanced Level Agricultural Students., 329
- Integrated Solution to Monitor and Audit Network for IT & Non-IT Personnel (Development of a Friendly Prototype)., 383
- Integro-Differential Inequalities and the Impact of White Noise in Dynamic Market Models., 204
- Intelligent Chat Bot for Chatting with People Having Stress and Depression., 384
- Intelligent Weather Forecasting System for Sri Lanka., 353
- Interaction of Phosphates with Brick Clay Particles for Water and Wastewater Treatment., 120
- Interactive Computer-Based Study Package on the Structure and Functions of Human Digestive System for the G.C.E. (A/L) Biology Syllabus., 329
- Interactive Study Package on G.C.E. (A/L) Electronics., 329
- Internet Based Study Package to Enhance the Understanding of the Chemistry of Polymers at G.C.E. (A/L)., 330
- Interspecific Competition of Container Breeding Mosquitoes in Kandy., 415
- Introducing "Household Chemistry" for Advanced Level Chemistry Syllabus., 330
- Introducing "Scientific Method" for G.C.E. (Advanced Level) Student Projects Using Monkey Menace as an Example., 330
- Introducing Active Teaching-Learning Methods to Enhance Sixth Graders Achievement on 'Plant Diversity'., 330
- Introducing Atomic Structure to Advanced Level Students through their Active Participation in the Learning Process., 330
- Introducing Field Based Teaching Technique as a Teaching Tool for the Biodiversity Unit in the G.C.E. (A/L) Syllabus., 330
- Introducing Tamil Language in Computer Assisted Learning Software., 384
- Introduction of Factor of Safety Concept in Landslide Hazard Zonation Mapping: A Case Study from Ratnapura Municipal Council Area., 162
- Introduction of New Experiments in Chemistry for G.C.E. (A/L) Classes., 331
- Introduction of Plant Tissue Culture Practical for G.C.E. Advanced Level Science Students., 331
- Introduction of Spectroscopy to the A/L Syllabus., 331
- Invasive Potential of *Pinus caribaea* Morelet in Wet and Intermediate Agro-Ecological Zones in the Knuckles Range, Sri Lanka, 276
- Investigating the Effect of Selected Macro and Micronutrients on Biological Treatment Systems Adopted by Sri Lankan Textile Industry., 120
- Investigating the Statistical Properties of Exponential Family of Distributions and Estimation of Parameters., 361
- Investigation of Chlorpyrifos in Groundwater Under Onion Cultivation in Kalpitiya Peninsula., 192
- Investigation of Corrosion Inhibition of Aluminium Surfaces using *Neolitsea cassia* (L) (Wild Cinnamon) Extracts., 121
- Investigation of Diurnal Variation and Impact of Stress on Titratable Acidity of Pineapple var. Mauritius as Causative Effect on Internal Browning., 300

- Investigation of Dose Accuracy of Radiation in the Treatment of Breast Carcinoma Using Glancing Fields., 235
- Investigation of Electrical Properties of Barium Titanate Based Ceramics., 241
- Investigation of Environmental Fate of Some Selected Pesticides Using Electrochemical Methods., 90
- Investigation of Green Catalytic Properties of Clay Nanocomposites., 92
- Investigation of Lead Pollution in Pinga-Oya and Comparison of Analytical Results of Lead Content Using Atomic Absorption and UV/Visible Spectrophotometers., 121
- Investigation of Misconceptions in Chemical Equilibrium among G.C.E. (A/L) Students: the Impact of Practical Classes in Eliminating Such Misconceptions., 331
- Investigation of Sorption of Methylene Blue (MB) Dye on Thermally Treated Brick Clay Particles., 121
- Investigation of Students' Achievement Levels in Mathematics at the G.C.E. (Ordinary Level) Examination., 331
- Investigation of the Extent of Acid Precipitation in Sri Lanka., 93
- Investigation of the Factors Affecting Performances in Mathematics in G.C.E. (O/L) in the Ambagamuwa Educational Zone (Nuwara-Eliya District - Tamil Medium)., 361
- Investigation of the Interaction of Glyphosate and Paraquat (Gramoxone) at Platinum and Glassy Carbon Electrode Surfaces through Electroanalytical Methods., 121
- Investigation of the Link between School Based Assessment Programme and the G.C.E. (A/L) Results in Combined Mathematics., 361
- Investigation of the Solid State Photochemical Reactivity and Polymorphism of Three Common Drugs., 121
- Investigation of the use of Laterite for the Removal of Ag^+ from Aqueous Medium., 121
- Investigation of the Waste Composition of Households and the Preparation of a Supplementary Book on Waste Management for G.C.E. (A/L)., 331
- Investigation on Level of Heavy Metals in Ecosystem in the Norochcholai Vicinity Area., 192
- Investigation on Suitability of Groundwater in Gampola Town for Domestic Consumption: A Post Epidemic Investigation., 157
- Investigation on the Extent of Pollution of the Kallar Lake., 122
- Investigation on the Extent of Success in implementing Advanced Level Biology Practical Work in Schools in the Kurunegala District., 332
- Investigation on the Natural Water Coagulant *Strychnos potatorum* ("Ingini") Seed Powder for Drinking Water Treatment., 122
- Investigation on the Quality of Mathematics Textbooks., 332
- Iodine Content of Five Salt Brands Available at Retail Outlets in Kurunegala Town., 21
- Iodization of Edible Common Salt with the Amended Food Regulation of Year 2005: a Case Study., 332
- Ion Transport Mechanisms in Mixed Alkali Glass., 241
- Isolation and Bioactivity Studies of Lichen Substances from Sri Lankan Lichens., 42
- Isolation and Characterisation of the Factor, Present in Ginger, which Reduces Cow Milk Allergy., 122
- Isolation and Characterization of a Trypsin Inhibitor from seeds of *Tamarindus indica*., 122
- Isolation of Endophytic Fungi of Sea Weeds from the Coastal Areas of Sri Lanka: A Study on Their Chemistry and Biological Activities., 94
- Isolation of Lipolytic Fungi and Partial Purification of Lipases., 27
- Isolation of *Listeria monocytogenes* from Ready to Eat Food Products., 291
- Isolation, Purification and Characterization of Inhibitors for Aspartic Proteinases from *Spondias pinnata*., 8
-
- J**
- Joint Distribution of the Water Levels of Kotte Canal and Kelani River Using Copulas., 361
-
- K**
- Keyboard Configuration for Tamil Unicode Characters., 384

L

- Laboratory Identification of *Pneumocystis jiroveci* in Clinically Suspected Pneumocystis., 291
- Land Suitability Analysis for Agricultural Crops: A Case Study of Padiyatalawa D.S. Division., 170
- Landslide Hazard Identification in Nuwara Eliya District and Some Mitigation Measures., 157
- LANManager: A Concurrent Management of Computers in LANs., 384
- Leachate Characteristics during the Early Stage of Decomposition of Municipal Solid Waste., 192
- Learning Ability of G.C.E. (Ordinary Level) Students in Geometry., 332
- Learning Difficulties in Advanced Level Electrochemistry and Suggestions to Overcome Them., 332
- Learning Difficulties in Grade 10 Science Students and Possible Solutions through Demonstration Experiments., 332
- Learning Difficulties of G.C.E. (A/L) Combined Mathematics Students in Newton's Laws of Motion., 333
- Levels of Polyaromatic Hydrocarbons in Kandy City., 192
- Liana Vegetation in Kurulu Kele Forest in Kegalle., 333
- Library Management System in Tamil Using Barcode., 384
- Life Cycle of Automobile Oil in Sri Lanka., 192
- LiFeO₂ and LiCoO₂ Based Ceramics as Alternative Cathode Materials for Molten Carbonate Fuel Cells., 210
- Low Cost Approach on Chlorpyrifos Residue Analysis in Vegetables., 122
- Low Cost Methods for Colour and Metal Ion Removal from Industrial Effluents and Polluted Water., 96
- Low-Cost and Environmentally-Friendly Methodologies for Treatment of Water and Wastewater., 95
- Low-Cost Laboratory Teaching Kits for Automatic Control Education in Developing Countries., 204

M

- M16A1 Land Mine Detection Using Backpropagation Neural Network., 384
- Mahawewa Landslide-Causes of Reactivation and Some Suggestions for Mitigation., 157
- Making G.C.E. Advanced Level (A/L) Physics More Attractive through Improved Teaching at Pre-G.C.E. (A/L) Classes., 333
- Management and Rehabilitation of Young Elephants at Elephant Transit Home, Udawalawe., 415
- Management Information System for Agricultural Product Export Company., 384
- Management of Coastal Resources in Channel Islands of Negombo Lagoon., 157
- Manual of Geographic Information Systems Vol. 1., 170
- Manual of Geographic Information Systems Vol. 2: Laboratory Manual., 170
- Manufacture of Precipitated Calcium Carbonate from Dolomitic Quick Lime., 130
- Manufacturing of Mushroom Incorporated Rice Biscuits and Its Quality as Affected by Packaging., 300
- Mathematical Model for Blending of Aggregate by Weight., 205
- Mathematical Skills Needed for G.C.E. (Advanced Level) Physics., 333
- Measurement of Fluoride Ions in Drinking Water., 122
- Measuring Damages and Colour Regions in Tree Leaves Using Image Processing Techniques., 385
- Mechanical Properties of Ancient Clay Bricks and Plasters of Jethawana Sthupa., 241
- Mechanistic Investigation of Interaction of Chromium Species and Thermally-Treated Brick Clay., 97
- Mechanistic Modeling of Arsenic Retention on Natural Red Earth in Simulated Environmental Systems., 193
- Mechanistic, Spectroscopic and Molecular Model Probing of the Arsenic-Gibbsite Interface, 43
- Medical Information Management System for Vavuniya General Hospital., 385
- MESH Network for Software Process Modeling (MNSM), 385

- Metalloporphyrin Coated Electrodes as Sensors for Pesticides., 98
- Methodology to Remove Colour from Textile Waste Water Effluent., 193
- Microbial Insecticides from *Bacillus thuringiensis* and Fungal Metabolites from *Hirsutella thompsonii*., 44
- Microorganisms and Microbial Biofilms as Agents of Cellulosic Biodegradation of Invasive Weeds in Sri Lanka., 277
- Mixed Type Finite Element Method for Radiation and Scattering Problems in Unbounded Domains., 202
- Mobile Access Asset Control System., 385
- Mobile Application for Academic Library Services., 385
- Mobile Based System for Providing Road Traffic Information., 385
- Modeling Approach to Explain the Impact on the Batticaloa Lagoon by the Unnichchai Tank., 193
- Modeling Costal Fresh Fish Production in Sri Lanka., 361
- Modeling Interactions of Pyrite and Monochlorophenols., 99
- Modeling Land Suitability for Expansion of Rubber Cultivation in Monaragala District: A GIS Approach., 170
- Modeling of Arsenic Adsorption on Gibbsite Nanoparticles., 134
- Modeling the Demand for Sri Lankan Air Line by Using Time Series Analysis., 361
- Modelling and Forecasting of Wind Direction and Wind Speed in Selected Weather Stations, 362
- Modelling Crop Growth by Non-Linear Models., 362
- Modelling Drought Condition in Hambantota District: A Time Series Approach., 362
- Modelling Monsoonal Rainfalls with Sunspot Numbers Using Transfer Function Noise Model., 362
- Modelling Spatiotemporal Variables through Data Driven Approximated Forms., 362
- Modification of the G.C.E. (A/L) Laboratory Experiments by Introducing the Real World Applications to Enhance the Curiosity of Students in Chemistry., 333
- Modified Approach to Enhance the Teaching of the Unit "Man and the Environment" in G.C.E. (A/L) Chemistry Syllabus., 333
- Modified Atmosphere Packaging for Local Avocados (*Persea americana* Mill.), 300
- Modified Atmosphere Storage of Type "Kolikuttu" Bananas., 300
- Molecular Characterization of Human Cytomegalovirus (HCMV) in Some HCMV Infected Renal Transplant Patients in Sri Lanka., 27
- Molecular Characterization of Some Chikungunya Virus Isolates from 2007/08 Outbreak in Sri Lanka., 27
- Molecular Detection, Quantification and Characterisation of Hepatitis C Virus Strains in Sri Lanka., 2
- Molecular Diagnosis of Specific Strains of Mycobacteria in Kandy and Matale Districts of Sri Lanka., 9
- Molecular Identification of Methicillin Resistance and Virulence Marker in *Staphylococcus aureus*., 291
- Monitoring Air Quality at Galaha Junction Using Active and Passive Sampling Methods., 193
- Monitoring Air Quality Using Low Cost Techniques and Assessing the Impact of Air Pollution on Vegetative Crops., 177
- Monitoring of Selected Nutrients in Mango during the Processing for Manufacturing of Mango Jam., 123
- Monitoring the Eutrophication Process in Uranikudha of the Batticaloa Lagoon., 193
- Morphological and Anatomical Studies of Two Wild Rice Species: *Oryza eichingeri* Peter and *Oryza rhizomatis* Vaughan., 294
- Morphological Diversity of Trichomes in Some Selected *Argyreia* Species. (Family - Convolvulaceae), 334
- Morphology, Protein Characterization and Seasonal Abundance of Acephaline Gregarines (Apicomplexa: Aseptatina) of Three Earthworm Species., 415
- Mortality Patterns in Wild Elephants in Sri Lanka., 182
- Mosquito Larvicidal Activity of Plant Essential Oils and Essential Oil Compounds., 123

- Mosquito Larvicidal Activity of Selected Plant Extracts and Isolation of Active Ingredient from *Pagianta dichotama*., 130
- Mosquito Larvicidal Biological Control Agent from Sri Lankan Isolate of *Metarhizium anisopliae*., 123
- Mosquitocidal Studies of Mugetanol Derivatives and Herbal-Based Mosquito Coils., 123
- Motivating G.C.E. (A/L) Students Towards Chemistry Related Projects., 334
- Motivation of G.C.E. (A/L) Students to Understand Organic Chemistry through Real Life Applications., 334
- Multi Agent System for Cooperative Tasks., 385
- Multi Technique Approach for the Determination of the amount of Active Ingredient in Amoxicillin Capsules., 123
-
- N**
- Natural Defence Mechanisms in Mango Fruit and their Potential in Management of Postharvest Diseases., 254
- Natural Dissolution Mechanisms of Serpentinite Soils from Sri Lanka: Leaching of Chromium, Nickel and Manganese to the Environment., 100
- Natural Language Question Answering System for Locating Resources in an E-Library., 386
- Natural Oscillations in Approximately Linear Second Order Dynamic Models., 205
- Need for an Organized Remedial Teaching Programme in Mathematics for Pre-Advanced Level Science Classes., 334
- Negative Binomial Distribution as an Alternative to Poisson Distribution for Clustered Counts., 362
- Nematicidal Compounds from some Sri Lankan Plants., 101
- Nest Site Fidelity and Nesting Behaviour of Marine Turtles in Rekawa Turtle Rookery., 411
- Nesting Behaviour, Reproductive Output, Genetic Structure and Nest Paternity of Green Turtles Nesting at Kosgoda Rookery in Sri Lanka., 401
- Network Based Distributed Intelligent Intrusion Detecting System., 386
- Network Enabled Energy Measuring System., 386
- Neural Network Approach to Predict Milk Yield of Dairy Farm., 386
- Neural Network Based Reverse Engineering Approach to Recognize Printed Sinhala Script., 386
- Neural Network Model for Estimating the Emission of Greenhouse Gases in Ecosystem with Soil Factors., 386
- Neutron Activation Analysis of a Meteorite Sample., 242
- New Approach to Enhance Scientific Reasoning Ability in Properties of Matter Unit of A/L Physics Syllabus., 334
- New Approaches in Physical Chemistry Practical and Developing Some Experiments., 334
- New Approaches in Teaching Chemical Kinetics., 335
- New Information Technology Approach to TELCO Revenue Assurance., 386
- New Unit Plan for the Unit "Matter and Radiation" in Advanced Level Physics Syllabus., 335
- Non-Linear Model for Stream Flow Prediction in the Kalu River Upper Catchment in Sri Lanka., 363
- Novel Approach to the Control of *Aedes aegypti*, a Vector of Dengue Fever and Pollution Abatement by the Use of Porphyrin Derivatives., 45
- Novel Experiments for Teaching Advanced Level Physics., 335
- Novel Teaching Package to Enhance Learning Ability of A/L Biology Students., 335
- Numerical model for simulating shoreline change., 174
- Nutrient and Heavy Metal Removal Capacity of *Pistia Stratiotes* L. from a Freshwater Wetland at Kelaniya., 193
- Nutrients and Sources of Pollutants of Maduganga Estuary, Sri Lanka., 194
-
- O**
- Objects Indexing and Cut-Out in a Sequence of Frames., 387
- Occurrences and Environmental Impacts of Acid Sulfate Soil in Colombo Suburbs., 194
- Ocean Colour Remote Sensing : Bay of Bengal During North East Monsoon., 174

- Offline Sinhala Handwritten Character Recognition Using Matrix Matching Method., 387
- Online Bibliographic Database for Eastern University Library Sri Lanka., 387
- Online Internal Verification System for EDEXCEL HND Programs., 387
- Online Mail Tracking System., 387
- Online Orientation System for the Open University of Sri Lanka., 387
- On-line Staff and Student Management System for Ruwanpura National College of Education., 387
- Online Student Registration System with SMS Based Course Management., 388
- Online System for Exam Registration and Results Processing., 388
- Online System to Analyse Production Faults by Using Process History Data., 388
- Online Vehicle Reservation and Monitoring System for the University of Peradeniya., 388
- Ontology Based Information Extraction for Disease Intelligence., 388
- Ontology Driven Clinic Management for Sri Lankan General Hospitals., 354
- Operational Parameters of a Waste Water Treatment Plant Four Decades after Construction., 194
- Optical Character Recognition (OCR) System for Printed Tamil Text Using the Unicode Standard., 388
- Optical Character Recognition Using Image Processing and Artificial Neural Network Techniques., 388
- Optimal Designs., 363
- Optimization of Activated Sludge Process for a Brewery Waste Water Treatment under Local Conditions: Plant Process Control and Management by a Quality System., 130
- Optimization of Technology to Control Development of Bitterness in Dehydrated Jak Fruit Flour., 301
- Optimizing the Inventory Cost of Carbon Dust., 205
- Optimizing the Ordering of Raw Material for Pharmaceutical Products., 205
- Optimum and Shortest Way Finder., 389
- Oral Hypoglycaemic Activity of the Traditional Native Drug Varipra Sadinadi and the Antioxidant Activity of the Drug and Its Constituents., 294
- Oscillations and Waves Experiments Using Low Cost Materials and Available Instruments in the School Laboratory., 335
-
- P**
- Participatory GIS for Rural Development Planning: A Case Study., 170
- Perception of Past Advanced Level Biology Students Towards Biology Curriculum., 335
- Performance Analysis of a Small Low Cost Beowulf Cluster with Mathematical Modeling in a Parallel Computing Environment., 389
- Performance Analysis of Coda File Systems., 389
- Performance Analysis of Existing Public Key Cryptosystems., 389
- Performance Characteristics of Gamma Camera., 236
- Performance characteristics of well counter in radioassay., 236
- Performance Evaluation and Comparison of Java RMI, RMI-IIOP., 389
- Performance Evaluation of Clay-Polyethylene-Clay Composite Biofilm Liner for Landfill in the Dry Zone of Sri Lanka., 194
- Performance of G.C.E. (Advanced Level) Physical Science Students on the Concept of Functions., 336
- Performance of Selected Forest Species Providing Non-Timber Forest Products in Sinharaja MAB Reserve, Sri Lanka., 278
- Performance of Sub Surface Vertical and Horizontal Flow Constructed Wetlands with Special Reference to Sri Lanka., 194
- Performance Study of Software Quality Management Techniques., 389
- Performance Testing for Scintillation Camera., 236
- Pesticidal Compounds from Plants and Effect of Host Plant Odours on Aphids., 47
- Pesticide Residue Analysis in Sri Lankan Made Tea., 123
- Pesticide Residue Analysis of Drinking Water in Girandurukotte Area where Chronic Kidney Disease is Prevalent., 124

- Pesticide Residue Analysis on Tomato, Brinjal and Cabbage., 124
- Phenotypic Detection of Carbapenemase and Metallo β Lactamase Production among Carbapenem Resistant Gram Negative Bacilli., 291
- Photocatalytic Degradation of Methylene Blue on FeTiO₃/ TiO₂/ PbS Hetero-Junctions., 134
- Photocatalytic Degradation of Remazol Blue Using Ilmenite and Titanium Dioxide., 194
- Physical and Electrochemical Properties of Polyanilines., 211
- Physical Quality Estimation of Rice by Image Processing., 389
- Physicochemical Investigations on Synthetic Spinels (MgAl₂O₄) and Sri Lankan Geuda., 48
- Phytoalexin in Egg Plant (*Solanum melongena*) Infected with *Phomopsis vexans* and *Fusarium solani*., 301
- Plagiarism Detection on Electronic Submissions of Text Based Assignments., 390
- Platform Migration Project for Bio Foods (Pvt.) Ltd., 390
- Polyasterism in Gemstones with Emphasis on Star Sapphire., 164
- Polypyrrole Based Conducting Polymers and their Electrochemomechanical Properties., 211
- Popularizing A/L Chemistry Practical among Teachers and Students by Integrating Concepts and Using Waste Materials Effectively., 336
- Population Study of Elephants in the Katagamuwa Sanctuary, Kataragama., 195
- Population, Environmental and Climatic Factors on Dengue Distribution in Colombo District., 182
- Possibility of Cadmium and Fluoride Accumulation in Tea Plants and Soils Fertilized with Eppawala Phosphate Rock., 195
- Possible Effects of Some Toxic Elements of Soil and Plants in Forest Dieback Areas of Hakgala Strict Natural Reserve., 195
- Post Tsunami Mitigation and Rehabilitation Work in Katugoda Village., 157
- Postharvest Longevity of Papaya (*Carica papaya* L) as Affected by Methods of Handling., 301
- Postharvest Losses and Induction of Resistance in Aubergine (*Solanum melongena*) against Anthracnose caused by *Colletotrichum capsici*, Using a Weak Pathogen, *Fusarium solani*., 280
- Potential Applications of Rupaha Marble Rock., 336
- Potential for Artificial Groundwater Recharge in a Wellfield : a Case Study in the North Western Province., 176
- Potential for Groundwater Development in Hard Rocks a GIS Approach., 171
- Potential Use of Vesicular Arbuscular Mycorrhizal Fungi to Improve the Seedling Growth of Lesser Known Tree Legumes with Special Reference to *Pericopsis mooniana*., 281
- Practical Guide on Phytohormones for G.C.E. Advanced Level Biology., 336
- Predicting a Suitable Path for Ordinary Level Students., 390
- Prediction of Dengue Transmission and Identification of Factors Responsible for Breeding of Vectors in Dengue Risk Areas of Matale District., 363
- Prediction of Weather Patterns and their Relationships with Flowering of Selected Tree Species in Sinharaja World Heritage Site., 363
- Preformed and Induced Chemical Resistance of Tea Leaf against *Exobasidium vexans* Infection., 50
- Preliminary Evaluation of Toxic Heavy Metals and Flouride in Drinking Water at Medawachchiya., 124
- Preliminary Investigation on Drinking Water Quality of Dug Wells in Kattankudy Divisional Secretariat Eastern Province., 124
- Preliminary Studies on Development of A PCR Based Technique for the Diagnosis of *Trichomonas vaginalis*., 291
- Preliminary Study for Enhancing Performance of Physics among Weak Students in G.C.E. (O/L) through Student Oriented Discussion., 336
- Preliminary Study of Enzymatic Changes in a Cohort of Patients Presenting with Fever and Hepatorenal Syndrome., 21

- Preliminary Study on Cercariae of Digenetic Trematode Parasites of Some Freshwater Snails in a Selected Site., 415
- Preliminary Study on the Decay of the Inner Surface of Concrete in Alum Treated Water Storage Tanks., 124
- Preliminary Study on the Salivary Glands of *Haematobia exigua* De Meijere 1903 (Diptera: Muscidae)., 416
- Preparation and Characterisation of Bismuth Based High T_c - Superconductors., 242
- Preparation and Characterisation of Polyaniline/Titanium Dioxide Heterojunctions for Possible Use in Solar Cells., 242
- Preparation and Characterization of Ferrite Nanoparticles., 134
- Preparation of a Computer Based Self Guided Study Package for G.C.E. Advanced Level Biology Students., 336
- Preparation of a Computer Based Self-Learning Package for A - Level Chemistry Students., 337
- Preparation of a Computer Based Self-Study Guide for G.C.E. Advanced Level., 337
- Preparation of a Diffusion Material For Colouration of Colourless Topaz., 164
- Preparation of a Guide for G.C.E. A/L Biology Students to Teach Assessment of Soil Erosion by Using Simple Methods., 337
- Preparation of a Study Pack on Sri Lankan Ecosystems Related to the Grade 9 Syllabus for Effective Learning., 337
- Preparation of a Supplementary Book on 'Man and the Environment' (Unit 15) for G.C.E. (A/L) Chemistry Students., 337
- Preparation of a Supplementary Book on Petroleum Industry for the G.C.E. (Advanced Level) Students., 337
- Preparation of a Supplementary Guide for Advanced Level Projects Using a Model Experiment., 338
- Preparation of a Supplementary Guide for the Beginners of Advanced Level Chemistry (Unit 1.3, 1.4 - Old Syllabus)., 338
- Preparation of a Supplementary Guide on Diagnostic Tests in Medicine for G.C.E., 338
- Preparation of a Supplementary Manual on "Problem Solving in Physical Chemistry., 338
- Preparation of an Activity Book Using Active Learning Method (ALM) to Teach Basic Principles of Ecology., 338
- Preparation of an Adherent Hydroxyapatite Layer on Stainless Steel for Orthopedic Applications., 130
- Preparation of Supplementary Book on Agrochemicals for G.C.E. (Advanced Level) Students., 338
- Preparation of Supplementary Book on Animal Husbandry for G.C.E. A/L Agriculture Students and Teachers., 339
- Preparation, Characterization and In-Vitro Release Study of Ascorbic Acid-Encapsulated Liquid Crystal Liposomes., 134
- Preparation, Characterization, Electrical Properties and Applications of 2:1 Layered Silicate/ Conducting Polymer Nanocomposites., 51
- Presentation of Clinical Symptoms in Malaria Patients Residing in Malaria Endemic Area of Sri Lanka., 416
- Prevalence and Identification of *Cryptosporidium* Infection in Pediatric Patients., 291
- Prevalence of Bacterial Meningitis among Children Admitted to the Teaching Hospital Kurunegala., 21
- Prevalence of Dengue Vector Mosquitoes and Factors Affecting Dengue Transmission in Wellawatta Municipal Council Area., 195
- Prevalence of *Naegleria* Species in Water Bodies of Maho and Nikaweratiya Divisional Secretariat Divisions., 292
- Prioritization of Community Development Activities: GIS as a Tool., 171
- Private Tuition Attendance by G.C.E. (A./L.) Biology Students: a Case from Gampaha District., 339
- Probable Role of Fluoride and Aluminium in the Incidence of Chronic Renal Failure in Anuradhapura District., 181
- Problems and Perceptions of Teachers and Students on Newly Amended G.C.E. (A/L) Agriculture Syllabus., 339
- Problems Encountered in Teaching Physics Concepts at G.C.E. (Ordinary Level) by Science Teachers: a Case Study Conducted in the Jaffna Education Zone., 339

- Problems Faced by Students and Teachers in Learning and Teaching Agriculture in G.C.E. (A/L) in Kandy and Nuwara Eliya Districts in the Central Province., 339
- Product Development of Drumstick (*Moringa oleifera*) Using Pod Scrapings and Seeds., 301
- Profiler for Testing Java Programmes (Profiler Agent and Graphical User Interface)., 390
- Profiler for Testing Java Programmes (Socket Server and the Analyser)., 390
- Proposed Regimes for High Dose Rate (HDR) Treatments for Cancer of the Cervix Based on Linear Quadratic Model., 236
- Protease Inhibitors in *Sesbania grandiflora* and *Terminalia catappa*., 21
- Protein, Energy, Zinc, Iron and Vitamin A Nutriture in Children (3 - 5 Years) of Low Socio-economic Status in Kandy, Sri Lanka., 2
- Proton Conduction in Condensed Phase., 242
- Provenance and Distribution of Silica Sand Deposit at the Sri Lanka Air Force Premises - Ekala, Sri Lanka., 195
- Purification and Characterization of Acid Proteinases from *Nepenthes distillatoria* L., 10
- Purification and Characterization of Phospholipase A₂ of Sri Lankan Russell's Viper (*Vipere russelli russelli*)., 124
- Purification and Characterization of Thermostable Dnases from Bacteria in Hot Springs of Trincomalee, Sri Lanka., 11
- Purification and Molecular Characterization of Acid Proteinases from Filarial Parasite *Setaria digitata*., 12

Q

- Qualitative and Quantitative Estimation of (a) Glycyrrhetic Acid In Liquorice (b) Methimazole in Carbimazole by Using Plasma Desorption Mass Spectrometry (PDMS) and High Performance Liquid Chromatography (HPLC)., 125
- Quality Assessment of Deep Groundwater in Monaragala District., 195
- Quality Assurance Measurements on Radiological Imaging Equipments., 236
- Quality Assurance of Image Fusion of Pinnacle-3 Radiation Treatment Planning System and Evaluation of Treatment Plans., 236
- Quality Control of Gamma Camera., 237
- Quality Control Parameters of Fluoroscopic X-Ray Units Used in Sri Lanka., 237
- Quality Enhancement of Sri Lankan Zircon., 165
- Quality Improvement of Fertilizers by using Control Charts for Variables., 131
- Quality of Generic and Branded Drugs in Sri Lanka., 131
- Quantification of Anionic Surfactants in Effluent of Effluent Treatment Plant of Garment Washing Industries., 125
- Quantification of Erosion Rates and Evolution of Geomorphology in the Highlands of Sri Lanka., 143
- Quantification of Proton and Organic-Chlorine Interactions in Pyrite - Water Interface: A Mechanistic Approach., 145
- Quantitative Analysis of Rainwater for Investigation of Air Pollution at Peradeniya., 125
- Quantitative and Qualitative Assessment of Pesticide Residues in Large-Scale Vegetable Plots Surrounding the Tea Plantation., 125
- Quantitative X-Ray Diffraction Analysis of Polymorphs of Mebendazole Drugs Available in the Sri Lankan Market., 125
- Querying Database in Natural Language., 390

R

- Rabies Post Exposure Treatment: Cost Reduction through Responsible Pet Ownership, 158
- Radiation Dose Verification and Radiobiological Review of Carcinoma Cervix in Amersham Brachytherapy Manual Afterloading System., 237
- Real Time GIS Mapping Solution for GPS Enabled Remotely Operated Demining Platforms., 171
- Reference Model for Disease Surveillance System., 390
- Reference Model for Next Generation Electronic Health Record System., 391
- Reference Model for the Design Pattern Automation., 391
- Regression Model for the Stream Flow Prediction in the Upper Kothmale Catchment in Sri Lanka., 363

- Regulatory Framework for Near Field Communication (NFC) Based Mobile Payments in Sri Lanka., 391
- Relation of Maternal Haemoglobin and Serum Protein Concentrations to Birth Weight of Newborn: A Case Study in Mannar District., 21
- Relationship Between Geological Structure and Geophysical Characteristics of Hard Rocks with Ground Water Potential
A Case Study from Nochchiyagama, Anuradhapura District., 162
- Relationship between School-Based Assessment Ranking and Problem-Solving Ability of A/L Chemistry Students., 339
- Relationship between Serum Carbamazepine Concentration and Epilepsy Control., 22
- Relationship between Varietal Characteristics of Melon (*Cucumis melo* L.) and the Infestation of Melon Fly (Diptera: Tephritidae)., 301
- Relationship of Dengue Morbidity with Climatic Factors, Distribution of Vectors and Risk Areas of Dengue in Kandy District., 146
- Relevance of the Advanced Level Microbiology Curriculum for Employment and Higher Education in the Central Province., 340
- Remote Monitoring Loan Management System., 391
- Removal Mechanism of Phosphate Sulfate and Color on Feldspar., 196
- Removal of 2-Chlorophenol in Water Using Montmorillonite Clay and Montmorillonite-Polyaniline Nanocomposites., 125
- Removal of Arsenate and Arsenite by Fullers Earth., 126
- Removal of Cadmium by Thermally and Chemically Modified Peat., 126
- Removal of Dye Colour from Aqueous Solutions by Adsorption on Mineral Surfaces., 131
- Removal of Excess Iron in Ground Water., 196
- Removal of High Concentrations of Iron in Water by Electrocoagulation and Filtering System: A New Technique for Domestic Uses., 196
- Removal of Iron from Rubber Factory Effluent using Dried *Salvinia* Plant Material., 131
- Removal of Nitrate from Drinking Water by Oil Coated Sand Filter., 196
- Removal of Phosphate and Phenol in Wastewater using naturally available Materials., 131
- Removal of Salinity from Saline Water Using Freely Available Natural Substances., 340
- Removing Metal Ions Present in Electroplating Effluents Using Feldspar, Kaolin and Laterite., 196
- Respiration and Ethylene Production in Relation to Anthracnose Development in Two Local Mango Cultivars., 301
- Restoration of Plant Diversity in a Monoculture Pinus Plantation in Lower Hantana, Sri Lanka., 282
- Results Management System for the Faculty of Science of the University of Peradeniya., 391
- Revision of G.C.E. (A/L) Electronic Curriculum to Suit the Requirement of Modern Industry., 340
- Rhizobial-Fungal-Phenolic Interactions in N_2 Fixing Symbiosis., 255
- Risk Analysis and Inundation Mapping along Nilwala River Basin., 171
- Risk Mapping and Ecological Analysis of Human Leptospirosis in Kandy, Sri Lanka., 158
- Rock Slope Stability Assessment Using Stereographic Projection Method and Limit Equilibrium Analysis., 162
- Role Model Design and Implementation using a Set Approach., 391
- Role of Brackish Water Breeding *Aedes aegypti* and *Aedes albopictus* in Transovarian Transmission of Dengue Virus., 292
- Role of Cattle, Grey Langur and Elephant in Seed Dispersal of the Invasive Alien Plant *Prosopis juliflora* (Mesquite)., 288
- Role of Natural Antifungal Substances, Peel pH and Potassium Fertilization in Banana Fruit Resistance to Anthracnose., 256
-
- S**
- Schema Driven Mapping: Managing XML in Object-Relational database., 391
- Scheme of Evaluation for the Continuous Assessment of A/L Chemistry Practicals., 340
- School Information Management System., 392
- Schottky Junctions with Some Conducting Polymers., 242

- Screening, Isolation and Purification of Potential Antiparasitic Compounds from Medicinal Plants., 27
- Seasonal and Spatial Variation of Thermocline and Halocline in the Indian Ocean around Sri Lanka., 174
- Sedimentation Problem in the Rantambe Reservoir., 197
- Sedimentology and Micropaleontology of recent- and Paleo-Tsunami Sediments of Sri Lanka., 147
- Selection of Potential Solid Waste Disposal Sites around Galle Urban Area Using GIS Techniques., 171
- Self Guide for Enhancing Performance of Straight Line Motion and Force Among Weaker Students in Grade 10 Physics., 340
- Self Learning Study Pack for G.C.E. (A/L) Biology Classes on Plant-People Relationships in Kandy City and Suburbs., 340
- Self Learning Study Pack on 'Insect Pests' for A/L Biology Students., 341
- Self Study Guide: to Understand the Bernoulli's Equation and its Application., 341
- Self-Cleaning Cellulose Fabric with TiO₂ Nano Particles., 134
- Semi - Intelligent SQL Querying System., 392
- Semi-Automatic Online Examination System with SMS Notification for Essay and Structured Type Questions., 392
- Semisynthesis and Bioactivities of Lichen Substances., 53
- Sensitization of Titania with Natural and Moderated Flavylum Pigments and MEH-PPV Polymer for Photovoltaic Devices., 227
- Separation of Tea Flavan-3-OLS by High-Speed Counter-Current Chromatography and Antioxidant and Antifungal Activity Studies., 102
- Serological Detection and Identification of Rickettsial Species Infecting Humans., 13
- Serological Detection of Antibodies to Human Rickettsia and Toxoplasma Gondii in Backyard Poultry in Kanthale Divisional Secretariat., 27
- Serum Calcium and Oxidation-Reduction Status of Erythrocytes in Diabetic and Non-Diabetic Cataracts., 22
- Serum Progesterone, TSH and Oxidant Stress in Subfertile Women., 22
- Site Identification for Solid Waste Disposal for the City of Colombo Using GIS Techniques., 171
- Site Selection for Waste Disposal Using GIS., 172
- Situation Analysis and Development Strategies for Elephant Orphanage at Pinnawala., 183
- Situational Analysis of *Legionella pneumophila* and Some Physical and Chemical Properties of Cooling Tower Waters in Selected Hospitals and Tourist Hotels., 292
- Social and Psychological Effects Impacted upon the Widows of Military Personnel who Died in Active Duty in the Ethnic Crisis of Sri Lanka Army., 158
- Social Impact on Drought Mitigation by Rain Water Harvesting in Nikaweratiya Division., 158
- Social Impact on Internally Displaced Persons Living in Long Term Camps., 158
- Social Impact on Resettlement of Landslide Victims at Okandagala Village, Hanguranketha., 158
- Social Issues Confronted by the Re-settlers of Tsunami Affected Areas in Hambantota District., 159
- Socio Economic Changes of Tsunami Affected Families in Tissamaharama., 159
- Socio Environmental Interaction in Water Quality Variations Case Study from Coastal Villages of Ampara District., 197
- Socio-Economic and Cultural Consequences of Internal Displacement., 159
- Sociological Study of Military Disables at the Salawa Ranaviru Village in Avissawella., 159
- Software Program for Extreme Flow Predictions: Case Study of Flow at Caledoniya., 363
- Soil and Water Contamination from Tannery Waste: Fate, Distribution and remediation of Chromium., 197
- Solar Cells Based on Dye Sensitized Nanoporous TiO₂ semiconducting Films., 242
- Solid Polymer Electrolytes Based on Polyacrylonitrile (PAN) and Organically Modified Ceramics (Ormocers)., 212

- Solvent Effect for Extraction of Aflatoxin B₁ from Animal Feed., 126
- Solving Shortest Path Problem Using Genetic Algorithms., 392
- Some Aspects of Farm-Rearing Of Post-Larvae and Fry of Commonly Cultured Carps (Pisces: Cyprinidae), and Development of Methodology Suitable for Rearing of Post-Larvae and Fry by Rural Communities of Sri Lanka., 411
- Some Aspects of the Biology and the Fishery of Exotic Cichlids in Victoria, a Deep Reservoir in Sri Lanka., 401
- Some Aspects of the Ecology of Elephants at the Pinnawala Orphanage Sri Lanka., 341
- Some Common Misconceptions of Advanced Level Physics Students., 341
- Some Experiments and Demonstrations in Introductory Fluid Dynamics., 341
- Some Factors Affecting the Postharvest Longevity of Blue Water Lily (*Nymphaea* sp.) Flowers., 295
- Some Factors Influencing the Kidney Failure in Padaviya Area, Anuradhapura District., 197
- Some Factors Underlying the Resistance of Banana Variety "Kahambala" to Anthracnose Disease., 302
- Some Formulation Studies of Toothpaste using Eugenol Rich Flavour and Calcium Carbonate., 131
- Some Geochemical Aspects of Tsunami Affected Soils in South Western Coast of Sri Lanka: Present Status., 159
- Some Morphological and Reproductive Features of *Santalum album* L. and *Piper longum* L., 283
- Some Studies on the Environmental Impact and Waste Treatment Methods Practised by Rice Mills in Vavunia District., 197
- Some Studies on the Variation of Physico-Chemical Parameters in a Sequence Batch Reactor Installed to Treat Fruit Canning Effluent., 197
- Source Code Generator to Invoke Apache AXIS2 Web Service., 392
- Spatial Analysis of Soil Fertility for Better Agricultural Land Management., 172
- Spatial and Temporal Changes of Water Quality of Tsunami Affected Areas in the South Western Coast: Sri Lanka., 148
- Spatial and Temporal Variations of Hydrogeochemistry in Ancient Tank Cascade Systems in Sri Lanka: Evidence for a Constructed Wetland., 149
- Spatial Distribution of Soil Nutrients in the Forest Dynamic Plot at Sinharaja., 364
- Species Composition and Diversity of Mangroves in Madu Ganga Mangal., 295
- Species Limits and Phylogenetics of the Endemic Genus *Stemonoporus* THW. (Dipterocarpaceae)., 283
- Stability, Strain and Speed of Polypyrrole Actuators., 213
- Statistic Model for the Prediction of the Risk Level of Myocardial Infarction., 364
- Statistical Analysis of Factors Influence on Respiratory Health of School Children in Kandy., 364
- Statistical Analysis of Total Solar Radiation in Colombo, Sri Lanka., 364
- Statistical Analysis on Teachers' Awareness of the School Based Assessment Programme., 364
- Statistical Analysis on the Effect of Global Warming Phenomenon in Colombo and Anuradhapura Districts., 364
- Statistical Modeling for Distribution of Body Surface Area among Cancer Patients., 365
- Statistical Modeling of Extreme Daily Rainfall in Colombo., 365
- Statistical Modeling of Topographic Elevation Using Shuttle Radar Topography Mission Digital Elevation Data., 365
- Statistical Techniques for Soap Production Process in a Local Industry., 205
- Statistical Verification and Further Improvement of the Models for Carbon Dioxide Emissions., 365
- Status and Mechanisms of Insecticide Resistance in Anopheline Vectors of Malaria in Sri Lanka., 402
- Status of Insecticide Resistance and Resistance Mechanisms in Some of the Rice Insect Pests and Four of their Predators., 412

- Status of Insecticide Resistance Mechanisms in Some of the Insect Pests of Vegetables and Two Insect Predators., 14
- Strategies and Related Difficulties in Solving Algebraic Inequalities at Collegiate Level., 341
- Strategies for Better Planning Approach towards Solid Waste Management in the CMA and a Methodology for Comparison Between Regional Solution and Localized Solution., 198
- Strategies for Mastering Concepts in General Chemistry., 341
- Stream Sediment Geochemistry of Three River Basins of Sri Lanka with Special Emphasis on Geochemical Ratios and Gem Potential., 150
- Stream Water Blackening by Effluent Discharge of a Yarn Dyeing Industry., 131
- Strength of the Global Warming Phenomenon in Kandy District., 365
- Structural Changes in Sri Lankan Population., 365
- Structural Studies of the Capsular Polysaccharide from *Streptococcus pneumoniae* Type 25F and Studies on Green Tea Constituents., 103
- Structure - Activity Studies of Aryl Alkenes and Synthesis and use of Chiral Inductors in Iridoid Synthesis., 56
- Students' Learning Ability of Calculus in the G.C.E. (Advanced Level) Combined Mathematics Syllabus., 342
- Studies of Plant Extracts as Natural Antioxidants., 126
- Studies on Anthelmintic Efficacy of Medicinal Plants Against Gastrointestinal Nematodes of Goats., 15
- Studies on Clinically Suspected Dengue Patients Using RT-PCR and Blood Parameters., 22
- Studies on Electrodeposited ZnSe Thin Films., 242
- Studies on Extending Postharvest Life of "Embul" Banana in Low Cost, Evaporative Cooling System., 302
- Studies on Ovary, Ovule and Anther Culture of Coconut (*Cocos nucifera* L.), 257
- Studies on some Medicinal and Related Plants of Sri Lanka., 104
- Studies on the Utilization of Some By-Products in Building Materials, Ceramic and Catalyst Industry., 57
- Study Guide in Magnetism for Advanced Level Students., 342
- Study Guide on Air and Water Pollution for Advanced Level Students., 342
- Study of Abnormal Hemoglobins and Thalassaemias in an Anaemic Population., 22
- Study of Antigenic Salivary Gland Proteins of Mosquitoes and Detection of Antibodies against them in Human and Animals., 16
- Study of Bioaccumulation of Heavy Metals in Aquatic Flora and Fauna on the Lunawa Lagoon., 198
- Study of Change in Atmospheric Lead (Pb) Levels in Colombo with the Phasing Out of Leaded Petrol in Sri Lanka., 126
- Study of Conceptual Understanding of Physics of Grade 10 Students in the District of Matale., 342
- Study of Diversity and Taxonomy of Lichens in the Horton Plains National Park with a View to Biomonitor the Ecosystem Health., 58
- Study of Electrical Conductivity and Dielectric Relaxation of PEO Based Composite Polymer Electrolytes and PAN Based Polymer Electrolytes., 228
- Study of Electrical Conductivity of Natural Rubber Containing Some Selected Additives., 243
- Study of Fragmentation of Upper Ureteric Calculi by Extracorporeal Shock Wave Lithotripsy (ESWL), 237
- Study of Human Elephant Conflict in Kurunegala District., 159
- Study of Important Physico-Chemical Parameters, Marginal Vegetation and Pollution Aspects of Pinga Oya, a Stream in the Mahaweli Mid-Catchment Area., 198
- Study of Inflation in Sri Lanka Using New Colombo Consumer's Price Index Compared to the Old Colombo Consumer's Price Index., 366
- Study of Insecticidal Properties of *Euphorbia antiquorum*., 198
- Study of Internal Browning of Two Cultivars of Pineapple with Special Reference to Heat Shock Treatment as a Control Measure., 258

- Study of Investment Climate of Manufacturing Industries in Sri Lanka., 366
- Study of Ionic Conductivity of (Polyethylene Oxide) (PEO) Based Polymer Electrolytes with Fillers., 135
- Study of Jurassic Plant Fossils in Tabbowa Sediments, Sri Lanka., 295
- Study of Microsporogenesis and Haploid Induction in Selected Species of Theaceae and Solanaceae., 284
- Study of Modelling Approaches for Estimation of Global Solar Radiation for Sri Lanka., 366
- Study of Physicochemical and Quality Aspects of Frozen ChowChow (*Sechium edule*)., 302
- Study of Physico-Chemical Changes of Banana var. 'Kahambala' During Fruit Development and Ripening., 302
- Study of Potato Dry Rot Caused by *Fusarium* Species., 302
- Study of Print Intensity Variation of Cigarettes., 132
- Study of Renal Function of a Sample of Patients on Long-term Diclofenac Sodium for Rheumatoid Arthritis, 22
- Study of Science Projects Carried out by G.C.E. Advanced Level Students., 342
- Study of Security Weaknesses of IEEE 802.11b and a Solution to improve its Security., 392
- Study of Soil Weathering Profiles in Determining Geotechnical Problems in the Urban Area of Kandy., 163
- Study of Temporal and Spatial Variability of Dry Spells in Dry Zone in Sri Lanka., 160
- Study of the Biodiversity Associated with Ambuluwawa Natural Forest and the Preparation of a Nature Trail Guidebook for A/L Biology Students (Based on Unit-2 Biological Diversity of the Teacher's Guide)., 342
- Study of the Casual Organisms and the Effect of Latex on Stem End Rot Development, Respiration and Ethylene Production in 'Karuthacolomban' Mangoes., 302
- Study of the Concepts of Limit Theorems and their Applications in the G.C.E. (A/L) Combined Mathematics Syllabus., 343
- Study of the Distribution and Abundance of Key Mangrove Plant Species in Pambala Mangal., 343
- Study of the General Certificate of Education (Advanced Level) Combined Mathematics Syllabus., 343
- Study of the Impact of the Current G.C.E. (Advanced Level) Combined Mathematics Syllabus on the First Year Mathematics Courses Offered by the Faculties of Science at the Undergraduate Level., 343
- Study of the Influence of School and Home Environments on the Health of Children., 366
- Study of the Physicochemical Characteristics of Banana and Response to Postharvest Acid and Calcium Treatment., 285
- Study of the Solasodine Content in Different Species of *Solanum* in Sri Lanka., 126
- Study of the Water Quality of Diyawanna Oya Conducted during the South-West Monsoon Period., 198
- Study of Thermal and Electrical Properties of Some Polymer Electrolytes Based on PEO and PAN and some Intermediate Temperature Solid Oxide Fuel Cell (ITSOFC) Materials Based on Gadolinia Doped CERIA., 229
- Study of Urban Development in City of Galle Using GIS and Remote Sensing., 172
- Study of Wood Rots in Tea (*Camellia sinensis*) with Special Reference to That Caused by *Nemania diffusa* (*syn. Hypoxylon vestitum*)., 259
- Study on Cuprous Oxide/ Cuprous Sulphide Thin Film Solar Cells., 243
- Study on Difficult Areas of G.C.E. Advanced Level Molecular Genetics and Preparation of Supplementary Study Material., 343
- Study on Environmental Issues due to the Development of Nuwara Eliya - Badulla Road., 198
- Study on Growth of Tomatoes Grown Under Protected Culture Using Non-linear Curve Fitting., 366
- Study on Haemoglobin, Serum Protein Concentrations and Serum Total Antioxidant Capacity in First Year Female Undergraduates of the University of Peradeniya., 23
- Study on Hormonal Levels of Subfertile Men with Idiopathic Non-Obstructive Azoospermia or Oligospermia., 23

- Study on In Vitro Culture Conditions for Plant Regeneration of *Santalum album* (White Sandalwood), 28
- Study on Low Cost Preservation of Lime Juice., 303
- Study on Numerical Problem Solving Ability of G.C.E. (A/L) Students Offering Chemistry., 343
- Study on Partial Characterisation of Excretory – Secretory (ES) and Somatic Antigens of *Explanatum explanatum* and Establishment of Its Phylogenetic Relationship by Genetic Characterization., 28
- Study on Physical and Mechanical Properties of *Bambusa vulgaris* and *Dendrocalamus giganteus* for Possible Value Addition in Industrial Flooring., 243
- Study on Polypyrrole/ Dodecyl Benzene Sulphonate (PPy/DBS) Based Actuators., 243
- Study on Relevance of G.C.E. (Ordinary Level) Mathematics Examination Paper for the Sri Lankan Educational Needs., 344
- Study on Road Traffic Injuries a Disaster in Sri Lanka., 160
- Study on Setting Time of Cement., 243
- Study on Spatial and Temporal Changes of Ground Water Quality in the Tsunami Affected Navalady Area in the Batticaloa District., 199
- Study on Surface-Subsurface Hydrology in Vavuniya UC Limits., 199
- Study on the Levels of Chlorpyrifos in Dry Zone Water Sources and their Potential Health Effects., 199
- Study on the Occurrence and Comparison of Trichomes in Selected Wild Rice Species and Hybrid Rice Varieties in Sri Lanka., 295
- Study on the Prevailing Gaps in the Chemistry Knowledge Between the G.C.E. O/L and the G.C.E. A/L., 344
- Study on the Water Quality of a Paddy Field in Pannipitiya Area under Application of Chemical Fertilizers., 199
- Study on Usage Patterns of Alcohol, Tobacco and Drugs among School Children, 366
- Study on Water Pollution in the Matale Urban Area., 199
- Study Pack to Introduce Postharvest Technology of Fruits and Vegetables to Advanced Level Biology Students., 344
- Study to Investigate the Reasons for Low Interest in the Area of Probability and Statistics in G.C.E.(A/L) Combined Mathematics Students in Kurunegala District., 344
- Study to Prepare a Workbook for the Selected Sub Units of Basic Concepts in the Advanced Level Chemistry Syllabus., 344
- Subscriber Management System for Customizable Customer Relation Management., 392
- Success and Failure of the Student-Centered Learning Method in Sri Lankan Schools., 344
- Suggestions for Overcoming the Learning Difficulties of Grade Ten Students in the Chemistry Unit One., 345
- Suitability Study on Different Maturity Stages of *Averrhoa carambola* L. Variety (Honey Sweet) in Fruit Juice., 303
- Supplementary Book on Common Salt and Petroleum Refining Industry for the G.C.E. Advanced Level Students., 345
- Supplementary Guide for Teachers and Students, on Selected Medicinal Plants Used in Ayurvedaya., 345
- Supporting Tool for Teaching Data Structures and Algorithms., 393
- Surface Modification of Iron Oxide Nanoparticles by Casein., 135
- Survey of Endoparasitic Zoonoses in Stray Dogs at a Selected Locality (Thamankaduwa) in Polonnaruwa District., 416
- Survey of the Problems Associated with the Teaching Learning Process of G.C.E. (A/L) Chemistry in Sri Lanka and their Links To G.C.E. (O/L) Science., 345
- Survey on Establishment of Coastal Vegetation for Tsunami Protection in Sri Lanka., 160
- Survey on Identification and Overcoming Difficulties in Carrying Out Chemistry Practical Work in Schools in Uva Province., 345
- Survey on Occupational Health and Safety Management Systems Applications in Sri Lankan Industries., 132

- Synthesis and Characterization of Doped and Undoped Zircon based Ceramics., 215
- Synthesis and Characterization of Li Transition-Metal Oxide Electrode Materials, and their Applications in Li-Ion Batteries., 230
- Synthesis and Characterization of Photochromic 5-Chloro-4,6-Dimethyl-2-Hydroxybenzaldehyde., 126
- Synthesis and Characterization of Poly (3,4-Ethylenedioxythiophene) Intercalated in Bentonite Clay., 127
- Synthesis and Characterization of Poly (Ethylene Oxide) (PEO) - Based and Polyacrylonitrile (PAN) - Based Polymer Electrolytes to be Used in Photoelectrochemical (PEC) Solar Cells., 215
- Synthesis and Characterization of Some Composite Polymer Electrolytes Based on Poly (Ethylene Oxide) (PEO)., 231
- Synthesis and Characterization of Some PEO-Based, Nano Composite Polymer Electrolytes., 232
- Synthesis of Aggregation Pheromone of Black Beetle and Studies on 1,6 Germacradien-5-OL., 105
- Synthesis of Essential Oil Derivatives for Development of Insecticidal Products against Mosquitoes and Houseflies., 107
- Synthesis of Glycolipids for use as Liquid Crystals and Surfactants., 106
- Synthesis of Monomers and Polymers Based on Metal [Pd(II), Pt(II), Ru(II) and Cu(II)] Functionalised 3,4 - Ethylenedioxythiophene Complexes and their Characterization., 60
- Synthesis of N,N'-Ethylenebis (Acetylacetoniminato) and Dithiooxamido Transition Metal Complexes and Investigation of their Potential for Binding Anion, Cation and Small Molecules., 107
- Synthesis of Potent Bio-Active Acridone Alkaloids., 108
- Synthesis of Transition Metal Macrocyclic Complexes for the Utilization of CO₂., 127
- Synthesis, Characterization and Electrical Properties of Some Solid Polymer Electrolytes Based on Poly (Ethylene Oxide), PEO., 217
- Synthesis, Characterization and Molecular Modeling of γ -Fe₂O₃ Nanoparticles: Water Treatment and Drug Delivery., 59
- Synthesis, Properties and Applications of Nano Gibbsite Crystals: A Substrate for Arsenate Remediation., 109
-
- T**
- Tamil Search Engine for Unicode Standard., 393
- Taxonomic Revision of Hymenophyllaceae of Sri Lanka., 286
- Taxonomy and Natural History of Bees in Selected Areas of Sri Lanka., 403
- Taxonomy, Distribution and Host Plant Relationships of Thrips in Selected Sites in Sri Lanka., 413
- Tea Catechins: Antibacterial Activity against Methicillin-resistant *Staphylococcus aureus* (MRSA) and Enhancement of Sensitivity of MRSA to Oxacillin., 110
- Teacher's Guide for Teaching d-Block Elements in Advanced Level Chemistry., 345
- Teaching "Properties of Matter and their Uses" to 8th Graders Using Problem Based Learning Method., 346
- Teaching 'Environment Related Activities' at Key Stage One to Help Children in Developing Science Process Skills to Attain Scientific Literacy in Future., 306
- Teaching Force, Pressure, Work and Energy Concepts for 8th Graders Using Problem-Based Learning (PBL) Approach., 346
- Teaching Thermal Physics through Computer Based Interactive Lecture Demonstrations and Laboratory Sessions., 346
- Temporal Variability of Soil Temperature at Different Depths., 367
- The Removal of Phosphate in Water by Adsorption on Laterite., 196
- Thermal Degradation Behavior of Clay Polymer Nanocomposites., 135
- Thin Film Growth at Finite Temperature., 243
- Thin Film Growth: Studies on 2+1 D Shadow Model., 243
- Tidal Characteristics and Modelling of Tidal Wave Propagation in Shallow Lagoons of Sri Lanka., 218
- Time Series Model for Paddy Production in Sri Lanka., 367

- Time Series Model for Traditional Export Income in Sri Lanka., 367
- Time Series Model for Wheat Flour Consumption in Kalutara District., 367
- Time Series Regression Modeling of Economic Development and Carbon Dioxide Emissions., 367
- Time Sheet and Human Resource Management System for "Bizycorp (Pvt.) Ltd"., 393
- Tissue Compensators in Radiotherapy Treatment., 237
- Tool for Testing Java Programs., 393
- Tools Support for Design Pattern., 393
- Toxicity and Biological Activity Studies of Green Leafy Vegetables Consumed in Sri Lanka., 17
- Toxicological Studies of Venom on Mice of Two *Bungarus* Species in Sri Lanka., 18
- Tracer Study of Advanced Level Physical Science Stream School Leavers in Selected Provinces., 346
- Tracer Study on Future Prospects of the Advanced Level Science Students in Sri Lanka., 346
- Tracking Moving Objects and Reconstruction in 3D Space., 393
- Transliteration Keyboard Configurations for Sinhala and Arabic., 393
- Transparent Nano-Composite Electrodes for Dye-Sensitized Solar Cells., 135
- Transport Properties of Polymer Electrolytes Based on Poly (Acrylonitrile) and Poly (Ethylene Oxide) Complexed with Copper Salts., 244
- Transport Properties of Polymer Electrolytes Based on Poly (Ethylene Oxide) Complexed with Copper Salts., 244
- Transport Properties of Polymer Electrolytes Based on Poly (Ethylene Oxide) Complexed with Magnesium Salts., 244
- Trends and Forecasting of Electricity Consumption in Sri Lanka., 367
- Trends in Paddy Production in Sri Lanka., 367
- Two Dimensional Multi Electrode Resistivity Survey for Subsurface Mapping: A Case Study from Matale District., 200
-
- U**
- Understanding Light Emitting Properties of 8-Hydroxyquinoline-Resorcinol-Formaldehyde Polymer Metal Chelates., 127
- University Time Table System., 394
- University Timetabling System Based on Graph Colouring and Constraint Manipulation., 394
- Upgrading the Sampling Procedure of Surgical Gloves., 205
- Uptake of Cadmium and Nickel by Selected Plant Species under Laboratory Conditions., 200
- Usage of Shortest Path Algorithm to Find the Most Effective Path., 394
- Use of an Integrated Approach to Improve Science Teaching to Eighth Graders., 346
- Use of Computers in Remedial Teaching., 347
- Use of Computers in Teaching and Learning Grade 10 Mathematics Among the Schools in Kandy District., 347
- Use of Concept Maps to Improve Teaching of Geometry in G.C.E. (O/L) Classes., 347
- Use of Diluted Natural Rubber Centrifuged Latex for Pillow Manufacture., 132
- Use of Force Concept Inventory to Assess the Conceptual Knowledge of Secondary Level Students in Force and Wave Concepts., 347
- Use of GIS as a Management Tool in Monitoring, Surveillance, and Control of Foot and Mouth Disease in Sri Lanka., 172
- Use of GIS for Indexing Urban Hierarchy., 172
- Use of GIS In Estimating the Potential of Groundwater Availability in Koggala Coastal Aquifer, Sri Lanka., 172
- Use of GIS in Habitat Mapping of Two Sri Lankan Hornbill Species., 172
- Use of Groundwater for Coastal Water Supply Schemes, Minimizing the Salinity Problem: A Case Study at Kattankudy in Batticaloa District, Sri Lanka., 163
- Use of Image Enhancement Techniques to Assist Diagnosis of Heart Enlargement., 394
- Use of Linear Air Tracks for Illustrating Some Basic Mechanical Principles., 347
- Use of Multivariate Techniques for Classification of Rice (*Oryza sativa* L.) Germplasm., 368

Use of PCR Technique to Detect Human Rickettsia and Ehrlichial Pathogens in, 28

Use of Problem-Based Learning to Teach Properties, Applications and Reactions of Substances at Grade Nine., 347

Use of Remote Sensing and GIS to Estimate Area Under Paddy Cultivation., 173

User Dependant Speech Based Lip Synchronization., 394

Utilization of Carambola (*Averhoa carambola*) for the Formulation of Low Sugar Ready-To-Serve Drink., 303

Utilization of Cassava through Freezing., 303

Utilization of Conducting Polymers as Sensitizers in Solid-State Photocells., 127

Utilization of Flushing Yield to Determine Hydraulic Parameters of Hard Rock Aquifers., 163

Utilization of Game Theory in Computer Security as Applied to Intrusion Detection System., 394

Utilization of Rice Husk to Remove Metal Ions in Solution., 127

Utilization of Sargassum to Remove Cadmium in Waste Water., 200

V

Validity of Objective Type Test Questions for the Examination of General Certificate of Education (Ordinary Level) Science in English Medium., 348

Value Enhancement of Red Spinel., 165

Variation in Cholesterol Concentration in EDTA Plasma and Serum Prepared After Early and Delayed Removal of Formed Elements., 23

Variation of Groundwater Quality Trends: A Case Study from Sammanthurai Well, Sri Lanka., 127

Variation of Molybdenum Concentration in Daily Elution of Tc^{99m} at Nuclear Medicine Unit University of Peradeniya., 237

Vectors and Transmission of Malaria in a Canal and Traditional Natural Stream Irrigated Areas in Sri Lanka., 368

Vegetation, Structure and Floristic Composition in the Irrigation Extension Area of the Lower Walawe Basin, Sri Lanka., 286

Vehicle Navigation System Based on Shortest Path., 394

Village Information System (VIS) as a Prototype for Multipurpose Cadastre., 173

Viral Aetiology in Children Less than 3 Years with Acute Respiratory Tract Infection., 292

Visual Programming Language for Java., 395

Vulnerability Analysis and Risk Assessment of Floods in Ratnapura Municipal Council Area., 151

Vulnerability Assessment and Disaster Management Planning in the Coastal Area of the Ampara District., 173

W

Wanni- Highland Boundary Shear Zone of Sri Lanka: Field and Structural Evidence., 152

Waste Human Hair as an Oil Recovery Material., 132

Waste Water of Vehicle Service Stations Quantitative Analysis and a Method of Treatment., 200

Water Distribution Systems and Diarrheal Disease Transmission : a Case Study in Kegalle District., 183

Water pollution: how to teach and learn., 348

Water Quality in Selected Rural Tanks in Matara District in Relation to Anthropogenic Activities., 348

Water Quality of Maha Oya., 200

Water Quality Variations of Villages around Serpentine Bodies at Indikolapelessa, Udawalawa., 200

Way Point Navigator: A Navigation System to Find the Shortest Path for Transportation., 173

Web Based Automated System for Nurse Scheduling., 395

Web Based Evaluation System for Department of Technical Education and Training., 395

Web Based HR System and Payroll System for Green Apparel (Pvt.) Ltd., 395

Web Based Information Management System (IMS) for a Research Institute., 395

Web Based Information System for the Provincial, Zonal and Divisional Education Offices of Central Province., 395

Web Based Project Monitoring System., 395

Web Based Study Package Designed for Statistics and Probability Unit of G.C.E.

- Advanced Level Combined Mathematics Syllabus in Sri Lanka., 348
- Web Enabled Bandwidth Prioritizing in Squid Cache without Disturbing Existing Connections., 396
- WEBGIS Application for Spatial Identification of Community Development Projects., 173
- Weight Loss and Storage Life of Lime in Relation to Fruit Size, Stage of Maturity and Storage Temperature., 303
- Wheel-Based Side-View Car Detection Using Snake Algorithm., 396
- Wild Orchids in Upper Hantane Sri Lanka., 295
- Windows Based Multi User Computerized Government Payroll Management., 396
-
- Z**
- Zinc Oxide Thin Films for Dye-Sensitized Solar Cell Applications, 135
- Zinc Oxide-Based Dye-Sensitized Solar Cells., 135

Author Index

A

- Abayaratne, A. M. R. J. N. K., 116
 Abayasekara, Charmalie Lilanthi, 252
 Abewardhana, B.U.G.A.K., 190
 Abeygooneratne, Kithsirimevan, 226
 Abeykoon, A.M.D.M., 376
 Abeykoon, A.M.E.K., 357
 Abeykoon, A.M.G.G.L.K.B., 182
 Abeykoon, I., 310
 Abeykoon, N.H., 291
 Abeykoon, W.D.D.C., 364
 Abeynayake, J.S., 27
 Abeypala, G.A.U.P., 186
 Abeyrathne, A.R.N.M., 106
 Abeyratna, N.C., 337
 Abeyratne, M.C. Kumari, 185
 Abeyratne, Vilani Deasika Kumari, 177, 188
 Abeysinghe, A.M.S.W., 344
 Abeysinghe, J.M. Damayanthi, 125
 Abeysirwardana, P.C., 388
 Abeywardana, B.W.N.S.K., 114
 Abeywardana, K.D.T.N., 191
 Abeywardana, P.B.N., 167
 Abeywardana, S.B.Y., 134
 Abeyweera, S.M.S., 164
 Abeywickrama, P.U., 23
 Abhayasinghe, P.R.P.W.M.I.K., 391
 Abusalihu, Salmathul Jaseela, 299
 Adhikari, A.M.S.K.P., 107
 Adikari, A.B., 385
 Adikari, A.M.A.I.K., 163
 Adikari, A.M.H.V., 198
 Adikari, D.W.S.M., 121
 Agalawatte, P.K., 341
 Ahilan, S., 339
 Ahilan, Sitpalan, 238
 Ahilan, Yasodha, 69
 Ainkaran, Ponnuthurai, 361
 Akilavasan, J., 133
 Akramus, Z., 134
 Alagesan, Kayalvily, 47
 Alagiyawanna, G.H., 369
 Alahakoon, C., 166
 Alahakoon, Nihal, 327
 Alahakoon, S.W.K., 308
 Alahakoon, W.P.C.M., 215
 Ali, M. Cader, 341
 Ali, M.A.A.A., 300
 Alibuhtto, Mohamed Cassim, 365
 Aliyar, M. S. Mohamed, 243
 Amarakeerthi, H.K.S., 396
 Amarakoon, A.H.M.N. Kumari, 335
 Amarakoon, K.P.S.A., 159
 Amarasekara, A.S.N., 364
 Amarasinghe, A.A.I.K., 190
 Amarasinghe, A.P.G.P., 323
 Amarasinghe, N. S., 22
 Amarasinghe, Nilupa R., 72
 Amarasinghe, U.S., 368
 Amarathunga, M.P.N.C., 157
 Amaratunga, A.A.D.D., 317
 Amaratunga, V.T., 312
 Amarawardana, H.M. Lakmali K., 128
 Amaraweera, T.H.N.G., 140
 Ambagahaduwa, I.M., 282
 Ambanwela, A.S.M.R.N.C.K., 194
 Ambikaibakan, R., 26
 Amirthalingam, Sathasivam, 361
 Amunugama, M. B., 289
 Amunugama, T. K., 333
 Anoma, H.U.K., 307
 Anura, S. J. M. N., 359
 Anuradha, E.P., 184
 Anuradha, S.G., 79
 Arachchi, H.S. Jayasinghe, 255
 Arachchi, N.P.M., 159
 Arachchi, R.S.M., 28
 Arachchi, S.P.K., 375
 Arasakesari, Velauthar, 317
 Aravinthan, S., 387
 Arawwawala, L.D.A.M., 3
 Ariyadasa, L.A.W.D., 194
 Ariyaratne, H.A.K. Suranjani, 174
 Ariyaratne, M.H.S., 411
 Ariyasinghe, A.R., 318
 Ariyasinghe, D.M.B.P., 133
 Ariyasinghe, G.M.S.I., 346
 Ariyawansa, Chandana, 380
 Ariyawardana, P.H.D.A., 196
 Aroos, S.N.A., 340
 Arudchelvam, Thiruchelvam, 370

Arulanathan, K., 209
 Arundathie, B. G. S., 128
 Ashraff, Aboobucker, 122
 Atapattu, A.A.K.U., 357
 Athapattu, A.A.I.D., 383
 Athapattu, A.M.L., 322
 Athapattu, A.S., 205
 Athukorala, E.A.D.M., 135
 Attanayake, A.M.A.S., 293
 Attanayake, A.M.T. Samanthika, 111
 Attanayake, H.M.K.B., 335
 Attanayake, S.G. Sudarshi, 302

B

Baduraliya, Chaminda H., 204
 Bahirathan, R., 388
 Bakeerathan, Gunaratnam, 357
 Balachandran, T., 323, 355
 Balagowry, Sambunathan, 116
 Balakrishnan, M., 317
 Balamurali, S., 234
 Balasooriya, B.M.R.K., 154
 Balasooriya, D., 330
 Balasooriya, Nanda Wipula Bandara, 141
 Balasooriya, Sajeewani Thushara, 301
 Balasuriya, Abhaya, 259
 Balasuriya, B.M.G.K., 17
 Bambaradeniya, Channa Nalin Bandara, 398
 Bambarandage, Thushari Damayanthi, 14
 Bandara, A., 172
 Bandara, A.M. Rohana, 162
 Bandara, A.M.R., 155
 Bandara, A.M.T.K., 11
 Bandara, B.M.N., 378
 Bandara, B.W.M.G.C., 126
 Bandara, Balasuri Muhandiramalegedara
 Champani Anuruddhika, 101
 Bandara, D.M.C.H., 233
 Bandara, D.M.D.P.K., 290
 Bandara, D.M.M.E.W. Kamalarathna, 341
 Bandara, H.M. Anura, 392
 Bandara, H.M.U.G.A., 133
 Bandara, I.M.C.C.D., 82
 Bandara, K.M.T.N., 374
 Bandara, Kasturiarachchige Nimal
 Premarathne, 41
 Bandara, L. R. A. K., 217
 Bandara, L.R.C.U., 391
 Bandara, Lakshmi, 297

Bandara, N.A.D.J., 122
 Bandara, N.G.M.G., 391
 Bandara, R. M. P., 311
 Bandara, R. M. T., 347
 Bandara, R.M.T.G.J., 373
 Bandara, R.S.A.K., 194
 Bandara, Sakunthala D.P., 316
 Bandara, T.M.W.J., 215
 Bandara, Y.M.W.S.B., 116
 Bandaranayake, A.M. Anushka, 97
 Bandaranayake, B.M.R.P., 296
 Bandaranayake, B.M.S.H., 129
 Bandaranayake, K.P.D., 377
 Bandaranayake, Niwandana Kumara, 66
 Bandaranayake, V.J., 114
 Baskaran, Kanagasabai, 326
 Basnayake, B.M.K.M.K., 304
 Basnayake, D. Deepamali, 367
 Basnayake, Senarath B., 164
 Bodiabadu, D.C., 319
 Bogamuwa, M. M. Samantha, 128
 Bogamuwa, Srimathi Priyadarshani, 297
 Bokalamulla, A. Ajantha Kumari, 312
 Bokalawela, R.S.P., 229
 Bombuwala, Bombuwalage Don Karunananda,
 42
 Bombuwala, Rajaguru Mudyanselage Thushari
 Priyangika, 30
 Bookoladeniya, H.C.S., 242
 Bootawatta, S.G., 199
 Bowatte, A., 21
 Boyagoda, Suyama H., 415
 Buddhika, U.V.A., 260

C

Chamanthi, Biyagamage, 346
 Champika, N.D.V., 295
 Chandana, G.A.D., 172
 Chandana, H.K.A. Sujith, 301
 Chandana, N.G.A.S.S., 23
 Chandima, O.K.D.D., 301
 Chandrakanth, Somasundaram, 203
 Chandrakanthi, R.L.N., 211
 Chandrani, P.S., 338
 Chandraratne, G.W., 166
 Chandrasegaran, Veloo, 192
 Chandrasekara, C.M.C.K., 270
 Chandrasekera, M., 313
 Chandrasena, W.D., 317

Chandrasiri, D., 124
 Chandrasiri, J.H. Asoka, 345
 Chandrasiri, K.W.D.M., 371
 Chandrasiri, O.L.N.G., 194
 Chandrathilaka, A.M.D.S., 89
 Charles, P.S.M., 155
 Chinthana, A.J.S., 123
 Christophaul, B., 387

D

Dahanayake, A.D.A.D.J.M.D.S.U., 207
 Dahanayake, S.T.A. Sepala, 328
 Damayantha, J.A.N.C.K., 362
 Damayanthi, Asoka, 188
 Damayanthi, K.H.N., 341
 Dananjaya, S.H.S., 129
 Dankanda, T.M.P.R.K.T., 325
 Dasanayake, W.W.D.M.G.D., 300
 Dassanayake, D.D.M.L., 156
 Dassanayake, D.M.S.N.B., 20
 Dassanayake, D.M.T.M., 118
 Dassanayake, Indu K., 380
 Dassanayake, Malaka Nilanga, 198
 Dassanayake, T.D.M.S.B., 160
 Dayananda, W.G.N.B.P., 183
 Dayarathna, R.W.Y.M., 346
 Dayawansa, E.G.D., 175
 de Alwis, K.K.S.K., 265
 de Alwis, T.M.D.R., 416
 de Mel, Widanalage Raviprasad, 203
 de Silva, A.S.K., 299
 de Silva, D.A.N., 378
 De Silva, D.P.H.R., 387
 De Silva, H.H.Y., 360
 de Silva, I.H.S. Kumara, 415
 de Silva, K.R.A., 191
 de Silva, K.W.D. Susila, 68
 de Silva, M.A.S.M.S., 302
 de Silva, M.T. Swineetha, 340
 de Silva, P. H. J. Chandika, 298
 de Silva, Poorni, 191
 de Silva, W.A.P.P., 410
 de Tissera, B.D.S.L., 23
 Dedduwa, M.S., 335
 Deepani, P.A.C., 388
 Dela, Jinie Dhanika Shirindra, 400
 Delapola, D.L., 325
 Dematage, N., 309
 Dematawewa, I.S. Kumari, 334

Devasurendra, A.M., 124
 Dewasurendra, P., 185
 Dhanapala, M.G. Vijitha, 132
 Dhanasekera, Deepika Prithini, 312
 Dharmadasa, H. Anoma, 342
 Dharmadasa, H.K.D.L., 322
 Dharmakeerthi, W.A., 182
 Dharmapala, A.M.U., 326
 Dharmaparakrama, A.L. Sarathchandra, 261
 Dharmarathne, Mahinda, 368
 Dharmaratne, Tilak Siri, 164
 Dharmasena, Niroshana Prabath, 117
 Dharmasena, U.K.N. Pasantha, 162
 Dharmasiri, R.M., 370
 Dharmasiri, U. Rasika, 116
 Dias, M.R.S., 186
 Dias, N.K.L.U.A., 154
 Dilhan, M.A.A. Buddhika, 286
 Dilrukshi, P.R.M.P., 397
 Dineshanrathna, H.G.K., 360
 Dissanayaka, D.J.G.S., 340
 Dissanayake, C.D.M.S., 193
 Dissanayake, D.M.C.R., 326
 Dissanayake, D.M.M.P., 191
 Dissanayake, D.M.S.P.K., 336
 Dissanayake, D.M.T., 311
 Dissanayake, D.M.T.H., 328
 Dissanayake, G.K.P., 294
 Dissanayake, K.M.D. Mahinda, 288
 Dissanayake, R.D.N.D.K., 347
 Dissanayake, S.C.J., 368
 Dissanayake, Uditha Niroshana, 363
 Dissanayake, W., 373
 Divaratne, Dilupama I., 243
 Diyabalanage, H.V.K., 108
 Domingo, S.L., 326
 Dorabawila, B.M.N.K., 189
 Dorabawila, S.S.K.B.M., 357
 Dulanjalee, P.H.E., 162

E

Ealasukanthan, T., 203
 Edirisinghe, E.M. Indika, 1, 6
 Edirisinghe, E.M.C.P., 355
 Edirisinghe, G.G.D., 366
 Edirisinghe, Kamani Rajika, 299
 Edirisooriya, E.M.S.G.M., 295
 Egodagamage, T.K.K.K., 339
 Egodawatta, E.A.I.N., 129

Ehelepola, E.W.K.J.B., 365
 Ekanayaka, E.A.P., 114
 Ekanayake, A.C.K., 171
 Ekanayake, C.B., 90
 Ekanayake, D.B.G.M., 22
 Ekanayake, E.M.D.J.K., 377
 Ekanayake, E.M.L., 401, 411
 Ekanayake, E.M.P.U., 172
 Ekanayake, E.M.S.D., 22
 Ekanayake, E.M.W.G.P., 328
 Ekanayake, E.W.M.G.W.S.G.B., 389
 Ekanayake, JayalathBandara, 384
 Ekanayake, Ruvini, 365
 Eramudugolla, Nuwanka Hiroshini, 199
 Eratne, S.U.B., 377
 Eriyagama, B.W.P.B., 376
 Esufali, Shameema Jafferjee, 303
 Etampawala, E.R.L.B., 283
 Ethayakanthan, S., 194

F

Fahim, A.W.M., 156
 Fahmiya, Noordeen, 359
 Fahumy, M., 293
 Faizal, Mohamed, 415
 Farzana, M.T.Z., 324
 Fasly, M.S.M., 160
 Fathah, M. I., 355
 Fazeel, U.M., 131
 Fernando, A.M.R., 24
 Fernando, H.D.N.S., 223
 Fernando, K.J.P., 240
 Fernando, M.H.G. Nisansala, 112
 Fernando, M.R., 347
 Fernando, M.S.A., 112
 Fernando, P.R.K., 163
 Fernando, P.V.J., 183
 Fernando, Pius Rodney, 241
 Fernando, Priyantha Lakshmen, 131
 Fernando, R.H.S.S., 245
 Fernando, S.P., 314
 Fernando, T.S.B., 127
 Fernando, W.D.N., 157
 Fernando, W.J.G.S.P.S., 119
 Fernando, Y.D., 390
 Fernando. W.i.T., 15
 Fervin, S.Z.R., 240
 Fonseka, H.F.C.P., 153
 Fonseka, W.C., 170

Francis, Muttharachchige Don
 PrashanLasantha, 164

G

Gajasingha, B., 379
 Galappaththige, S.K., 238
 Galkaduwa, M.B., 119
 Gamage, A.C., 291
 Gamage, B.S.C., 186
 Gamage, Chandrani Kumari, 371
 Gamage, K.L. Susantha, 160
 Gamage, M.A.S.K., 241
 Gamage, M.C., 319
 Gamage, S.J.K., 160
 Gamini, Medagoda Medagedara, 356
 Gamlath, B.G.R.W., 163
 Gamlath, N.J., 386
 Gamlathge, Malika Vinodani, 115
 Gammanpila, Himani M., 298
 Ganesan, Kumaravelu, 242
 Ganeshamoorthy, Kandasamy, 381
 Gawarammana, M.B.M.D.S., 364
 Gayani, P.A., 113
 Geethika, C.D.H., 115
 Gimhani, D.R., 26
 Ginige, Senaka Ramyanath, 360
 Gnanapragasam, G., 239
 Gnanapragasam, S.R., 365
 Gnanarathna, P.M.G.M., 130
 Gokulanandan, S., 333
 Gomesz, T.D.A., 201
 Gonapinuwala, S.T., 119
 Goonsekera, Iranga Wimala, 128
 Gopermanan, T., 173
 Gowrithasan, Kalpana, 199
 Gregory, W.A.D.S.N., 20
 Grero, K.T.C., 167
 Guluwita, Sudath Peiris, 243
 Gunarathinaraja, Karthegesu, 381
 Gunarathna, J.A.N.S., 292
 Gunaratne, L.M.W.K., 221
 Gunaratne, M.K., 300
 Gunaratne, V.P., 21
 Gunasekara, H.K., 168
 Gunasekara, I.W., 27
 Gunasekara, M.D.A., 329
 Gunasekera, S.N., 379
 Gunasena, Dilani Nilushika, 111
 Gunasena, S.L., 386

Gunasingam, Kirijadevi, 361
 Gunasingha, A.L.B., 173
 Gunasinghe, E.S.A., 386
 Gunasinghe, M.P.R.N., 241
 Gunasinghe, R.M.S.K., 337
 Gunasinghe, W.K.R. Niroshini, 264
 Gunathilaka, M.S.K., 343
 Gunathilaka, W.D. Samanthi, 114
 Gunathilaka, W.L.R.D., 359
 Gunathilake, G.M.A.K., 175
 Gunathilake, K.M.D., 277
 Gunathilake, R.M.S.U., 382
 Gunatilake, M.D.L. Priyankara, 63
 Gunatilake, S.K., 183
 Gunawardana, I.U., 374
 Gunawardana, M.W.P.D., 325
 Gunawardana, Nalaka, 113
 Gunawardana, Samantha, 236
 Gunawardana, D.C., 73
 Gunawardana, N.D., 291
 Gunawardhane, V.D.K., 311
 Gunewardene, B.D. Panditharathne, 361
 Gurukandura, K.H., 334
 Gurusinghe, D.I.C., 194

H

Hafil, Ashraff Mohamed, 78
 Halkewidana, H.D.A.W., 387
 Hanee, J.A.J., 307
 Hapuarachchi, Swarna D., 293
 Haroon, M.H., 34
 Hasitha, R.R.M., 160
 Hedeniya, H.V.U.R.B., 172
 Hemachandra, C.D., 157
 Hemantha, J.B.M., 383
 Hemanthi, H.L., 348
 Herath, G.C., 290
 Herath, H.A.U.I.A., 166
 Herath, H.M. Padmini Chandrani, 303
 Herath, H.M.A.B., 191
 Herath, H.M.A.K.B., 389
 Herath, H.M.A.M.C., 45, 118
 Herath, H.M.I.K., 182
 Herath, H.M.I.P., 27
 Herath, H.M.J.M.K., 175
 Herath, H.M.S.N., 20, 239
 Herath, H.M.U. Bandara, 174
 Herath, Herath Mudiyanseelage Sisira Bandara,
 237

Herath, J.M.M.K., 189
 Herath, K.R.P.K., 181
 Herath, S.S.L., 237
 Herath, W.H.M.A.T., 250
 Hettiarachchi, A.K., 172
 Hettiarachchi, A.P., 371
 Hettiarachchi, Chamika, 23
 Hettiarachchi, D.K., 182
 Hettiarachchi, H.A.J.R., 130
 Hettiarachchi, N.D., 153
 Hettiarachchi, P., 137
 Hettiarachchi, S.K., 167
 Hettige, H.D.S.N., 387
 Hettige, N.D., 188
 Hettihewa, S.K., 89
 Hewavitharana, H.A.N.S., 363
 Hewawarawita, L.S., 134
 Hubert, A.N.H., 346
 Hubert, Mariathas H., 352

I

Idamekorala, R.P., 378
 Iddamalgoda, I.A.D.V.R., 328
 Ikiriwatte, C.J., 268
 Ikrima, M.S.M., 169
 Ilham, Mohammed, 366
 Illangasinghe, I.K.M.S.C.K., 143
 Iman, S.H.M.U., 200
 Imran, M.M.M., 367
 Imthiyas, M.M. Mohammed, 380
 Imthiyas, S., 129
 Indrakeerthi, S.R.P., 263
 Indralingam, Arumugam, 310
 Indrasena, I.K., 115
 Indrasena, Priyadarshinie S., 189
 Inthirapalah, M., 376
 Iqbal, S.S.J.M., 315
 Iranganie, W.J., 334
 Irshad, M.P.M., 190
 Ishak, T.L., 340

J

Jafeen, M., 213
 Jahan, M.A.C.A., 386
 Jahufer, Aboobacker, 349, 356
 Jameel, A.B.S.H., 289
 Jayakody, J.K.B.N., 366
 Jayakody, J.K.P.M., 125
 Jayakumar, Seenithamby, 317

- Jayalal, R.G.U., 58
 Jayalath, P.P., 156
 Jayamanne, D. H. L. W., 124
 Jayaneththi, Salila Nalanthi J.K.D., 304
 Jayanetti, S.R., 415
 Jayantha, H.M.P., 170
 Jayarathna, I.P.L., 59
 Jayarathna, P.H.S.Y., 239
 Jayaratna, D.I., 339
 Jayaratne, H.A.C.G.K., 302
 Jayaratne, R.N.R., 178
 Jayaratne, Upeksha Priyantha, 12
 Jayasekara, A.J.M.A.K.A., 121
 Jayasekara, D.A.M., 371
 Jayasekara, I.U., 132
 Jayasekara, Indra, 200
 Jayasekera, C.N, 319
 Jayasekera, Palitha Wijaya Bandara, 286
 Jayasekera, Upul Gamini, 237
 Jayasena, Gamini, 163
 Jayasena, S., 355
 Jayasingha, J.P., 197
 Jayasinghe, C.A., 190
 Jayasinghe, C.D., 118
 Jayasinghe, C.L., 366
 Jayasinghe, Gamini Sarath Bandara, 64
 Jayasinghe, H., 343
 Jayasinghe, H.B.A.U., 239
 Jayasinghe, I.M.A., 184
 Jayasinghe, J.A.D.M.U., 377
 Jayasinghe, J.A.G.N., 389
 Jayasinghe, J.B.L., 298
 Jayasinghe, J.M.B.D.B., 339
 Jayasinghe, K.P.D.A.K.S., 166
 Jayasinghe, P.K.D.E., 292
 Jayasinghe, R.M.N.P.K., 168
 Jayasinghe, W.P.L., 381
 Jayasooriya, C.I.E., 392
 Jayasooriya, J.A.C.P, 71
 Jayasooriya, J.M.P.P., 165
 Jayasooriya, P.H.C.A., 368
 Jayasundara, J.M.G.I.C., 392
 Jayasundera, J.M.M.A., 113
 Jayasundera, S.N.N.B.W.M.K.K., 21
 Jayasundera, Upali, 300
 Jayasuriya, B.R.R.P., 166
 Jayasuriya, D.G.D., 290
 Jayasuriya, M.N.S., 331
 Jayathilaka, M.T.G.D.M., 369
 Jayathilaka, P.A.M.T., 244
 Jayathilaka, P.A.R.D., 228
 Jayawardana, B.D.S., 21
 Jayawardana, B.P.A., 196
 Jayawardana, Y.B.J.N., 158
 Jayawardane, B.A.D.S., 415
 Jayawardane, D.N., 388
 Jayawardane, J.K.B.M., 111
 Jayawardena, N., 168
 Jayawardena, U.A., 406
 Jayawardene, K.H.M.M.M., 116
 Jayaweera, J.P.M.W.K., 158
 Jayaweera, J.P.R.R.S., 392
 Jayaweera, P.S., 171
 Jayaweera, S.L.D., 26
 Jayawickramarachchi, H.K., 183
 Jazil, A.A.M., 344
 Jeevaretnam, Vathamy, 122
 Jeewantha, W.M.D., 395
 Jeganmohan, Nagarajah, 310
 Jerard, D. M. Sirimal, 125
 Jeyarajasingam, Niruba, 364
 Jeyaruban, Kanagarajah, 131
 Jeyasugiththan, Jeyasingam, 236
 Jeyasuthan, A., 240
 Jeyatheepan, Jeyapathy, 114
 Jiffriya, M.A.C., 390
 Johnson, S., 384
 Joseph, J.S., 198
-
- K**
- Kalhari, K. Susitha, 107
 Kalpage, A.S., 364
 Kalpage, S.W., 20
 Kalupahana, Sumudu S., 353
 Kalyanawathie, T.H., 327
 Kamaradiwela, K.A.D.W.U.K., 155
 Kanagarathnam, Uma, 126
 Kanagaretnam, Manoranjani, 185
 Kanagasabapathy, P., 391
 Kanagasabapathy, V., 324
 Kandasamy, Subashini, 196
 Kandeepan, S., 333
 Kandekumbura, R.M.N.S., 316
 Kandiah, T., 323
 Kankanamge, K.K.V.S., 327
 Kapukotuwa, Dammika B., 383
 Karagaswewa, Jinanjali Malmi Kumari, 281
 Karalliyadde, L.H., 244

- Kariapper, R.K.A.R., 386
 Kariyawasam, Champika Shyamalie, 304
 Kariyawasam, L.M., 308
 Karmegam, Vasanthi, 132
 Karunagoda, K.P.L.N., 331
 Karunaharan, Arunasalam, 129
 Karunanayake, Chandima Priyadharshani, 367
 Karunanayake, K.A.P.P., 329
 Karunanayake, K.O.L. Chathurika, 254
 Karunarathna, H.S.S., 157
 Karunarathna, M., 187
 Karunarathna, M.M.S., 405
 Karunarathna, S.P.D.S., 370
 Karunarathna, Y.A., 169
 Karunarathne, A.S., 155
 Karunarathne, I.G.C.N.K., 338
 Karunarathne, S.H.R.V., 384
 Karunarathne, S.M.M.L., 135
 Karunaratne, Anjani M., 2
 Karunaratne, D.N., 173
 Karunaratne, E.C. D. A., 185
 Karunaratne, G.C., 394
 Karunaratne, H.W.C.C., 115
 Karunaratne, Inoka, 403
 Karunaratne, K. A. B., 164
 Karunaratne, K. B. J., 316
 Karunaratne, S.B., 170
 Karunaratne, W.D.V., 113
 Karunaratne, Weeraman Subodhi, 40
 Karunasena, S.G.A.L.K., 112
 Karunathilake, R.M.L.C., 241
 Karunathilake, T.H.N.M., 61
 Karunawansa, I.S., 371
 Karunawathie, K.M., 341
 Kathirgamanathar, Selvaluxmy, 36
 Kathiriarachchi, Hashendra Suvini, 278
 Kavirathna, K.N.L., 168
 Keerthiratne, K.W.M.S., 96
 Keerthisinghe, K.M., 238
 Keerthiwansa, G.W.P., 372
 Ketheeswaran, Y., 342
 Kethesan, K., 374
 Khan, S.K.M.A., 310
 Kidhumathullah, M.M., 393
 Kirupalamoorthy, Suganthi, 315
 Kodikara, R.R.M., 242
 Kodikaraarachchi, Jayantha Chandralal, 388
 Kodituwakku, J., 159
 Kohilan, K., 370
 Koneshamoorthy, Navaretnam, 332
 Kooragama, U.P., 186
 Koralagama, Priyanka Kumudinee, 318
 Koswatte, R.M.K.G.S.P.B., 138
 Kotabewatta, P. A., 125
 Kotuwegedara, H.B., 369
 Kovintharajah, Ponniah, 360
 Krishantha, D.M. Milan, 51
 Krishantha, L.H.C., 240
 Krishnarajah, S. Rasiyah, 398
 Kudahetty, Chaminda, 172
 Kuhananthan, Sinnathamby, 361
 Kuhanesan, Sinnathamby, 224
 Kularathna, L.P., 299
 Kularathne, I.G.C.I., 175
 Kulasena, W.A.N.L., 147
 Kulathunga, L.C.M.K., 176
 Kulatilaka, P.H.N., 332
 Kulatunga, E.R.G.V.S., 368
 Kulatunga, I.H., 123
 Kumanan, K., 314
 Kumar, A.H. Dilip, 235
 Kumara, B.A.S., 318
 Kumara, B.A.U.I., 170
 Kumara, B.T.G.S., 395
 Kumara, D.G.D.D., 121
 Kumara, H.G.P., 118
 Kumara, I.G.C.K., 109
 Kumara, K.D.B., 330
 Kumara, K.S., 153
 Kumara, L.D.R.S., 154
 Kumara, M.P.N., 154
 Kumara, N.M.N.I.U., 131
 Kumara, T.M., 160
 Kumaraarachchi, K.H.D., 238
 Kumarakulasingam, Sumathy, 335
 Kumarasinghe, Chandrani, 343
 Kumarasinghe, E.A.R., 330
 Kumarasinghe, Janak Chandana, 341
 Kumarasinghe, N.T.B., 379
 Kumaratilake, W.L.D.R.A., 164
 Kumaratilake, W.L.D.R.A., 136
 Kumari, H.M.P.S., 8
 Kumari, K.A.S. Hemantha, 335
 Kumari, K.M.R.R.N.B. Seetha, 333
 Kumari, L.M.G.M.S., 333
 Kumari, P.G.R. Hemanthi, 301
 Kumarihamy, B.M. Mallika, 70
 Kumbalatara, K.A.C.D., 357

Kumbukage, T.R., 25
 Kumbukgolla, W.W., 110
 Kusumawathie, W.M., 342

L

Laggoda, Saman Kumari, 318
 Laheetharan, A., 350
 Lakmal, A. Harinda, 167
 Lakmali, P.K.B., 294
 Lakshman, V., 379
 Lalith Kumara, W.A., 287
 Lankeswara, Lankeswarage Palitha Perakum, 88
 Lasantha, W.M.M., 174
 Lebbe, A.M. Ahamed, 197
 Lekamge, Chandrika Subhashini, 303
 Lekammudiyanse, L.M.M.U., 200
 Lenora, R. Prabha P., 308
 Liyanagama, Saman, 195
 Liyanage, Chandani Samarawickrama, 104
 Liyanage, D.S.K., 135
 Liyanage, P. Udayanganee, 394
 Liyanage, P.L.C.L., 188
 Liyanage, Sriyani, 297
 Liyanage, Sunil, 273
 Liyanagedara,
 LiyanagedaraMudiyanselageMudithaPremak
 umara, 145
 Loganathan, N., 235
 Lokugalappatti, L.G.S., 415
 Lokuge, M.A., 372
 Lokuliyana, Dhananjaya Ramya Kumara, 57
 Lokuliyana, M.D., 302

M

Madanayake, M.P., 166
 Madugalla, M.A.S.R.K., 296
 Madurapperuma, M.A.D.S.S., 372
 Mafas, M., 393
 Magamage, C., 122
 Mahagamage, R.P.K., 344
 Mahatantila, W.D.K., 149
 Mahavithana, A.P., 133
 Maheepala, M.M.J.D., 359
 Mahendralingam, Anushya, 83
 Mahendranathan, C., 280
 Maheshwaran, S., 24
 Mahindapala, J.A.S.P., 380
 Makehekwala, Madhubhashini, 99
 Malalgoda, D., 169

Malavipathirana, P., 318
 Malavipathirana, Sarath, 98
 Malewana, W.E. Upulee, 123
 Maliyadde, M.S., 28
 Mallawaarachchi, S. Manjula, 297
 Mallawachchi, M.K.D. Wijaya Sri, 205
 Manamperi, A.S., 27
 Manamperi, A.S.P., 195
 Manawadu, U.D., 200
 Manawardhana, G.J.G., 236
 Manimarrphan, K., 366
 Manjceevan, A., 120
 Manjula, S.H.M., 169
 Mannapperuma, C.K., 247
 Manoharan, Subramaniam, 312
 Manoja, U.G.Y.M., 302
 Manoraj, A., 293
 Manoranjan, Tharmarajah, 33
 Manoratne, C. Hemapa, 80
 Manoshi, K.H.P., 27
 Mansoor, C.M.M., 393
 Marasinghe, B.S., 167
 Marasinghe, G.P.K., 70
 Marasinghe, Jeevani Prasadika, 189
 Marasinghe, M.A.J.C., 237
 Markandu, Thevaky, 117
 Marystella, M., 358
 Mathialahan, E., 122
 Mayadunne, N.S. Devika, 337
 Mayuiran, S., 205
 Medawatte, W.W.M.A.B., 276
 Meddage, N.R., 370
 Medis, S. D., 289
 Megasooriya, C.S., 389
 Menike, A.R.G.A.M. Abeykoon, 305, 330
 Menike, H.M.D.D.D., 338
 Menike, H.M.S. Herath, 184
 Menike, L.H.S.C., 360
 Methew, A., 324
 Molligoda, P.S., 24
 Moratuwage, S., 341
 Muhajireen, M. M. Mohamed, 117
 Mukarram, M.L.M., 309
 Mularachchi, N.S.K., 204
 Munasinghe, D.A.L., 21
 Munasinghe, Muditha Hiranthi, 187
 Munidasa, B.K.H. Chandrika, 262
 Muralitharan, S.D., 193
 Murugiah, Yarlmoli, 362

Murukamoorthy, Thanthonry, 327
 Muthulingam, A., 292
 Muzammil, M.M., 345

N

Nadeera, S.P.A., 326
 Nagasena, I.I., 289
 Nagulan, Ratnarajah, 369
 Naguleswaran, Arunasalam, 416
 Naleer, Mohamed, 358
 Nalinie, K.A.C., 296
 Nanayakkara, D.M., 13
 Nanayakkara, D.P., 18
 Nandakumara, S., 22
 Napagoda, M.T., 65
 Narampanawe, K.M.M.W.C.K., 346
 Naresh, Thambimuthu, 377
 Naseem, M., 157
 Nathanael, Evangeline Shirani, 401
 Navarathne, W.D.T.J., 127
 Navaratne, Srikanthi Pushpanjali, 112
 Nawarathna, N.M.V.K., 242
 Nawas, N. Fahima, 298
 Nawas, Noorul Fahima, 269
 Nawfal, Mohamed Mihlar Mohamed, 322
 Nayanananda, S.B., 127
 Nazeem, Mohamed, 320
 Nijamudeen, Abdul Majeed, 297
 Nilmini, E.L.S., 174
 Nilmini, L.H.A., 371
 Nilwakke, N.M.A.P.B., 372
 Nimali, H.W.G., 116
 Niriella, A.T., 120
 Niroshini, K.H.K. Tharanga, 16
 Nisa, M. Y. Misbahun, 120
 Nisansala, T.A.D., 375
 Nishantha, M.R., 119
 Nissanka, N.M.J., 93
 Nooraniya, J.S., 331

O

Olagama, K.R.K.S., 322
 Ossan, T.K. Sahid, 132

P

Pakirathan, S., 332
 Palagama, D.S.W., 121
 Palihapitiya, Chintha Priyanganie, 196
 Pallewatta, S.K., 295

Palliyaguruge, P. S., 390
 Palugaswewa, I.J.K., 198
 Panchalingam, V., 344
 Panchanatham, Srigeetha, 235
 Paramasamy, P., 24
 Paranirupananthan, C., 366
 Parthasarathy, S., 324
 Paskararajah, T., 367
 Pathirage, Rohan Priyantha, 355
 Pathiraja, Chandana Mahesh Sadagiri, 132
 Pathirana, A.A.I.S., 233
 Pathirana, C. Dedduwa, 338
 Pathirana, K.P.M.N., 187
 Pathirana, N.S., 159
 Pathirana, S.N.J., 27
 Pathirana, Sandamali, 303
 Pathirathne, Thusitha, 127
 Pathmanathan, Kandiah, 130
 Pathmathas, T., 237
 Pavalakanthan, P., 384
 Peiris, A.R.K., 240
 Peiris, H.H., 19
 Peiris, K.S.K., 344
 Peiris, M.C.R., 113
 Peiris, P.S.R., 393
 Peiris, Theresa, 123
 Peiris, Thusith, 126
 Peramuna, P.G.S., 345
 Peramune, Thamara Kumari, 327
 Peramunugama, D.H.P., 248
 Peratheepan, Pararajasingam, 243
 Perera, Antenette Niranjala, 285
 Perera, B. V. Pushpakumara, 287
 Perera, D. S. C., 130
 Perera, G.A. Kumudu Sandya, 212
 Perera, G.M.M., 292
 Perera, G.P.S., 199
 Perera, J.A.D.C.C., 173
 Perera, K.M.P.A.H., 114
 Perera, K.S.J.P., 313
 Perera, L. S. K., 382
 Perera, L.N., 376
 Perera, L.N.S., 267
 Perera, M. D. B., 416
 Perera, M.D. Bernadine, 402
 Perera, M.N.S., 395
 Perera, M.W.S., 5
 Perera, N. Yamuna Srimathi, 238
 Perera, P.I. Prasanthi, 257

- Perera, P.N.N., 373
 Perera, P.P.B.P., 158
 Perera, P.U. Muthumani, 294
 Perera, R.A.C.N., 117
 Perera, Sujeewa, 95
 Perera, W. Nadie, 19
 Perera, W.N.C., 168, 386
 Perera, W.V.S.M., 289
 Perera, Y.M., 303
 Peris, G. Marian L. A., 22
 Pillainayagam, Joseph Ajith, 236
 Piranavamar, T., 184
 Pitakumbura, D.G.S.W., 175
 Pitawala, H.M.J.C., 232
 Pitumpe, P.A. Chandra, 343
 Piyadigama, P.A.N.P.K., 168
 Piyarathna, S.M.S., 379
 Piyasena, K.G.N.P., 29, 74
 Piyasiri, B.S.M., 172
 Piyasiri, S.S., 299
 Piyatissa, P.M.J.R., 186
 Piyatunga, H.A.N.D., 186
 Polgampala, A.S.V., 310
 Ponnampalam, Santhana Nangai, 192
 Poopalasingam, Sankar, 243
 Prabakaran, D., 317
 Pradeep, B.G.S.A., 205
 Pradeepika, V.G.S., 372
 Pragalathan, A., 356
 Prasad, J.A. Tharaka, 288
 Prasangi. K.A.D.P., 118
 Prasanna, M.G.M., 295
 Prashantha, Thusith G.A., 161
 Premachandra, W.S., 295
 Premakumar, P.P., 387
 Premakumara, V.S., 316
 Premalal, E.V. Anura, 227
 Premalal, L.R., 314
 Premalatha, M.G.W.S., 330
 Premaratne, M.P.T., 300
 Premaratne, S.R., 94
 Premasiri, H.D.S., 81
 Premasundara, A.S., 165
 Premathilaka, K.M., 161
 Prematilake, Chalani, 363
 Prematilleke, K.P., 293
 Priyadarshani, A.M.A., 56
 Priyadarshani, W. P. Eureka, 385
 Priyadarshani, W.A.S., 390
 Priyadarshani, W.M. Deepika, 298
 Priyanka, S.L.N.V., 343
 Priyantha, A.S.C., 159
 Priyantha, G.V.D., 378
 Priyantha, N., 119
 Priyantha, U.G.R., 113
 Priyanthi, H.M.R.K.N., 319
 Priyanthi, R.H.C., 200
 Priyanthi, W.M.M., 167
 Priyanwada, N.H.N., 7
 Pulavan, P., 365
 Punchibandara, M.M.T., 25
 Punyasiri, P.A. Nimal, 50
 Pushpakumara, P.S., 327
 Pushpakumara, W.D. Densil, 380
 Pushpalatha, W.R.D.M.U., 321
 Pushpika, A., 313
 Puvanasingam, E.S., 358
 Puvanendran, S., 75
-
- R**
- Raafi, M.A.C. Mohamed, 384
 Ragupathyraj, Sivagnanam, 342
 Rahman, B.K., 332
 Rajaguru, R.M.C.K., 310
 Rajakaruna, D.J.A.S.De S., 127
 Rajakaruna, Padmini, 315
 Rajakaruna, R.H.M.N., 204
 Rajakaruna, Rupika S., 408
 Rajanathan, Clifford Judes, 356
 Rajapaksa, R.C., 408
 Rajapakse, Chamila Gihan, 359
 Rajapakse, P.S.K., 120
 Rajapakse, R.G.S.C., 10
 Rajapakse, R.M.M.Y., 77
 Rajapakse, R.M.N. Wasantha, 322
 Rajapakse, R.M.S.M., 161
 Rajapakse, S.A.K.R., 325
 Rajapaksha, K.T.P.M.P., 103
 Rajapaksha, R.D.S., 117
 Rajapaksha, R.G.N.K., 345
 Rajapaksha, R.M.A.U., 100
 Rajaratnam, Shubajini, 200
 Rajasundaram, Kuhashanthini, 334
 Rajkumar, T., 316
 Ramanathan, V., 237
 Ramesh, T., 338
 Ranasinghe, Amal Kaushalya, 394
 Ranasinghe, E.H.R.K., 291

Ranasinghe, I.D., 383
 Ranasinghe, J.I., 311
 Ranasinghe, Pradeep Nalaka, 150
 Ranasinghe, R. A. D. D. Nilanthi, 300
 Ranasinghe, R.A.A.S. Rohitha, 314
 Ranasinghe, R.L.D.S., 165
 Ranasinghe, R.M.N.P., 185
 Ranasinghe, R.P.H., 334
 Ranasinghe, S.K., 134
 Ranatungage, S.V., 301
 Ranawana, R.W.M.D.N.K., 348
 Ranaweera, L.V., 152
 Ranaweera, R.A.T. Manoj Sanjeewa, 381
 Ranaweera, R.P.S., 169
 Ranaweera, R.R.M.P., 392
 Ranaweera, S.P., 183
 Randeni, R.P.P., 332
 Ranganathan, Kalpana, 242
 Ranjith, B.M.G., 21
 Ranmadugala, Sajeewa B.H., 174
 Rasangika, T. H., 121
 Rasheed, Naseera Beevi Abdul, 319
 Rathnabharathie, B. Varuna, 296
 Rathnakumari, P.W.G.J., 289
 Rathnapala, N.A.S.N., 291
 Rathnaweera, M.K., 329
 Rathnayake, R.M.C.A.B., 385
 Rathnayake, R.M.D.N., 126
 Rathnayake, R.M.G.K., 295
 Rathnayake, R.M.N.B., 354
 Ratnakela, H.D.M.U.B., 345
 Ratnarajah, Sutharsana, 299
 Ratnasamy, M.S.C., 316
 Ratnasinha, Priyadarshani, 347
 Ratnayake, C.S., 171
 Ratnayake, I.S., 133
 Ratnayake, P.L.N.A., 320
 Ratnayake, P.U., 115
 Ratnayake, R.M. Rukmal P., 36
 Ratnayake, R.M.C.K., 325
 Ratnayake, R.M.C.S., 274
 Ratnayake, R.M.G.K., 308
 Ratnayake, R.M.N.B., 389
 Ratnayake, R.M.R.N.K., 302
 Ratnayake, R.M.T., 204
 Ratnayake, R.M.W. Kumara, 161
 Ratnayake, R.R., 249
 Ratnayake, W.I.G., 344
 Ratwatte, A.W.M.R.N.K., 235

Raveendran, S., 171
 Raveendranathan, P., 325
 Ravi, V., 184
 Ravirajan, Punniamoorthy, 241
 Ravishankar, N.T.N., 322
 Razmy, Athambawa Mohamed, 367
 Rixan, Fathima Ifthiya, 131
 Rizath, M.H. Mohamed, 391
 Rizvi, E.M.J. Muhammed, 271
 Rodrigo, M.G. Dilani, 115
 Rodrigo, P.D.T., 122
 Rodrigo, Udaya Indike, 86
 Rubasinghe, C., 186
 Rubasinghe, C.H.T., 192
 Rubasinghe, S.C.K., 283
 Rupasinghe, Maheshika, 330
 Rupasinghe, R. A. P., 290
 Rupasinghe, R.A. Apsara, 309
 Rupasinghe, R.A.N.P., 332
 Ruwan, P.M.S.A., 359
 Ruwanthilaka, J.A., 204

S

Sabanathan, Prameela, 356
 Sabaratnam, R., 383
 Safeena, M.I.S., 301
 Sahampath, J.A.A., 314
 Sakalasuriya, M.M., 338
 Salgadoe, A.V.C., 320
 Saluwadana, S.M., 311
 Samansiri, T.M., 296
 Samantha, W.A., 220
 Samanthi, J.H.S., 336
 Samaradiwakara, R.M.W.S, 288
 Samarakoon, A.S.D.R.S., 391
 Samarakoon, Nilantha B., 162
 Samarakoon, S.M.D.K., 239
 Samaranayaka, D.H.J.W.K., 405
 Samarasekara, A.P.K.G.S., 362
 Samarasekara, C.R.V.P., 26
 Samarasekara, W.I., 381
 Samarasingha, P.B., 230
 Samarasinghe, S.M.N., 387
 Samarasinghe, Sísira J.B., 393
 Samarasinghe, W., 156
 Samaratunga, S.M.A.B., 162
 Samaraweera, M.A.R.L., 222
 Samarawickrama, M.N. Chandana, 161
 Samarawickrama, M.P.S.R., 376

- Samoon, Mohamed Meerasahibu, 132
 Samson, Pitivila Liyanage, 342
 Sandanayake, A., 288
 Sandeswaran, R., 329
 Sandrasegarama, Shivashagthy, 378
 Sanjeewa, J.K.G. Prasad, 174
 Santhampillai, J.M., 23
 Santharooban, S., 189
 Sapinas, I.P., 196
 Sasikumar, V., 369
 Sathar, A.L.S. Abthus, 313
 Satharasinghe, C.H., 385
 Satharasinghe, P.M., 382
 Segar, S., 308
 Selvakkadunko, S., 358
 Selvarajah, K., 381
 Selvarangini, A., 385
 Senadeera, R.P., 362
 Senadheera, Asoka, 23
 Senadheera, S.S., 336
 Senanayake, J.S., 329
 Senanayake, K. P. S. B., 343
 Senanayake, Padmini Dharmalatha, 128
 Senanayake, S.M.A., 198
 Senani, P.L.K.M., 319
 Senapala, L.H.A., 339
 Senarath, H.P.S., 63
 Senaratne, T. N., 290
 Senavirathna, N.K., 298
 Senaviratne, G.M.M.M.A., 376
 Senevirathna, A.M.W.K., 296
 Senevirathna, D., 20
 Senevirathna, D.B., 2
 Senevirathne, E.M.D.S., 193
 Seneviratne, J.W.Y., 368
 Seneviratne, Neetha Geethanjalie, 190
 Seneviratne, P. Champika, 315
 Seneviratne, Rohitha Y.M.K., 191
 Senthilkumar, K.S., 370
 Senthilkumaran, Kanapathipillai, 320
 Serasinghe, Roshan Niranjala, 357
 Sereladevan, Ravinthiran, 371
 Shafiya, J.A.J., 288
 Shalika, A.R.R., 294
 Shanmugam, Pradeepa, 355
 Shanmuganathan, S., 199
 Shanthilatha, H.H., 293
 Sharifdeen, M.M., 127
 Shasikumar, N., 362
 Shivakumar, A., 124
 Shiyana, M.Z.S., 312
 Shripathy, T., 190
 Silva, D.A.R., 111
 Silva, M.A.S. Sankhanath, 188
 Silva, N.R., 363
 Silva, S.A.N.C., 131
 Silvalingam, P.K., 324
 Sinnathamby, Renuka, 124
 Sinniah, G.D., 253
 Sirajudeen, H.L., 395
 Sirisena, U.V., 291
 Sirisena, W.P.C.M., 233
 Sirisumana, D.P. Kanchana, 389
 Siriwardana, Pamodya Nilanthi, 125
 Siriwardana, R.M.L.S., 363
 Siriwardena, E.K.D.H.D., 133
 Siriwardena, HenarathHettiarachchige Don
 Ajith Lal, 165
 Siriwardhana, A.C.P.K., 370
 Siriwardhana, D.A.S., 44
 Siriwardhana, R.M.C.K., 362
 Siriwardhana, R.M.R. Damayanthi, 329
 Siriyalatha, R.M., 345
 Sivakumar, Sathiyaprabha, 337
 Sivakumar, Vallipuram, 369
 Sivananthan, Sarasanandarajah, 236
 Sivanesharajah, N., 340
 Sivarupan, Tharmalingam, 242
 Sivatuban, S., 376
 Sivayogan, Thusheeta, 243
 Sivayoganathan, Kalaimagal, 379
 Sivayoganathan, Sivayini, 134
 Skantharajah, P.S., 320
 Solangaarachchi, D., 166
 Solangaarachchi, D.I.K., 372
 Somapala, K.S., 195
 Somaratna, K.A., 155
 Somaratne, O.S.R., 391
 Somasiri, H.P. Preethi Sudarshana, 120
 Somasundaram, Sashikala, 85
 Sooriyabandara, M.G.C., 287
 Sooriyage, R.S., 130
 Sothyruvan, Thiruchittampalam, 105
 Soundararajah, Q.Y., 219
 Srimalka, G. Prasadha, 198
 Sriranganesan, Jeyanthini, 202
 Sriyani, W.A.C., 155
 Subadra, M., 340

Subashinie, R.P.R, 339
 Subasinghe, S.A.S.S., 390
 Subramaniam, Gnanasundari, 197
 Sugathadasa, C.A., 375
 Sugathadasa, K.K., 175
 Sugathadasa, B.H.K. Rohan, 22
 Sugeeshwari, D.M.S., 25
 Sugunathas, Kugathas, 187
 Sumanasinghe, D.N., 395
 Sumaneathiran, T., 197
 Sumathipala, N.S., 361
 Sunil, Ahangama Gamage, 272
 Sunthararajah, T., 173
 Surendranathan, Elanganathan, 193
 Surendranathan, V., 375
 Sureshkanna, Puvanentheran, 203
 Sureshkumar, S., 392
 Surige, C.S., 292
 Suriyawansa, S., 167
 Susantha, R. Nalaka, 67
 Suthakaran, S., 347
 Suthakaran, Subramaniam, 121
 Suthakaran, T., 326
 Swarnalatha, G.P.S., 333

T

Tennakone, Harshani, 241
 Tennakoon, N.S., 25
 Tennakoon, S.N.K.K., 308
 Tennakoon, Tennakoon Mudiyansele
 Thusitha Nanda, 210
 Thadani, Vinitha M., 53
 Thahir, F.H., 290
 Thalagahagedara, Poornima Manoji, 192
 Thalagoda, U.C., 360
 Thalagune, E.M.G.W.M.B., 205
 Thambugala, T. R. Wilani, 128
 Thananjeyan, N., 165
 Thanaraj, V., 288
 Thaneswaran, Velauthapillai, 369
 Thangarajah, P., 328
 Thangarajah, Renuka, 126
 Tharmaseelan, Sivapathasundram, 390
 Tharshanna, Nadarajah, 367
 Tharumasoruban, Thamarajah, 205
 Thasneem, M.Y., 383
 Thatheeswaran, Sivasubramaniam, 382
 Thavakiruba, S.P., 184
 Thayananth, Selvarajah, 193

Thayananthan, P., 157
 Thayaparan, A., 384
 Thayaseelan, K., 195
 Theepthakumar, Thanabalasingham, 358
 Theivathavapalan, Jamuna, 185
 Theiveegarajan, Thambiappah, 384
 Thiagarajah, T., 315
 Thilakarathna, P.N.L., 125
 Thilakarathna, U.G.H.N., 171
 Thilakarathne, L.R., 358
 Thilakarathne, Chaminda Nuwan, 162
 Thilakasiri, D.B.R.P., 195
 Thilakasiri, N.W.A.I., 381
 Thilakawansa, H.K.D.D., 372
 Thilakerathne, H.M.A.G.B., 156
 Thiranagamage, T.G. W., 123
 Thiruchelvam, Kariharan, 26
 Thotawatthage, C.A., 395
 Thushara, H.K.R., 173
 Tilakarathne, U.T., 382
 Tillekarathne, K., 413
 Tissera, P.C.N., 373

U

Udakara, S., 244
 Udawatte, Chandana Premakumara, 48
 Udunuwara, U.K.N.A., 20
 Uduwage, V.V., 124
 Uduwela, R.A., 389
 Umakajan, S., 392
 Upali, I.M.S., 321
 Upali, L.D., 378
 Uruththiramoorthy, S., 314
 Usoof, S.A., 28
 Uthayaraj, Rajaratnam, 336
 Uwais, M.M.M., 388

V

Vadivelu, K. Senthil, 337
 Vageesan, H., 309
 Vaheesar, Kandasamy, 120
 Vaikunthan, S., 363
 Varaprathan, Kesavarajan, 240
 Varathan, N., 365
 Vasanthakrishnan, R.B., 9
 Vathanie, M.S., 311
 Velauthamurthy, K., 60
 Velmurugu, Y., 221
 Velupillai, T., 292

Venugoban, Kanesh, 382
 Vidanapathirana, Kamal Pushpakumara, 211
 Vignarooban, Kandasamy, 231
 Vigneswaran, Nadarajah, 321
 Vigneswaran, Theivendram, 367
 Viknesh, N., 359
 Vinoharan, V., 396
 Vishwajith, K.A.D.R., 24
 Vitarana, M.C., 26
 Vithanage, Meththika Suharshini, 193
 Vithanage, N.S., 151
 Vithanage, Vajira, 331
 Vitharana, K. B. Adikaram, 335
 Vitharana, P.R.K.A., 306, 321

W

Wadduwage, S.R., 169
 Waduge, Lalitha Kamal, 315
 Wakkumbura, Mapa, 385
 Walisinghe, H.A., 25
 Walpola, Jayantha, 386
 Wanasinghe, A.H., 348
 Wanasinghe, W.M.S.C., 126
 Wanasooriya, W.M.D.I., 187
 Wanigasekara, U.W.N.P., 246
 Wanigasekara, W.A.D.I.D., 161
 Wanigasekara, W.M.C.B.B., 374
 Wanigasekara, W.M.C.K.B., 374
 Wanigasekera, W.M.J. Priyalal, 374
 Wanigasuriya, L.L.N., 375
 Wanniarachchi, W.A.C.P., 346
 Wanninayake, S.B., 159
 Wanninayake, W.T.M.A.P.K., 243
 Warnakulasuriya, Sarath, 321
 Warnasooriya, W.M.P.B.K., 112
 Warusavithana, R.C., 393
 Watagoda, R.I., 396
 Wataketiya, W.W.C.N., 388
 Wathurakumbura, S.K., 323
 Wattuhewa, Indra Sriyani, 323
 Weerahewa, H.L.D., 258
 Weerakkody, T., 294
 Weerakoon, Krishni Chanika, 412
 Weerakoon, Nishantha Sripali, 390
 Weerakoon, W.R.W.M.A.U., 256
 Weeraman, Tharungika Thushari Karunarathne,
 83
 Weeraratne, T.H., 407
 Weerasekara, W.M.N., 309
 Weerasekara, W.M.P.M.B., 135
 Weerasekera, W.M.G.B., 163
 Weerasinghe, A.G.A. Jayantha, 69
 Weerasinghe, D.P. Priyangani, 112
 Weerasinghe, H.A.S., 266
 Weerasinghe, W. Jayaneththi, 336
 Weerasinghe, W.A.S.M.D., 158
 Weerasinghe, W.D.C., 394
 Weerasooriya, C.S., 377
 Welagedara, A.S., 148
 Welagedara, Anuradha, 131
 Weliwegamage, Ubhayathilaka Sisira Kumara,
 38
 Wettasinghe, R.K., 154
 Wickrama, S.M. Inosha, 394
 Wickramaarachchi, W.A.P.N., 135
 Wickramage, S.A., 24
 Wickramarachchi, D., 356
 Wickramaratne, H.U.S., 163
 Wickramasinghe, M.P., 364
 Wickramasinghe, N.T., 25
 Wickramasinghe, P. Mahesh, 116
 Wickramasinghe, S.I.S., 324
 Wickramasinghe, W. Champa Priyadarshanie,
 337
 Wickramasinghe, W.A.D.C.H., 158
 Wickramasooriya, D.T., 318
 Wickramasooriya, Warnitha S., 331
 Wickremasinghe, Medha Manel, 328
 Widurusinghe, U.M. Ratnakumari, 129
 Wijayakoon, W.M.S.K.V., 394
 Wijayalath, W.A.W.P., 182
 Wijayarathna, E.D.B.P., 130
 Wijayarathna, P.H.S.S., 375
 Wijayarathna, S.B.A.M.B.Y., 192
 Wijayasiri, D.R., 323
 Wijayatunga, W.M.S., 118
 Wijayawardhana, M.A.G.S., 168
 Wijayawardhana, R.G.A., 180
 Wijegunaratne, D.S.N., 348
 Wijekoon, A.M.N., 196
 Wijekoon, Chandana P.K., 393
 Wijekoon, R.D.W.M.J.L.S., 197
 Wijekoon, W.H.M.P.P.B., 385
 Wijekoon, W.M.A.M.B., 102
 Wijekoon, W.M.A.S.R., 192
 Wijeratne, C.N. Bandara, 187
 Wijeratne, E.M.S., 218
 Wijeratne, GodapolageNissanka, 142

Wijeratne, K.G.H.B. (Rev. Fr.), 342
 Wijeratne, K.M.U., 154
 Wijeratne, K.T., 135
 Wijeratne, S., 92
 Wijeratne, W.D.H.M., 313
 Wijesekara, H.K.D.K., 43
 Wijesekara, Kolitha Bandara, 284
 Wijesekara, N.W.A.N.Y., 156
 Wijesekara, S.S.R.M.D.H.R., 179
 Wijesekera, W.A.D.H.G.M., 204
 Wijesinghe, A.K., 334
 Wijesinghe, C.C.B., 374
 Wijesinghe, D.D., 239
 Wijesinghe, T.W.A. Wasantha, 119
 Wijesinghe, W.A.J.P., 303
 Wijesinghe, W.M.C.M., 146
 Wijesinghe, W.W.R., 294
 Wijesiri, W.D.D., 238
 Wijesundara, C.S., 404
 Wijesundara, D., 165
 Wijesundara, D.M., 197
 Wijesundara, K.W.E.M.P., 373
 Wijesundara, S.R., 183
 Wijesundara, W.M.C.S., 414
 Wijesundara, W.M.M.S., 189
 Wijethilaka, M.W.S.K., 313
 Wijethunga, M.U.I., 182
 Wijewardena, K. Buddika, 126
 Wijeyaratne, W.M.P.K,M. Chandrika, 336
 Wimaladharm, W.H., 380
 Wimalasena, C.R., 123

Wimalasena, M.D.N. Renuka, 195
 Wimalasena, M.D.N.R., 331
 Wimalawardhane, H., 312
 Withanachchi, Indra, 320
 Withanachchi, S.J., 395
 Withanage, B.P., 164

X

Xavier, P.A.T.P.A., 158

Y

Yalegama, C., 31
 Yalingasinghe, A.W.G.S., 297
 Yapa, P.N., 275
 Yapa, Y.A.A. Kumara, 236
 Yaparathne, Y.M.C.D., 321
 Yatigamma, S. Kumari, 309
 Yatigamma, T.M.S.S.K, 185
 Yoganathan, Thirunavukkarasu, 234
 Yoharajan, S., 171
 Young, Sansfica Marilyn, 139

Z

Zahir, I.L.M., 170
 Zahmeeth, S.S., 350
 Zainudeen, N.H., 394
 Zainudeen, U.L., 206
 Zainudeen, Umer Lebbe, 242
 Zareeha, M.T., 347

Supervisor Index

Explanation:

Supervisor's surname, initials. (Location No. – Page No. ; Location No. – Page No. ;)

Eg.: Amaradasa, R.M.W. (650–319; 676–332)

A

- Abayasekara, C.L. (161–302; 329–297; 331–296; 701–254; 847–340; 865–256; 866–246; 1073–253; 1074–247; 1276–289; 1286–250; 1395–260)
- Abeyakoon, Sarath (857–233)
- Abeygunasekera, K.D.G.M. (1335–327)
- Abeykoon Menike, A.R.G.A.M. (808–311; 1213–310; 1307–322; 1223–387)
- Abeysekara, A.M. (323–126)
- Abeysekara, D.T.D.J. (1245–20)
- Abeysekera, Tilak (355–20)
- Abeysinghe, I.S.B. (232–128; 465–125; 548–50)
- Abeyweera, S.M.S. (1123–164)
- Abeywickrama, K.P. (394–299; 399–297)
- Abeywickreme, W. (629–195)
- Adikaram, N.K.B. (01–259; 4–252; 30–300; 40–300; 41–301; 42–300; 43–302; 44–296, 45–302; 46–296, 47–298; 216–258; 305–280; 330–296; 539–263, 701–254; 865–256; 866–246; 1073–253; 1286–250)
- Agampodi, S.B. (1029–158)
- Ahangama, D. (189–301)
- Ahilan, K. (571–336)
- Alahakoon, P.M.K. (279–394; 283–374; 285–382; 286–389; 287–385 ; 340–376; 357–371; 359–380; 360–381; 361–377; 362–370; 453–369; 818–378; 884–377; 942–373; 944–374)
- Alahakoon, S. (10–236)
- Alahakoon, Sanath (528–206)
- Alexander, Ryan A. (1319–393)
- Alkema, Dinard (911–151)
- Amaradasa, R.M.W. (650–319; 676–332)
- Amarakoon, A.M.T. (468–118)
- Amarasinghe, Udeni B. (364–161; 373–191; 416–162; 421–161; 490–163)
- Amarasinghe, M.D. (427–193)
- Amarasinghe, N.J. de S. (262–348; 503–326; 563–308)
- Amarasinghe, S.W. (774–159)
- Amaratunga, E.A.P.D. (530–5)
- Amarawansa, T.S. (64–316; 1167–234)
- Amerasinghe, F.P. (37–415, 387–397)
- Amerasinghe, N.J. de Silva, (262–348)
- Amerasinghe, P.H. (25–408; 31–415, 34–416, 51–416; 82–327; 387–397; 452–335; 699–2)
- Annersten, H. (02–48)
- Arambewela, L.S.R. (251–125; 531–3)
- Arivalzahan, S. (1333–365)
- Ariyaratne, H.A.C.K. (1212–313)
- Ariyaratne, H.B.S. (1325–129)
- Arshed, Tahira (257–333)
- Ashton, P.M.S. (71–272)
- Athauda, S.B.P. (98–70; 100–113; 213–12; 214–10; 239–122; 861–9; 870–114; 867–114; 964–119; 968–122; 969–124; 1070–8; 1149–27; 1247–21)
- Athuraliya, T.N.C. (34–416),
- Attanayake, Nishantha (724–169; 800–171; 912–165; 1126–165; 1128–169; 1320–168)
- Azmy, S.A.M. (1265–188)
- Jinadasa, K.B.S.N. (1156–183; 1159–194; 1266–183)
-

B

- Bambaradeniya, C.N.B. (29–164; 350–287; 511–286; 1072–247)
- Bamunuarachchi, A. (331–296)
- Bamunuarachchi, T.C. (1256–275)
- Bandara, A.M.N. (1033–172)
- Bandara, B.M.R. (231–128; 308–71; 531–3; 600–293; 601–292; 653–294; 691–321; 745–294; 920–89; 1215–92; 1240–63; 1242–110)
- Bandara, D.C. (605–321; 606–307; 608–328; 674–337; 851–348)
- Bandara, H.M.N. (58–313; 109–243; 116–347; 179–141; 190–315; 193–313; 252–122; 381–81; 409–118; 569–337; 806–316; 807–314; 909–77;

951–199; 962–60; 963–125; 1037–133; 1078–114; 1144–133; 1167–234; 1241–79)
 Bandara, J. (1101–133)
 Bandara, K.N. (421–161)
 Bandara, L.R.A.K. (390–244; 447–324; 828–314; 992–317; 1102–308)
 Bandara, T.W.M.T.W. (1322–170)
 Bandara, W.M.A.T. (291–131; 320–113; 336–130; 344–112; 345–126; 346–116; 378–131; 407–111; 411–111; 412–111; 413–112; 430–193; 433–200; 442–318; 637–61; 639–43; 708–309; 919–109; 1181–135; 1216–100; 1336–59; 1356–99)
 Bandaranayake, Champa Kumari (491–26)
 Bandaranayake, P.W.S.K. (94–212; 259–319, 385–229; 441–341; 575–241; 645–238; 705–316; 960–311; 1061–239; 1133–318)
 Banneheka, B.M.S.G. (948–357)
 Basnayake, B.F.A. (768–187; 1160–194; 1161–190; 1396–179)
 Bergman, Bill (06–210)
 Bodinayake, C.K. (704–338)
 Breckenridge, W.R. (05–400; 182–401; 184–415; 553–398)

C

Careem, M.A. (17–221; 93–211; 95–211; 108–238; 114–341; 152–347; 400–313, 434–242; 507–221; 596–243; 599–240; 791–206; 941–213; 1111–340)
 Cederlof, Ulf (217–218; 311–209)
 Chandrajith, R.L.R. (430–193; 576–241; 612–356; 697–149; 994–176; 1196–116; 1236–156; 1286–250; 1314–120; 1332–159)
 Chandrakanthi, D.R.L. Nayana (652–332; 824–311)
 Chandrasena, Lal (353–22; 354–22)
 Chelvendran, S. (967–115)
 Chroust, Gerhard (255–385)
 Cooray, Karven J. (833–292)
 Corea, F.M.R. (278–390; 281–390; 478–393)

D

Dahanayake, K. (11–185; 179–141; 811–157; 907–147; 1290–157)
 Dahanayake, U. (1171–235)
 Damunupola, J.W. (1220–322)
 Dangahadeniya, U. (353–22)

Dangolla, Ashoka (573–330; 772–155; 1091–156; 1140–155; 1255–182; 1340–159)
 Das, K. Ram (79–236)
 Dasch, G.A. (1069–13)
 Dassanayake, Hemantha (106–184)
 Daundasekera, W.A.M. (392–297; 398–299; 560–314; 718–298; 841–300; 865–256; 1176–295; 1282–267)
 Daundasekera, W.B. (169–356; 171–203; 195–131; 202–205; 205–364; 497–205; 959–360; 1083–360; 1086–358; 1095–130; 1097–205; 1106–344; 1109–315; 1183–203; 1218–201)
 Daya, D.D.N.B. (251–125; 844–320)
 Dayawansa, P.N. (656–198)
 de Alwis, Ajith (250–132)
 de Costa, Sunitha (238–125)
 de Costa, W.A.I.M. (160–299; 198–299)
 de Silva, Aruna Dharshan (1052–25; 1053–25; 1248–24)
 de Silva, L.B. (219–104)
 de Silva, M. (374–186; 375–415; 376–414; 454–415; 455–415; 589–192; 592–408; 660–195; 757–404; 762–189; 765–184)
 de Silva, M.P. (103–115)
 de Silva, M.S.W. (1240–63)
 de Silva, P.K. (16–200; 97–411; 632–405; 769–189; 921–198)
 Deegalla, Sampath (1298–390; 1310–390; 1311–386)
 Dematawewa, C.M.B. (958–360)
 Dharmadasa, J.P.D. (438–325)
 Dharmagunawardana, H.A. (363–162; 365–163; 366–161; 367–162; 368–162; 370–197; 414–161; 415–162; 417–160; 418–163; 419–161; 529–180; 555–295; 631–160; 787–181, 802–169; 804–171; 905–176; 908–148; 1038–175; 1141–175)
 Dharmaratne, H.R.W. (98–70; 214–10; 510–74; 534–65; 680–17; 910–34; 918–94; 1114–29; 1151–15; 1257–7)
 Dharmaratne, P.G.R. (29–165; 32–164; 36–164; 303–165; 1117–136)
 Dharmaratne, Samath D. (721–160; 747–155; 1018–368)
 Dharmaratne, T.S. (796–168)
 Dharmasena, Chinthaka (337–132)
 Dias, Dileeka (1143–138)
 Dias, Sardani (628–194)
 Dillimuni, D. (14–164)

Dissanayake, B. Nilanthi (1387–290; 1390–288; 1387–290; 1390–288)
 Dissanayake, C.B. (128–150)
 Dissanayake, D.M. (296–22)
 Dissanayake, D.P. (101–120)
 Dissanayake, M.A.K.L. (57–320; 92–217; 94–212; 120–316; 136–326; 147–346; 178–220; 179–141; 257–333; 258–328; 310–228; 285–382; 390–244; 391–244; 400–313; 440–310; 458–80; 498–244; 598–240; 635–231; 677–335; 698–232; 863–230; 1071–215; 1165–238; 1170–234; 1237–134)
 Dissanayake, U.N. B. (288–205; 379–204; 402–343; 404–341; 501–334; 504–331; 568–315; 647–327; 666–203; 667–204; 703–334; 846–332)
 Dittus, W.P.J. (05–400)
 Dobedoe, R.S. (1285–215)

E

Edirisinghe, A.G.H.J. (1092–154)
 Edirisinghe, E.M.R.K.B. (1240–63)
 Edirisinghe, J. Sarath (1090–153)
 Edirisinghe, J.P. (19–183; 55–398; 63–341; 150–342; 386–403; 446325; 522–191; 695–405; 1179–413; 1329–329)
 Edirisinghe, Udeni (269–312; 590–190)
 Eeswara, J.P. (651–331)
 Ekanayake, M.B. (1349–327)
 Ekanayake, N. (295–22)
 Ekanayake, Piyasiri (403–334; 435–238; 435–235; 499–240; 509–224; 859–237; 927–239; 928–240; 929–238)
 Ekanayake, Senarath (162–303; 164–297; 393–302; 396–301; 935–301; 936–298; 937–295)
 Ekanayake, S.B. (1347–132)
 Ennis, C.J. (515–116)
 Evarad, J.M.D. (492–25)

F

Fernando, G.W.A.R. (432–187; 433–200; 628–194; 658–195; 661–194; 665–193; 759–191; 764–197; 914–184; 915–199; 917–140; 924–188; 926–189; 1057–201; 1063–183; 1093–160; 1152–190; 1153–195; 1177–266; 1261–191; 1267–200)
 Fernando, M.F.S.W. (256–298; 298–298)

Fernando, Nimalka (984–173)
 Fernando, P.H.P. (223–6; 352–21; 546–1; 1382–21)
 Fernando, W.J.N. (112–130)
 Fernandopulle, Neil D. (525–26; 716–24; 731–26; 781–24; 940–2; 1052–25; 1054–27; 1064–27; 1248–24)

G

Galagedara, L.W. (1374–157)
 Gamage, P. (1328–170)
 Ganehenage, Manavadevi Udugala (675–308; 1115–107; 1132–338; 1136–328; 1355–113; 1379–127;)
 Gnanachandran, S. (726–159; 982–170)
 Goonasekera, C.D.A. (358–376)
 Gunadasa, H.N. (196–131)
 Gunapala, P.Y. (290–132)
 Gunaratne, A.M.T.A. (991–329; 1264–182; 1304–322)
 Gunaratne, L.H.P. (65–361; 170–366; 264–339; 270–362; 271–361; 275–357; 347–355; 348–360; 517–365; 609–339; 754–356)
 Gunasekera, Amila (1028–158)
 Gunasekera, C.D.A.
 Gunasekera, Maya (716–24)
 Gunasekera, S.W. (351–23; 355–20; 356–19)
 Gunasena, Prasanna (747–155)
 Gunatilake, H. (211–278)
 Gunatilake, Jagath (687–166; 696–139; 724–169; 727–171; 738–166; 743–169; 795–173; 797–169; 799–168, 802–169; 803–168; 804–171; 830–172; 889–168; 900–171; 901–167; 902–167; 911–151; 913–165; 955–172; 956–172; 957–168; 982–170; 983–170; 984–173; 988–172; 1031–170; 1032–166; 1033–172; 1034–169; 1035–171; 1094–168; 1126–165; 1127–167; 1143–138; 1194–171; 1234–154; 1305–166; 1322–170; 1338–146; 1375–162)
 Gunatilleke, C.V.S. (28–273; 71–272; 75–321; 76–304; 84–304, 85–303; 181–274; 211–278; 294–288; 304–261; 386–403; 456–262; 511–286; 538–265; 567–333; 756–282; 1178–280; 1179–413; 1284–283)
 Gunatilleke, I.A.U.N. (16–200; 71–272; 84–304; 181–274; 211–278; 304–261; 456–262; 538–265; 756–282; 906–363; 939–276; 970–

355; 1072-245; 1178-270; 1284-283; 1321-360)

Gunawardana, M.P.S.S. (857-233)

Gunawardana, G.S.P. de Silva (680-17)

Gunawardana, R.P. (02-48; 03-57)

Gunawardana, U.A.D.P. (326-287)

H

Heenkenda, H.M.S. (831-268)

Hemalal, K.D.P. (462-114; 903-131; 1096-130)

Hennayake, S.K. (1385-186)

Herath, Tissa R. (08-286)

Herath, G.B.B. (1056-184; 1059-184; 1066-188; 1067-199; 1074-247; 1203-174)

Herath, Gemunu (767-191; 923-184)

Herath, H.M.D.R. (749-159; 770-156; 775-158; 776-153; 810-157; 1026-154; 1138-158; 1238-159; 1373-159)

Herath, H.M.S.B. (544-234)

Herath, H.M.T.B. (172-108; 175-68)

Herath, H.M.T.U. (1100-133)

Herath, W.H.M.W. (219-104)

Hettiarachchi, C.V. (1112-311; 1239-89)

Hettiarachchi, G.H.C.M. (1065-23)

Hettiarachchi, L.S.K. (133-118)

Hettiarachchi, N.F. (145-335; 784-239)

Hewamanna, R. (860-235)

Hewavithana, P.B. (35-236; 679-235)

Hewawasam, A.L.T. (1057-200)

Hewawasam, Tilak (1041-143)

Hirimburegama, K. (932-28)

Hoher, Valeri (700-257)

Hoole, S.R.H. (282-369)

Horadagoda, A. (100-113; 239-122)

Hubert, M.H. (730-367)

Hulme, P.E. (939-276)

Hussain, S.F. (159-296; 187-303)

I

Iddawela, W.M. Devika R. (835-1046; 1389-291)

Ileperuma, O.A. (02-48; 60-198; 70-330; 80-344; 107-197; 110-242; 129-83; 154-345; 173-85, 183-188; 209-190; 247-121; 266-344; 333-83; 369-197; 428-185; 429-193; 461-177; 521-193; 532-93; 537-178; 787-181; 1287-331)

Ileperuma, D.C.K. (831-268)

Indraratne, S.P. (657-186)

Indrasiri, L.H. (801-173; 1128-169)

Induruwage, K. Lal (799-168)

Iqbal, M.C.M. (222-284; 664-200; 759-191; 1032-166; 1177-266)

J

Janakan, N. (1204-358)

Jansson, Per-Erik (334-103)

Jayakody, A.N. (316-316)

Jayakody, S. (1148-119; 1154-182)

Jayasekara, L.A.L.W. (989-205)

Jayasekera, C. (399-297; 1243-31)

Jayasekera, L.R. (181-274)

Jayasena, H.A.H. (697-149)

Jayasinghe, C.K. (46-296)

Jayasinghe, J.M.A.C. (10-236)

Jayasinghe, Saroj (940-2)

Jayasinghe, Subadra (325-120)

Jayasinghe, U.L.B. (220-70; 233-128; 308-71; 334-103; 684-72; 995-73)

Jayasiri, H.B. (545-174; 659-194)

Jayasuriya, K.M.G.G. (1002-359; 1029-158)

Jayathissa, H.A.G. (1334-154)

Jayawardana, P.A.A.T. (545-174)

Jayaweera, P.M. (337-132; 1341-134)

Jayaweera, Prasad (1339-354)

Jayawickrama, Dimuthu (132-123; 225-336; 312-38)

Jeyakumaran, N. (859-237; 1333-365)

Jinadasa, K.B.S.N. (1265-188)

Johnpillai, A.G. (1122-203)

K

Kaluarachchi, T.K.P.K. (530-05)

Kanaganathan, S. (479-377; 480-381; 583-381; 617-382; 620-390; 621-369; 974-369; 1135-342)

Kanakaratne, U.N.S.S.

Kanakaratne, Upul Nalaka D.S. (832-291; 1047-289)

Kandasamy, K. (450-317; 558-317)

Kannangara, J. (896-154)

Kappagoda, C.T. (546-1)

Karunanayake, Eric H. (494-23)

Karunanayake, K.O.L.C. (1383-182)

Karunarathna, W.G. (115-317; 119-326)

- Karunaratne, A.M. (39–297; 53–285; 68–344; 135–336; 165–297; 212–269; 384–264; 399–297; 831–268; 1278–289)
- Karunaratne, B.A. (643–241; 1170–234)
- Karunaratne, B.S.B. (06–210; 24–241; 158–342; 276–243; 500–239; 509–224; 549–207; 576–241; 580–240; 594–243; 633–219; 634–226; 642–240; 643–241; 644–239; 682–223; 1171–235; 1285–215)
- Karunaratne, D.G.G.P. (377–132; 723–131; 922–192; 1202–129; 1232–129)
- Karunaratne, D.N. (848–330; 903–131; 993–325; 1096–130; 1145–134; 1217–106; 1243–31; 1281–277; 1288–334)
- Karunaratne, N.L.V.V. (127–42; 172–108; 215–36; 234–128; 389–36; 457–69; 459–45; 465–125; 640–53; 789–75; 1040–58; 1142–44; 1397–248)
- Karunaratne, S. (57–320; 257–333; 265–323; 406–309; 551–305; 552–305; 554–306; 650–319; 690–346; 707–323; 741–346; 852–346; 1134–309; 1300–323; 1308–328; 1312–346; 1324–324; 1345–327; 1348–346; 1372–347)
- Karunaratne, S.H.P.P. (139–336; 157–312; 180–14; 230–128; 307–412; 540–410; 702–402; 1258–407)
- Karunaratne, W.A.I.P. (1179–413)
- Karunasinghe, Dulakshi S.K. (1084–359)
- Karunasiri, R.P.U. (18–239; 78–337; 123–358; 147–346; 156–341; 186–243; 217–218; 260–318; 311–209; 436–243; 572–, 329)
- Kehelpannala, K.V.W. (788–152)
- Kendaragama, K.M.A. (955–172)
- Kepler, Johannes (255–385)
- Kodituwakku, K.A.W. (1039–175)
- Kodituwakku, Saluka R. (481–393; 482–374; 486–369; 518–379; 584–391; 586–568; 587–374; 624–392; 625–392; 636–353; 668–386; 669–371; 670–377; 671–383; 672–372; 713–26; 733–387; 777–155; 792–389; 793–395; 822–373; 875–387; 876–374; 880–385; 882–392; 887–377; 890–396; 891–370; 892–391; 894–373; 943–372; 971–391; 973–377; 976–386; 978–395; 996–350; 1003–394; 1004–380; 1009–391; 1010–373; 1014–369; 1018–368; 1019–375; 1020–387; 1035–171; 1087–373; 1088–383; 1089–395; 1120–388; 1208–372; 1209–371; 1223–387; 1224–393; 1227–389; 1229–376; 1235–392; 1292–382; 1294–383; 1305–166; 1306–375; 1309–375; 1315–385; 1319–393; 1331–374; 1339–354; 1351–396; 1352–370; 1353–371; 1357–380; 1366–376; 1367–382)
- Kotagama, S.W. (05–400)
- Kottegoda, Nilwala (1105–320; 1378–118)
- Krishnarajah, S.R. (1269–192)
- Kularatne, S.A.M. (352–21; 1069–13; 1173–289)
- Kularatne, W.G. (563–308)
- Kulasooriya, S.A. (08–286; 27–281; 137–321; 208–187; 221–271; 1281–277)
- Kumar, N.S. (83–66; 126–30; 250–132; 334–103; 384–264; 512–107; 916–102; 920–89; 995–73; 1242–110)
- Kumar, V. (07–41; 86–47; 89–64; 96–56; 174–101; 218–105; 219–104; 229–128; 388–40; 533–69; 548–50; 638–33)
- Kumara, A.H. Dilip (858–233)
- Kumara, G.R.A. (1241–79; 1343–133)
- Kumaragamage, D. (13–183; 292–192)
- Kumarihamy, C.B.T. (808–311)
- Kusumawathie, P.H.D. (1338–146)
-
- L**
- Leelananda, S.A. (74–333; 148–342)
- Liyanaage, Janitha (925–185)
- Liyanaage, K.M. (314–311; 338–392; 485–389; 489–389; 506–324; 519–396; 618–378; 673–380; 709–322; 821–375; 1219–378)
- Liyanaage, Thusharie (1150–19)
-
- M**
- Madduma Bandara, C.M. (556–294; 1381–182)
- Magana-Arachchi, D.N. (1274–290)
- Mahanama, K.R.R. (101–120)
- Mahaulpatha, W.A.D. (798–172)
- Mahendran, T. (105–120; 1262–193)
- Mahesan, Y. (101–120)
- Malavipathirana, S. (1030–114)
- Manawadu, Lasantha (727–171)
- Manobavan, M. (665–191; 915–199; 923–184)
- Manuweera, G.K. (90–198; 207–189; 249–199; 307–412; 540–410; 868–122)
- Mapa, B.M.A. (370–197)
- Mapa, R.B. (737–155)

Marasinghe, Piyal (556–294)
 Mathavan, V. (14–164)
 Mellander, B.E. (92–217; 178–220; 310–228;
 385–229; 698–232; 1071–215)
 Mendis, B.J.P. (685–167)
 Miranda, M.L.K. (52–233)
 Mizoe, J. (113–236)
 Mohamed, M.T.Z. (130–129)
 Mohotti, Keerthi (232–128)
 Montpellier, J-L Verdeil (700–257)
 Morel, R. (1277–291)
 Motha, J.T.S. (1116–137)
 Mowjood, M.I.M. (725–160; 1374–157)
 Mubarak, A.M. (15–188; 88–186; 196–131)
 Mudduwa, L.K.B. (1150–19)
 Munasinghe, D.M.S. (1325–129)
 Munasinghe, M.A.K. (955–172)

N

Nainanayake, A.D. (1060–294)
 Nanayakkara, Asiri (996–350; 1353–27)
 Nanayakkara, D.K.K. (839–23; 1393–22)
 Nanayakkara, D.P. (1250–21)
 Nanayakkara, G.L.S. (56–315; 155–316; 703–
 320)
 Nanthakumar, V. (795–173; 1210–171)
 Nandakumaran, N. (1238–159)
 Nandalal, K.D.W. (904–175; 1082–363; 1194–
 171)
 Narayanan, Pradush (931–234; 1168–233; 1169–
 234)
 Nasir, H.M. (619–384; 622–378; 623–384;
 794–384; 846–332; 877–393; 879–393; 950–
 370; 961–367; 1193–375; 1207–376; 1380–
 202)
 Navarathna, Champa M. (1034–169)
 Navaratne, Ayanthi (102–113; 309–78; 312–
 38; 383–86; 508–67; 564–342; 565–342; 574–
 322; 648–308; 751–119; 790–90; 864–406;
 947–124; 967–115; 1075–122; 1104–345;
 1147–123; 1299–307)
 Navaratne, N.M.G.S.B. (988–172)
 Navaratne, S.W. (185–142; 301–163; 302–164;
 796–168; 1117–136)
 Nissanka, S.P. (630–188)
 Noordeen, F. (1047–289; 1275–290; 1388–292;
 1389–291; 1391–292)
 Nugaliyadde, L. (591–185)

P

Padmalal, U.K.G.K. (293–287; 349–288)
 Padmasiri, J.P. (23–196; 99–116; 206–185)
 Pallewatte, A.S. (1279–235)
 Panagoda, G.J. (920–89; 1172–288)
 Pathirage, R. (131–112)
 Pathirana, K.P.P. (217–218; 422–174; 722–157)
 Pathiratne, K.A.S. (297–119)
 Pathmanathan, N. (20–242; 595–241)
 Peiris, B.L. (516–358; 1125–357)
 Peiris, T.S.G. (582–367; 1139–160)
 Perera, A.O.C. (853–341)
 Perera, A.A.I. (289–203; 527–204; 607–343;
 742–394; 885–388; 888–387; 890–396; 895–
 369; 975–378; 980–395; 1008–391; 1011–390;
 1110–329; 1129–332; 1131–327; 1191–392;
 1214–336; 1221–382; 1291–387; 1309–375;
 1360–381; 1365–388; 1368–372)
 Perera, A.A.S. (443–314; 856–343; 1108–333;
 1302–347)
 Perera, A.D.L. Chandani (26–88; 59–319; 134–
 322; 827–345; 854–333; 1145–134; 1146–124;
 1217–106; 1346–344; 1378–118)
 Perera, A.L.S.C. (687–166; 739–173; 780–167;
 986–166)
 Perera, D.K.A. (860–235)
 Perera, G.A.D. (77–309; 141–320; 153–327;
 191–329; 226–337; 371–185; 428–185; 451–
 328; 604–308; 782–332; 783–323; 1137–339;
 1212–313)
 Perera, H.K.I. (867–114; 1149–27; 1244–21;
 1251–22)
 Perera, J.S.H.Q. (67–335; 81–325; 142–340;
 151–331; 224–331; 267–343; 342–112; 444–
 313; 547–51)
 Perera, Kanthi (473–365; 474–363; 613–367;
 693–368; 712–363; 715–366; 1000–363;
 1001–365; 1081–359; 1082–363; 1085–364;
 1185–364; 1186–362; 1187–365; 1204–359;
 1228–361)
 Perera, L.R.K. (299–164; 496–164; 813–163;
 1123–163)
 Perera, Lal (817–366)
 Perera, N.D. (50–32)
 Perera, P.A.J. (213–12; 223–06; 295–22; 296–
 22; 351–23; 353–22; 354–22; 530–05; 546–
 01; 699–02; 1070–08)

Perera, Reggie (728–153)
 Perera, S.A.Chandrika N. (736–24)
 Pilapitiya, Sumith (21–192; 33–198; 87–193; 1385–186)
 Pinidiyaarachchi, U.A.J. (979–374; 1016–375; 1118–373; 1296–382; 1326–379; 1361–395; 1364–384)
 Pitawala, H.M.T.G.A. (425–174; 659–194; 662–199; 663–187; 696–139; 723–131; 761–186; 764–197; 766–187; 908–148; 917–140; 1116–137; 1155–186; 1157–196; 1246–190; 1260–199; 1268–198)
 Piyadasa, R.U.K. (797–169)
 Pragnadarshana, W.M. (1107–344)
 Prame, W.K.B.N. (1332–159)
 Prasantha, B.D.R. (649–329)
 Premadasa, N.W.A.J.K. (1247–21)
 Premalal, K.H.M.S. (740–155)
 Premalal, H.M. Sarath
 Premaratne, B.A.H.R. (1042–290)
 Premaratne, K. (12–242; 64–316; 120–316; 405–347; 434–242; 558–317; 597–242; 683–227; 862–222; 1036–135; 1231–135; 1377–133)
 Priyantha, H.M.D.N. (22–189; 55–398; 105–120; 121–348; 132–123; 133–118; 140–113; 176–95; 177–98; 194–127; 235–117; 247–120; 122–; 312–38; 383–86; 410–111; 448–338; 515–116; 522–191; 535–96; 588–196; 611–115; 678–124; 706–339; 729–308; 748–119; 750–195; 753–338; 760–196; 790–90; 814–120; 925–185; 953–118; 1076–120; 1077–121; 1148–119; 1198–97; 1211–126; 1269–192; 1297–121; 1330–121; 1392–197)

R

Ragel, Roshan G. (1007–384; 1012–386; 1310–390; 1311–386)
 Rajakaruna, R.S. (864–406; 1225–339; 1259–401)
 Rajapakse, R.G. Sanath C. (968–122; 990–328; 1244–21; 1271–27; 1283–11; 1337–82; 1342–132; 1384–24)
 Rajapakse, R.M.G. (26–88; 73–340; 104–118; 144–334; 197–127; 341–127; 343–125; 346–116; 381–81; 437–326; 458–80; 459–45; 469–117; 513–127; 547–51; 579–241; 633–219; 688–332; 734–338; 735–338; 815–117; 843–

309; 909–77; 962–60; 1030–114; 1098–135; 1099–134; 1100–133; 1101–133, 1199–134; 1201–130; 1215–92; 1241–79; 1303–135; 1337–327; 1342–133; 1376–132)
 Rajapakse, R.P.V.J. (51–416; 111–416; 493–23; 524–28; 680–17; 830–172; 836–291; 842–26; 1042–290; 1044–289; – 1045–290; 1046–289; 1069–13; 1140–155; 1151–15; 1173–289; 1254–27; 1280–28; 1394–16)
 Rajasingham, S. (1147–123)
 Rajendra, J.C.N. (480–381; 505–329; 594–243)
 Ramanan, A. (1351–396; 1363–382)
 Ramanayake, D.N.D. (477–383; 484–394; 487–389)
 Ramasamy, R. (25–408)
 Ranasinghe, J.G.S. (758–18; 837–155; 838–20; 933–25; 969–124; 1050–25; 1150–19; 1250–21; 1271–27; 1283–11; 1394–16)
 Ranasinghe, Mahinda I. (732–314; 845–330)
 Ranasinghe, R.M.I. (809–123)
 Ranawana, K.B. (118–343; 263–321; 306–411; 327–288; 697–149; 719–295; 1072–245; 1158–187; 1163–185; 1164–190; 1261–191)
 Rangarajah, S. (1210–171)
 Ranjith, H.L. Anii (541–235; 542–237)
 Rathnasiri, H.P.G.S. (1081–359)
 Ratnasiri, N.B. (553–398)
 Ratnasooriya, W.D. (531–3; 653–294)
 Ratnayake, R.M.P. (758–18)
 Ratnayake, R.R. (1281–277)
 Ratnayake, Uditha (685–166; 686–172; 889–168; 913–165; 987–166; 1113–175)
 Rosairo, S. (839–23)
 Rupasinghe, M.S. (128–150)
 Ruwanpura, S.M.P. (964–119)
 Rydeberg, Lars (217–218; 311–209)

S

Sakata, S. (113–236)
 Samarakkody, R.P. (321–126; 324–117)
 Samarakoon, Lal (957–242)
 Samaranayake, B.G.L.T. (886–383)
 Samarasekera, Pubudu (1103–340)
 Samarasekera, Radika (322–126; 462–114; 466–123; 512–107; 778–123; 872–123; 946–130; 953–118; 965–113; 1142–44)
 Samarasinghe, S.M. (692–360)

- Samarasinghe, W.L.G. (1051-26; 1055-26; 1253-27)
- Samaraweera, P. (449-343; 865-256; 940-2; 1054-27; 1064-27; 1245-20; 1259-401; 1271-27; 1272-24)
- Samitha, S. (12-242; 125-357; 166-362; 168-317; 244-355; 245-359; 274-358; 714-362; 1184-355)
- Sandirigama, P.M.T.B. (823-368; 878-378; 883-388; 1006-370; 1017-376; 1188-391; 1189-392; 1190-387; 1192-395; 1205-394; 1222-390; 1226-376; 1293-381; 1295-381; 1298-390; 1313-383; 1350-395; 1358-385; 1359-391)
- Santiapillai, C. (76-337; 85-303; 91-334; 149-341)
- Sarananda, K.H. (30-300; 38-300; 163-301; 188-303; 200-298; 332-298; 395-301; 397-302; 744-303; 786-300; 840-296; 934-299; 1049-303)
- Saravanakumar, P. (1068-293)
- Satharasinghe, A. (898-173)
- Sedara, Upali M. (1371-323)
- Senadeera, G.K.R. (581-127; 593-238; 1170-235)
- Senanayake, S.M.N.A. (66-356; 254-380; 277-371; 280-370)
- Senanayake, Saman (356-19)
- Senarath, W.T.P.S.K. (646-293)
- Senaratne, A. (08-286; 210-195; 248-200; 372-365; 420-161; 1058-197; 1141-175; 1162-193; 1262-193)
- Seneviratne, Anoja (1234-154)
- Seneviratne, G. (460-255; 495-25; 550-249; 966-115; 1174-294; 1178-270; 1395-260)
- Seneviratne, V.A. (677-335; 698-232; 752-112; 829-336; 855-314; 1024-318; 1165-238; 1200-135; 1237-134; 1301-326)
- Seneviratne, Vajira (869-127)
- Shantha, K.D.P. (739-173)
- Shantha, T.H.S. (1166-234)
- Shanthini, R. (473-365; 613-367)
- Siddhisena, K.A.P. (1263-182)
- Silva, E.I.L. (182-401)
- Silva, K.T. (720-156)
- Silva, S.S.P. (837-20; 838-20; 933-25; 1050-25; 1053-25)
- Siribaddana, Anoma (861-09)
- Siripala, W.P. (785-243; 1270-241)
- Siriwardena, Y.P.S. (763-199; 924-188)
- Sivakanesan, R. (352-21; 355-20; 768-187; 1048-23; 1243-31; 1249-21; 1252-20; 1386-20; 1393-22)
- Sivakumar, V. (855-314; 1023-342; 1025-317; 1197-310; 1279-235)
- Sivanantharajah, S. (743-169; 780-167; 805-166; 898-173; 902-167; 956-172; 985-165; 1127-167; 1328-170)
- Sivayoganathan, C. (313-320)
- Siyambalapatiya, S.B. (203-204; 204-205; 1182-204)
- Skaarup, Steen (17-221; 94-212; 95-211; 507-221; 791-206; 941-213)
- Smith, Mark (1285-215)
- Smith, P. (93-211)
- Somaratne, S.M. (771-159)
- Somaratne, S. (763-199)
- Sooriyapathirana, D.S.S. (1369-335; 1370-325)
- Srikaran, R. (825-333; 826-323)
- Sumanasinghe, V.A. (1272-24)
- Sumathipala, H.H. (445-313)
- Suneetha, K.B. (262-348)
- Suraweera, H.J. (1100-133)
- Surendran, S.N. (1344-325; 1391-292)
- Surige, C.S. (1276-289)

T

- Takahashi, Kenji (213-12)
- Tennakoon, D.T.B. (62-317; 103-115; 143-315; 176-95; 235-117; 253-129; 268-337; 318-117; 426-196; 470-117; 526-129; 535-96; 547-51; 561-309; 570-345)
- Tennakoon, Sakunthala (102-113; 236-124)
- Tennakoon, K. (578-242; 683-227)
- Tennakoon, K.U. (61-312; 192-319; 211-278; 222-284; 227-319; 231-128; 538-265; 939-276; 1284-283)
- Tennakoon, Sampath (1090-153)
- Thattil, R.O. (49-367; 65-361; 125-357; 166-362; 167-361; 168-317; 170-366; 205-364; 241-359; 242-363; 246-367)
- Thevanesam, V. (601-292; 717-292; 832-291; 834-291; 1043-490; 1241-79; 1273-291)
- Thewarapperuma, P.S.S. (123-358)
- Thiruchelvam, T. (319-114; 463-116; 464-122)

U

Udawatta, C.P. (292–192; 303–165; 439–345; 496–164; 523–194; 813–163)
 Udugama, J.M.C. (610–237)
 Unelius, Rikard (96–56)

V

Vaheesar, K. (678–124)
 Van der Hoek, W. (34–416),
 Vasanthathilaka, V.W.J.K. (296–22)
 Vidanaarachchi, J.K. (1196–116)
 Vinayakarajah, E. (336–130)
 Vinobaba, P. (926–189)
 Vithana, Champika (408–126; 514–121; 676–332)
 Vithanage, Meththika (1216–100; 1392–197; 1396–179)
 Vitharana, P.R.K.A. (1021–324; 1022–324; 1317–330)

W

Walgama, K.S. (358–376; 715–366; 1206–371; 1233–362)
 Wanigasekera, W.M.A.P. (1257–7),
 Wanigasundera, W.A.D.P. (630–188)
 Wannigama, G.P. (72–337; 220–70)
 Wasalaarachchi, Pujitha S. (69–235)
 Watawana, L. (54–236; 543–236; 812–237)
 Wattegama, S.V. (954–364)
 Wattegama, Sarath (48–237)
 Weerakkody, W.A.P. (317–321)
 Weerakoon, D.K. (349–288; 566–319; 1062–183)
 Weerakoon, H.D.K.G.A. (328–288)
 Weerakoon, L.K. (700–257)
 Weerakoon, S.B. (474–363; 1000–363)
 Weerakoon, S.R. (467–115)
 Weerasena, O.V.D.S.J. (1142–44)
 Weerasinghe, Buddhi (738–166)
 Weerasinghe, H.M.S.P.M. (460–255, 562–310; 746–338; 930–293; 949–359; 991–330; 998–364; 1177–266; 1178–270; 1256–275)
 Weerasinghe, Indira S. (512–107; 872–123; 946–130)
 Weerasooriya, S.V.R. (9–145; 430–193; 471–116; 515–116; 639–43; 748–119, 814–119; 919–109; 1180–134; 1216–100; 1336–59; 1356–99)
 Weerawardane, N.D.R. (930–293)
 Weerawarnakula, S. (300–164; 301–163)
 Werellagama, D.R.I.B. (372–189; 431–196; 432–187; 655–191; 1074–247)
 West, K. (94–212)
 Wickramanayaka, P.N. (1228–361)
 Wickramanayake, Nalin (1001–365)
 Wickramasinghe, Anura (175–68; 236–124; 323–126; 382–63; 457–69; 459–45; 638–33; 689–331; 789–75; 916–102)
 Wickramasinghe, Seetha I. (690–346; 707–323; 741–346; 849–312; 859–237; 1130–310; 1327–339)
 Wickramasooriya, S.P.P.A. (377–132)
 Wijayabandara, Jayantha (335–131)
 Wijayagunawardane, M.P.B. (710–339)
 Wijayakulasooriya, J.V. (339–388; 483–393; 488–379; 520–372; 550–249; 585–380; 626–394; 627–379; 819–379; 820–386; 881–384; 893–387; 952–381; 972–388; 977–370; 1005–372; 1013–386; 1015–372; 1121–386; 1206–371; 1230–368; 1354–385)
 Wijayarathna, Gamini (803–168; 1316–167)
 Wijayasinghe, H.W.M.A.C. (863–230)
 Wijayawardana, R.L. (228–335; 261–318; 502–324; 577–242; 1166–234)
 Wijegunasekara, J.K.A.B. (237–120; 779–124)
 Wijekoon, P. (66–356; 122–356; 167–361; 240–367; 243–361; 272–365; 273–359; 306–411; 348–360; 380–349; 401–348; 472–358; 475–361; 536–352; 612–356; 614–365; 615–356; 616–355; 755–366; 816–366, 817–366; 874–368; 906–363; 949–359; 954–364; 970–355; 997–350; 998–364; 999–357; 1002–359; 1079–366; 1080–355; 1124–362; 1321–360)
 Wijekoon, S. (695–405)
 Wijeratne, E.M.S. (424–173; 425–174; 641–174)
 Wijesekera, S.K. (1045–290)
 Wijesooriya, W.A.D.D. (432–187)
 Wijesundara, D.S.A. (557–293; 602–295; 681–283; 1040–58; 1282–267; 1397–248)
 Wijesundara, M. de S. (835–292; 836–291)
 Wijesundara, Subhasini (694–358)
 Wijesundera, L.B.D.R.P. (1270–241)
 Wijesuriya, G.E. (117–310)
 Wijesuriya, Thamara (1005–372)
 Wijesuriya, Wasana (900–170)
 Wijetunge, J.J. (773–154)
 Wijewickrama, Hemasiri (800–171)

Wijewickrama, M.I.D.H. (416–162; 798–172;
800–171; 988–172)
Wilson, Shanthi (199–299; 201–302)
Wimalaratne, Omala (1028–158)
Wimalasiri, K.M.S. (467–115; 871–116; 873–112;
1195–126)
Wolseley, Pat (1040–58)

Y

Yakandawala, Deepthi (138–334; 146–315, 315–
312; 511–286; 555–295; 603–295; 557–293;
654–295; 681–283; 700–257; 711–345; 745–
294; 938–341; 1289–390)

Yakandawala, Harishchandra (1027–156)
Yapa, Kanthi (423–174)
Yapa, P.A.J. (646–293)
Yapa, R.D. (1119–379; 1362–371)
Yapabandara, A.M.G.M. (693–368; 712–363)
Yatigammana, S.K. (897–186)

Z

Zoysa, A.K.N. (529–180)
Zoysa, Kapila (750–195)

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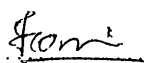
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