15th Academic Sessions

Research for Socio-ecological Sustainability

Abstracts

15th Academic Sessions

University of Ruhuna

7th March 2018

Abstracts

15th Academic Sessions
and
14th Vice Chancellor's Awards

07th March 2018

University of Ruhuna

Matara, Sri Lanka

Abstracts

15th Academic Sessions and 14th Vice Chancellor's Awards

Editor in Chief:

Snr. Prof. P.R.T. Cumaranatunga, Faculty of Fisheries and Marine Sciences & Technology

Organizing Committee and Editorial Board:

Chairperson: Dr. H.B. Asanthi, Faculty of Fisheries and Marine Science & Technology

Secretary: Dr. K.H.M. Ashoka Deepananda, Fisheries and Marine Science & Technology

Faculty Representatives:

Dr. M.K.D.K. Piyarathna, Faculty of Agriculture

Dr. K.G.C. Kumara, Faculty of Engineering

Dr. U.A.D. Jayasinghe, Faculty of Fisheries and Marine Sciences & Technology

Mr. N. Keebiyahettie, Faculty of Humanities and Social Sciences

Dr. M.W. Indrani, Faculty of Management and Finance

Dr. Gayani Liyanage, Faculty of Medicine

Dr. S. Wanniarachchi, Faculty of Science

Mrs. S. Senevirathna, Library

Mrs. R. Sivanesan, Administration

Web Editor: Dr. P.K.S. Jayasinghe, Faculty of Technology

Treasurer: Dr. K.S.S. Atapaththu, Faculty of Fisheries and Marine Sciences & Technology

Printers: NEATGraphics (pvt) Ltd., Matara

Foreword

The Academic Sessions and the Vice Chancellors Awards Ceremony is one of the most prestigious events in the annual calendar of University of Ruhuna since year 2003. Main objective of the Academic sessions is to provide a platform for the staff and post graduate students of University of Ruhuna to present their research findings and discuss the issues in different research fields. Another objective is to appreciate and encourage the most outstanding intellectuals in the University through Vice Chancellors Awards.

This year the 15th Academic sessions and 14th Vice Chancellor's Awards ceremony is organized by the Faculty of Fisheries and Marine Sciences & Technology, and, the event is planned to be held on 7th March 2018. It is my great pleasure to write this Foreword to the proceedings containing 84 research abstracts under the technical sessions of; Science, Fisheries and Aquatic Sciences, Medicine and Allied Health Sciences, Agriculture and Environmental Sciences, Engineering and Technology, and Social Sciences and Management. This year's academic session highlights the importance of ecology for social development, hence themed as 'Research for Socio-ecological Sustainability'. Also, the Key note speech on 'Ocean Science research for Socio-ecological sustainability' by Professor Joseph Daniel Ortiz from Kent State University, USA opens our eyes to see future research fields to achieve the goal of sustainable national development. A wide array of research in abstract forms are provided herewith in this document as a printed resource in the University for further reference by interested researchers and will serve the general public.

I wish to express my deepest gratitude to Senior Professor Gamini Senanayake, the Vice Chancellor of University of Ruhuna, for his guidance and endless support during the whole process of this work. My sincere thanks will be towards Dr. Nayana Alagiyawanna, the Deputy Vice Chancellor for his valuable advices and support given to the organizing committee. My special thanks to the invited orator, Prof. Thakshila Serasinghe for accepting our invitation within a short period. I would like to thank all contributors who submitted their valuable research findings for the success of this academic event. I am grateful to all reviewers for their time consuming volunteer service in technical evaluation of the research papers. Finding reviewers, communicating, collecting revised abstracts and other necessary documents on time, and in proper manner is a huge task succeeded by all Faculty Coordinators. I also would like to thank the Secretary, Dr. K.H.M. Ashoka Deepananda for his delightful work and the Chief Editor, Senior Professor P.R.T. Cumaranatunga for her tireless efforts. Finally, I thank to treasurer of the event Dr. K.S.S. Atapththu and all the members of the Faculty of Fisheries and Marine Sciences & Technology who supported in numerous ways for the ultimate goal of this event.

Dr. H.B. Asanthi
Chairperson,
15th Academic Sessions and 14th Vice Chancellor's Awards Ceremony
University of Ruhuna
07th March 2018

Contents

Message from the Vice Chancellor

It is my great pleasure to send this message for the Proceedings of the 15th Academic Sessions of the University of Ruhuna. Over the past 14 years starting from 2003 (Silver Jubilee Year of the University), this conference has provided a cross-disciplinary venue for researchers and practitioners to address the rich space of communications and networking research and technology.

The primary goal of this year conference is to promote research and developmental activities among academics and non-academic staff of the University of Ruhuna. I am sure that, 15th Academic Sessions will be a unique opportunity for all colleagues of the university to interact positively and productively in their research fields as in the previous years' sessions.

As a university dedicated to academic excellence and high impact research, I am proud to observe significant improvement in quantity, quality and relevance in research performed by our staff along with our vision "To be the prime intellectual thrust of the nation".

Vice Chancellor's Awards Scheme which was introduced in 2014 to honor and recognize the outstanding academics and students of the university has become an annual event in parallel to Academic Sessions and this will be the 14th consecutive year of awarding Vice Chancellor's Awards. I would like to take this opportunity to congratulate the recipients of Vice Chancellor's Awards in 2017.

The conference would not have been possible without the enthusiastic and hard work of a team. I would like to express my appreciation to the chairperson and all the other members of the organizing committee for their valuable contribution in assembling the high quality conference program. A conference of this nature relies on contributions of many volunteers, and I take this opportunity to acknowledge the efforts of reviewers for the quality and depth of the reviews, and their sense of responsibility and responsiveness under very tight deadlines.

I look forward to an exciting conference of insightful presentations, discussions, and sharing of technical ideas and wish the Academic Sessions a great success.

Snr. Professor Gamini Senanayake
Vice Chancellor
University of Ruhuna

Award of Emeritus Professorships

Prof. R.H.S. Rajaphaksha
Faculty of Agriculture

Prof. P. Vithanage
Faculty of Humanities and Social Sciences

Prof. W.W.D.A. Gunawardhena
Faculty of Agriculture

Recipients of the 14th Vice Chancellor's Awards - 2018

The Most Outstanding Scholar
Prof. Nilanthi Dahanayake
Faculty of Agriculture

The Most Outstanding Young Researcher
Dr. H.C.P. Karunasena
Faculty of Engineering

The Most Outstanding Student Inventor/Innovator
Mr. J.A.S. Niloka (SC/2014/9068)
Faculty of Science

The Most Outstanding Convener of International Conferences/Promoter of International Relations
Dr. G.S.Y. De Silva
Faculty of Engineering

Recipients of the Best Presenter Awards
14th Academic Sessions - 2017

Best Presenter (Oral) of Technical Session: Agriculture and Environmental Sciences
Dr. K.S.S. Atapththu (Faculty of Fisheries and Marine Sciences & Technology)

Best Presenter (Oral) of Technical Session: Science and Mathematics
Mr. G.R.L. Kodikara (Faculty of Fisheries and Marine Sciences & Technology)

Best Presenter (Oral) of Technical Session: Civil and Manufacturing Engineering
Ms. I.U. Nagasinghe (Faculty of Engineering)

Best Presenter (Oral) of Technical Session: Electrical, Mechanical and Information Engineering
Dr. A.P. Rathnayake (Faculty of Engineering)

Best Presenter (Poster) of Technical Session: Medical, Social and Environmental Sciences
Dr. M.T. Napagoda (Faculty of Medicine)

Best Presenter (Poster) of Technical Session: Science and Technology
Ms. B.M.J.K. Balasooriya (Faculty of Engineering)

Keynote Speech

Human Impacts on the Sea: Ocean Science Research for

Socio-ecological Sustainability

Prof. Joseph D. Ortiz

Professor of Geology, Kent State University, USA

Go back far enough on the evolutionary scale, and you find that we are creatures of the sea. We carry echoes of the ocean in our blood streams. Throughout time, our civilizations have grown, flourished and been replaced at the water's edge. The sea provided both barrier and pathway for exploration, expansion of trade, and often conflict. Even today, the sea sustains us with food; its microorganisms, in their teeming numbers, cycle carbon from the air through photosynthesis, exchanging it for the very oxygen that we breathe.

But as vast as it may be, the sea now faces major challenges: We are both loving and neglecting the sea, and we do so at our peril. Recent environmental syntheses estimate that much of the World Ocean is now impacted to various degrees by both direct and indirect human activities. The list of impacts is too vast to cover in a short lecture, but we can explore some of the most critical impacts - limited by my experience and expertise - to gain an understating of the challenges that the Ocean will face from increasing human pressure in the coming decades.

A useful framework from which to consider these challenges is in terms of indirect and direct impacts. The indirect, far-field, impacts of industrialization and population growth are ***climate change/global warming*** and ***ocean acidification***. These are coupled to nutrient pollution, ***eutrophication***, associated ***harmful algal blooms***, ***anoxia*** and the expansion of marine dead zones. In terms of direct impacts, ***overfishing*** and ***plastic pollution*** are posing serious challenges to ***marine diversity***, ***ecosystem stability*** and the ***ecosystem services*** that the sea can deliver. We will explore these challenges, consider some of the ways that research can help us to address these challenges and consider some potential solution or actions that can be taken to mitigate impacts on the world ocean.

Invited Oration

Use of Livestock Resources for Food Security in the Context of Climate Change

Snr. Prof. Thakshala Seresinhe

Senior Professor of Animal Science (Retired), Department of Animal Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka

Human population having physical social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life, at any given time is considered as food security. Household food security is the application of this concept to the family level, with individuals within households and families as the focus of attention.

Livestock contributes greatly to food security because: (1) they are suppliers of global calories, proteins, and essential micronutrients, (2) they are produced in areas that have difficulty in growing crops, (3) most of the feed for livestock is not appropriate for human consumption, and (4) they provide manure for crop production. The livestock sector contributes to the livelihoods of one billion of the poorest populations in the world and employs more than one billion people especially in developing countries.

Livestock products are an important agricultural commodity for global food security because they provide 17% of global kilocalorie consumption and 33% of global protein consumption. There is growing demand for livestock products, and its rapid growth in developing countries has been clearly identified. Worldwide milk production is expected to increase from 664 million tonnes (in 2006) to 1077 million tonnes (by 2050), and meat production will double from 258 to 455 million tonnes.

Global climate change is primarily caused by greenhouse gas (GHG) emissions that result in warming of the atmosphere. The livestock sector contributes approximately 15% of global GHG emissions and thus may increase land degradation, air and water pollution, and declines in biodiversity at the same time. Climate change will affect livestock production through competition for natural resources, quantity and quality of feeds, livestock diseases, heat stress and biodiversity loss while the demand for livestock products is expected to increase by 100% in 2050.

Therefore, it is a great challenge to maintain balance between productivity, household food security, and environmental preservation, while using livestock resources for food security.

As an example, changes in mixed crop-livestock systems are an adaptation measure that could reduce GHG emission while improving food security. This type of an agricultural system is already in practice in two-thirds of world, producing more than half of the milk, meat, and crops such as cereal, rice, coconut, oil palm, etc.

In global context, an integrated cropping, livestock farming and saline pond aquaculture system, which is practiced in Philippines have shown significantly reduced GHG emissions. The system was developed in the 1980s in the central Philippines and has been re-evaluated in terms of its potential to reduce emissions from livestock production, particularly in wet and wet-dry tropical regions. Use of silage from crop by-products and implementation of a feed-lot system of cattle after 300 days, enabled immediate and significant reductions of GHG emissions over extensive cattle grazing. Integration with a saline animal waste processing pond allowed production of natural feed products, cyanobacteria algal mat for use in aquaculture, as crop fertilizer and soil amendment or in the silage manufacture process. Stoichiometrically, bio-processing of waste material in saline ponds provided a novel solution to reduce GHG emissions from feedlots.

In local context, reducing the intensity of emissions of livestock production by coconut –dairy integrated system in southern Sri Lanka showed substantial progress. Dairying in the southern Sri Lanka is mostly a non-commercial activity, carried out by smallholder farmers, with an average herd size of 2-3 cows. The system is relatively extensive. Dairy cows reared under tethered conditions or graze freely under coconut trees, a practice permitted by some plantation owners for several decades. Productivity is very low. The average yield is around 2-3 liters of milk per day, and financial returns are poor. Around 0.5 million hectares of coconut land is estimated to be available for intercropping and cattle grazing, but is hampered by ongoing low productivity. The cattle graze natural herbage, considered weeds by the plantation owners, which vary in supply due to the bi-modal pattern of rainfall. Coconut poonac (oil cake) and rice bran are often given as a supplementary feed as local availability is high. Rice straw is occasionally used in dry seasons. Farmers were shown how to supplement the natural herbage that the cattle were grazing with a high protein tree fodder crop (*Gliricidia sepium* which is a widely cultivated, multi-purpose tree in southern Sri Lanka. At the same time as the tree fodder, farmers also introduced a low-cost concentrate comprising urea, rice bran, molasses and minerals. The productivity gains achieved through feed supplementation imply a reduction in the emissions intensity of milk production in integrated system. The actual effect on emissions intensity was not been measured, so this assumed that the methane yield under the supplemented diet did not differ fundamentally from the methane yield for forage grazing only. The changes to manure management and the substitution of chemical fertilizer by dung and urine have improved plant nutrient and soil fertility status. As dung and urine remained largely aerobic, the production

of greenhouse gases were minimized. The increase in nut and copra yield reinforced the willingness of landowners to permit cattle grazing on their land and, via reduction of fertilizer inputs. It was   also likely to have reduced the emissions intensity of nut and copra production. Coconut plantation owners benefited from higher nut and copra yields and from reduced inorganic fertilizer, herbicide and weeding costs (up to 40%).

Therefore, it can be suggested that changes in mixed crop-livestock systems can improve efficiency by producing more food on less land using fewer resources, such as water. Improving feeding practices as an adaptation measure could indirectly improve the efficiency of livestock production, while reducing GHG emissions. These practices can reduce the risk from climate change by promoting higher intake or compensating low feed consumption, reducing excessive heat load decreasing the feed insecurity during dry seasons.

Abstract Index

Science, Fisheries and Aquatic Sciences

Medicine and Allied Health Sciences

Agriculture and Environmental Sciences

Social Sciences and Management

Engineering and Technology

Science, Fisheries and Aquatic Sciences

Impacts of infestation of *Centrocestus* sp. on Gills and the Growth of Ornamental Fish Koi Carp (*Cyprinus carpio*): an Experimental Approach

B.G.D. Sumuduni [a], D.H.N. Munasinghe [a, *], W.P.R. Chandrarathna [b]

[a] Department of Zoology, Faculty of Science, University of Ruhuna, Sri Lanka.
[b] National Aquaculture Development Authority, Sri Lanka.

Abstract

Gill trematode *Centrocestus* sp. is known to infest many fish species in Sri Lanka. An experimental study was carried out to determine the effect of gill trematode on the gill structure and the growth of ornamental fish koi carp (*Cyprinus carpio*). Shedding of cercariae was induced by exposing the first intermediate host the snail *Melanoides tuberculata* to the sunlight. Three aerated tanks with 20 fish in each were treated as experimental tanks and 8 ml of water with approximately density of 4 cercariae μl^{-1} were introduced to them. Three other tanks were used as control (uninfected). After two months of infection 4 gills of infected fishes were observed and the metacercarial cysts were counted in each gill to observe whether there is any difference in infestation on gills. The standard length (cm) and weight (g) of 30 infested fishes and 30 non-infested fish were measured and condition factor was calculated using the equation $K = W/L^3$ (where K= condition factor, W= weight, L= standard length). Some gills of fish were fixed in Bouin's solution and processed for histopathological observations. The numbers of parasites infested on each gill were different, but there was no significant difference observed among them ($p>0.05$). According to the Kruskal Wallis test a significant difference of condition factor between infested and non-infested fish ($p = 0.012$) was observed. A negative correlation was observed between the parasite density and the condition factor of fish ($r = -0.627$; $p <0.001$). The histopathological observations showed distortion of the gill architecture. According to the results it can be concluded that the infestation of metacercarial cysts caused severe damage to the gills and the condition of koi carps which make a considerable impact on the economic value of this ornamental fish species.

Key words: Centrocestus sp., condition factor, Cyprinus carpio, gill architecture, parasite density

*Corresponding Author: dhnm@zoo.ruh.ac.lk

Impacts of Fishmeal-free Diets on Fillet Quality of Nile Tilapia, *Oreochromis niloticus*

S.S. Herath [a]*, Y.Haga [b], M. Endo [b] and S. Satoh [b]

[a] Department of Fisheries & Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Graduate School of Marine Science and Technology, Tokyo University of Marine Science and Technology, Tokyo, Japan

Abstract

The use of dietary alternative to fishmeal is becoming more common in aqua-feeds with parallel to rising demand and cost of fishmeal. In evaluating alternative ingredients for food fish, a great attention should be paid to the nutrient profile of resulting fish flesh, specially fatty acids and amino acid compositions to confer human health benefits of the resulted product. Therefore, the objectives of this study were to evaluate the effects of long-term feeding of fishmeal-free diets on growth performance and fillet quality of Nile tilapia in terms of amino acid and fatty acid composition and color. Five iso-nitrogenous diets including control diet with 10% fishmeal were prepared. The fishmeal was eliminated from the other four diets, by one of four corn co-products, namely high-protein distillers' dried-grains (HPDDG), distillers' dried-grains with solubles (DDGS), corn gluten meal (CGM), and corn protein concentrate (CPC). Duplicated group of 36 fish with initial mean weight of 21 g were fed one of the five diets twice a day to near satiety for 24 weeks. Fish fed the control, HPDDG, or DDGS diet had significantly higher ($P < 0.05$) growth performances than those fed the other diets.The dietary treatments did not affect the color, or amino acid composition of fish fillets. But the fatty acid composition was greatly affected by the dietary treatments. Total polyunsaturated fatty acid and total n-6 fatty acid levels were highest in the DDGS group followed by HPDDG. The total n-3 levels and n-3: n-6 ratios in the fillets of the control group were almost double when compared to corn-based dietary groups. This result suggest that complete fishmeal replacement with HPDDG or DDGS does not negatively affect the growth performance, fillet color and amino acid composition of Nile tilapia, but further improvement of n-3 fatty acid composition is necessary to ensure human health benefits.

Key words: Amino acids, fatty acids, fishmeal, growth, tilapia

Corresponding Author: sakunthala@fish.ruh.ac.lk

Development of an Early Mortality Syndrome Challenge Test for Shrimps Using Gnotobiotic *Artemia* sp.

J.M.S.N. Rathnapala [a, b, ∗], P. De Schryver [b] and P. Bossier [b]

[a] Department of Fisheries & Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Laboratory of Aquaculture and Artemia Reference Center, Faculty of Bioscience Engineering, Ghent University, Belgium

Abstract

Acute hepatopancreatic necrosis disease (AHPND) also known as early mortality syndrome (EMS), is a recently emerged bacterial disease in shrimp farming, which causes a unique pattern of mortality in shrimp post larvae in newly stocked ponds. Investigations on the control of EMS/AHPND are still in progress and it would be interesting to develop a standard challenge model to establish a fast, reliable and systemic evaluation on EMS/AHPND. Hence, this study was designed to provide basic tools for development of a standardized challenge model, focusing on the role of toxins, using gnotobiotic Artemia, with different pathogenic strains of Vibrio parahaemolyticus. Experiments with gnotobiotic Artemia sp. were designed to check whether the virulence of *V. parahaemolyticus* is related to the secretion of exotoxins into the surrounding medium. Challenge tests were performed to check the effect of filter sterilized cell-free supernatant and filter sterilized suspension obtained from resuspension of different strains of *V. parahaemolyticus* in marine broth, on survival of gnotobiotic Artemia sp. It indicated that KM, RY and MO904 strains of *V. parahaemolyticus* may be capable of producing exotoxins that are secreted into the culture medium. Spent medium of strain RY,KM and MO 904 resulted in a significantly different mortality ($p < 0.05$) from control and other strains. These so-called cell-free spent media are causing mortality in gnotobiotic *Artemia* sp. showing toxin mediated etiology. The mortality depends on the type of culture medium in which pathogens are cultured and the virulence of each pathogenic strain. Based on the results, it can be suggested that release of exotoxins by *V. parahaemolyticus* are negatively affecting gnotobiotic Artemia and that effect may vary depending on the *V. parahaemolyticus* strain. This study provides a basis for the development of a reliable in-vivo Artemia-based assay for AHPND toxins screening.

Key words: challenge test, exotoxins, gnotobiotic Artemia, shrimps, V. parahaemolyticus

*Corresponding Author: nrsajani@gmail.com

Impact of Arachidonic Acid (AA) on *Artemia franciscana* Challenged with Pathogenic *Vibrio harveyi*

R.D.N. Wijesinghe [a, *], K. Baruah [b] and G. Van Stappen [b]

[a] Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Lab of Aquaculture & Artemia Reference Center, Department of Animal Production, Faculty of Bioscience Engineering, Ghent University, Rozier 44, Gent 9000, Belgium.

Abstract

Highly unsaturated fatty acid, arachidonic acid (AA), the major eicosanoid precursor has received growing interest as a health-promoting agent for animal health. Even though AA holds immunostimulant, anti-inflammatory and anti-pathogenic properties against a variety of bacterial diseases, the mode of action of this molecule is unclear yet. Present study aimed at determining whether AA could induce protective effects against vibriosis disease in aquatic organisms by using axenically cultured *Artemia franciscana* and pathogenic *Vibrio harveyi* as host pathogen model system. The experiment was designed to deliver the AA following two administrative ways, continuous and pretreatment and assessed the effect of the compound on host-pathogen interaction. The gnotobiotic model system that was used in this study eliminates any possible interference of the natural micro-biota present in the experimental system and facilitates the interpretation of the results in terms of a cause effect relationship. At first, a dose response was carried out in two ways to elucidate the effect of AA on the host-pathogen interaction. The results provided clear evidences suggesting that continuous and pretreatment of AA, at an optimum concentration of 2 μM and 250 μM, respectively conferred maximum protection to *Artemia* against *V. harveyi* infection. Treating *Artemia* nauplii with AA in the presence or absence of an antioxidant enzymes mixture (catalase and superoxide dismutase) verified that the *Vibrio*-protective effect of the AA was due to generation of reactive oxygen species by oxidation of the compound. Furthermore, the results on the effect of AA on colonization of *V. harveyi,* determined by means of TCBS plate counting, showed a significant reduction ($p < 0.05$) of *Vibrio* counts in treated groups after 48 h of challenge. The overall findings suggest that the ability of AA to induce protective effects makes it a potential agent for controlling vibriosis in aquaculture.

Key words: Arachidonic acid, Artemia, continuous treatment, pre-treatment, Vibrio harveyi

Corresponding Author: dilani.rusl@gmail.com

Development of Recreational Fishing Industry in Sri Lanka

A.J. Jayasekara[*]

Department of Economics, Faculty of Humanities and Social Sciences, University of Ruhuna, Sri Lanka

Abstract

As a developing country Sri Lanka can enhance the Gross Domestic Production in fisheries sector by developing the recreational fishing as a popular activity with significant benefits to the economy. Even though Sri Lanka is a beautiful island, when it comes to recreational fishing, still lack knowledge about this amazing profitable industry. The objective of the study is to analyze the Strengths, Opportunities, Weaknesses and Threats (SWOT) in recreational fishing industry in Sri Lanka and to establish a research platform for its economic development. The study area Negambo, is the only place where recreational fishing is conducted in both inland and coastal marine areas. Primary data were collected through face to face structured interviews. The convenience sampling technique was used to select thirty-two respondents. SWOT analysis was used for analysis of data. According to the results the industry is identified as one of the most popular leisure activities among locals and foreigners with social befits, employment generation, poverty reduction and expansion in economic activities with multibillion-rupee industry. Lack of indigenous expertise, technologies, trained personnel and comprehensive policies, water pollution that adversely affects the quality and the quantity of the fish stocks and barriers to fish migration can be considered as weaknesses. Hydrological and biological values, social and cultural values could be established to develop a platform for conservation education, scientific research and employment generation, are identified as opportunities. High cost of fishing equipment, land leasing and ownership issues and social conflicts on natural resource use, are identified as threats. To make necessary harvest estimates and socio-economic information for the development, annual surveys and action-plans should be arranged. This information would support for ecosystem conservation and enhancement, promotion of public access to quality opportunities and discovery of advanced innovative solutions to challenges provided with scientifically sound and trusted social, cultural, economic and ecological information, while the growing demand increases for sustainable development of recreational fishing.

Qualitative and Quantitative Comparison of Chitosan Isolated from Pharaoh Cuttlefish (*Sepia pharaonis*) Bone, Indian Squid (*Loligo duvauceli*) Pen and Tiger Prawn (*Penaeus monodon*) Exoskeleton

R.G. Sanuja [a], P.R.T. Cumaranatunga [a, *], K.H.M.A. Deepananda [a] and N.K. Kalutharage [b]

[a] Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Department of Chemistry, Faculty of Science, University of Ruhuna, Sri Lanka.

Abstract

Fish processing industry is a significant source for earning foreign exchange to Sri Lanka. Thus it plays a very important role in the country's economy. When considering the cuttlefish, squid and shellfish processing, hundreds of tonnes of waste are discarded and it has become a major environmental concern due to its slow degradation. The present study was designed to isolate the biopolymer: chitosan, from selected two cephalopod species *Loligo duvauceli* (Indian squid - Ln) and *Sepia pharaonis* (Pharaoh cuttlefish-Sp) and compare them qualitatively and quantitatively with previously isolated chitosan from *Penaeus monodon* (Giant tiger prawn -Pm). Pre-conditioning, De-mineralization, De-proteinization, De-colouration and De-acetylation steps were followed to isolate chitosan from the prawn shell, squid pen and cuttlefish bone. After extracting chitosan samples, the percentage of yield, physico-chemical and functional properties as moisture, ash, solubility, nitrogen, WBC, FBC and DD, and FT-IR reports were analyzed to compare the extracted chitosan samples. For the three species mentioned above, prawn (Pm), cuttlefish (Sp) and squid (Ld) yield was respectively 24.27%, 28.21% and 62.6%; moisture was respectively 7.52%, 8.33% and 9.27%; ash was respectively 0.65%,0.32% and 0.04%; Nitrogen was respectively 6.16%, 82.15% and 94.08%; solubility was respectively 15.28%, 34.73% and 52.17% ; WBC was respectively 600.61%, 673.27% and 705.21% and also FBC in coconut oil was respectively 644.15%,767.84% and 853.42%. in sunflower oil was respectively 556.53%, 602.45% and 678.23, and in soybean oil was respectively 65.21%, 637.21% and 778.65%. Among the three chitosan samples, chitosan isolated from the pen of *Loligo duvauceli* (Indian squid) was of best quality and was better than chitosan isolated from *Penaeus monodon* exskeleton. Possibility of using cephalopod and prawn waste to produce good qulity chitosan is evident from the results and it could be a good solution to reduce the environmental hazards caused by fih processing waste. Low cost techniques should be adopted to isolate chitosan, from fish processing waste, which should be considrred as a valuable resource for production of chitosan having many important industrial applications.

Key words: Chitosan, Loligo duvauceli, Penaeus monodon, Sepia pharaonis
Corresponding Author: ruchiracum@gmail.com

Determination of Vitamin C Content and Antioxidant Properties of Selected Sri Lankan Wild Fruit Species

V.P. Bulugahapitiya [a], A.P.H.I. Abeysuriya [a, *] and L.P. Jayatissa [b]

[a] Department of Chemistry, Faculty of Science, University of Ruhuna, Sri Lanka.
[b] Department of Botany, Faculty of Science, University of Ruhuna, Sri Lanka.

Abstract

As a country in the tropics, Sri Lanka has been gifted by nature with huge diversity of fruits. Since ancient times, thousands of wild fruit varieties have been consumed by Sri Lankan rural communities. Due to poor consumer awareness and lack of information on nutritional values of those fruits, those species have become neglected by the present society. Knowing the anti-oxidant capacity and vitamin C of these fruits is timely important as there is an increasing trend in the society to be away from the conventional fruits, due to use of chemicals for ripening to gain economic benefits by vendors. Therefore, the present study was carried out with the objective of determining ascorbic acid (AA) content, total vitamin C (TVC) content, 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging activity and ferric ion reducing antioxidant power assay (FRAP) of 16 species of Sri Lankan wild fruits namely, Kohukirilla (*Microcos paniculata*), Koan (*Schleichera oleosa*), Rata embilla (*Morus alba*), Nai batu (*Solanum capsicoides*), Kinithulu bovitiya (*Clidemaia hirta*), Maha bovitiya (*Melastoma malabathricum*), Heen bilin (*Oxalis berrelieri*), Pathok (*Opuntia dillenii*), Gandapana (*Lantana camara*), Jam fruit (*Muntingia calabura*), Ambul pera (*Psidium guajava*), Lovi (*Flacourtia inermis*), Batakirilla (*Erythroxylum moonii*), Ketambilla (*Dovyalis hebecarpa*), Rathambala (*Ixora coccinea*) and Heen ambilla (*Antidesma alexiteria*). AA and TVC content of 16 species of wild fruits studied, ranged from 5.3 – 121.7 mg/100g Fresh Weight (FW) and 5.8 – 123.7 mg/100g FW respectively. Highest AA and TVC contents were observed in Jam fruit (*Muntingia calabura*) (AA; 121.7±0.6 mg/100g FW, TVC; 123.7±0.4 mg/100g FW) followed by Maha bovitiya (*Melastoma malabathricum*), Kinithulu bovitiya (*Clidemaia hirta*) and Ketambilla (*Dovyalis hebecarpa*). Highest antioxidant capacity measured as DPPH, which is characterized by lowest IC_{50} value and FRAP assay was observed in Maha bovitiya (IC_{50}; 1.2 mg/mL, FRAP; 478.2 μmol Fe(II)/g FW), followed by Kinithulu bovitiya and Heen ambilla (*Antidesma alexiteria*). Antioxidant capacity measured as ferric reducing power showed a strong positive linear relationship with AA and TVC content and IC_{50} values obtained in DPPH showed a moderate negative linear relationship with AA and TVC content of fruits included in the study. Results of the present study revealed that neglected wild fruits in Sri Lanka are important as good sources of anti-oxidants and also with higher ascorbic acid content, when compared

to well-known vitamin C rich sources such as guava which has vitamin C content, IC_{50} and FRAP value of 70.4 mg/100g FW, 1.7 mg/mL and 35.03 μmol Fe(II)/g FW respectively. As natural anti-oxidants have been known to play an important role in reducing non-communicable diseases (NCDs), these wild fruits are promising agents to reduce the risk of NCDs and to ensure food security.

Key words: Antioxidant capacity, Ascorbic acid, Sri Lanka, Vitamin C, Wild fruits

Corresponding Author: hashiniabeysuriya@gmail.com

Finite Volume Method for Simulating the Resistance for Heating of a Rectangular Metal Sheet

K.A.S. Nisansala and P.A. Jayantha [*]

Department of Mathematics, University of Ruhuna, Sri Lanka

Abstract

The Finite Volume Method (FVM), as many other numerical methods, can be applied to obtain the numerical solutions for the systems that are governed by the conservation laws. Generally, it is an extremely difficult or impossible task to find out the analytical solutions for many PDE models in 2-D or higher dimensional spaces. This research was conducted to simulate the heat transfer of a rectangular metal sheet using Finite Volume Method. The electric current is supplied to a copper rod, which perfectly touches the given rectangular piece of metal by one end. According to the resistance of the copper rod the heat is generated and then it flows through the piece of metal. Electric potential satisfies the Laplace equation, then the heat generation term can be calculated for each grid point on the copper rod. A structured mesh was used for the whole domain. Thermal conductivity, specific heat capacity and electrical resistivity are considered to be temperature dependent physical quantities. By applying conservation law of energy, the power balance equation is derived and then the Finite Volume Method was used to solve this equation numerically for all grid points on the mesh. Method of manufactured solutions can be used as a programme and method verification technique for this problem. The results show that the temperature near the middle of the copper rod is higher than all other grid points.

Key words: Finite volume method, structured mesh, Method of manufactured solutions

Corresponding Author: jayantha@maths.ruh.ac.lk

Diversity of Dragonfly Species in the Hakkinda Islands of Mahaweli River in the Gatabe Area

H.I.G.C. Kumara* and V.A.M.P.K. Samarawikrama

Department of Geography, Faculty of Humanities and Social Sciences. University of Ruhuna, Sri Lanka

Abstract

Hakkinda Islands surrounded by the Mahaweli River, close to the Kandy-Gatambe area is a bio-geographical hotspot in Sri Lanka. However, bio-geographical importance of these islands have been overlooked during the last few decades as a result of development projects and varied human activities. Recently, Waratenna-Hakkinda area has been declared as a protected environmental area. According to the rudimentary survey, this protected area can be identified as a special habitat for dragonfly species, which biologically comes under the Class Insecta (Order–Odonata; Infraorder- Anisoptera). Since the knowledge about diversity of dragonfly species of the particular site is limited, this study was performed to bridge the gap in prevalent knowledge. This research is guided by Quantitative-Deductive research methodology. Under this methodology, line transects and quadrate sampling methods have been used in primary data collection process. According to research findings, a total of 16 dragonfly species from 08 families are identified and both riverine forest and river islands have rich diversity compared with home gardens in the area. Among the available species, 37.5% are identified to be endemic to the country. Three species, namely, Oriental Green Wing (*Neurobasis chinensis),* Black-tipped damsel *(Vestalis apicalis)* and Sri Lanka Ultima gem *(Libellago finalis)* are identified as vulnerable species. This research concludes that there is a high diversity of dragonfly species in this river islands and riverine forest areas, however human activities and their irresponsible behaviour may directly/indirectly negatively influence on dragonfly habitats and their breeding colonies. The research, thus, identifies an immediate requirement for a mechanism and regulations to protect a biologically important breeding colony of dragonfly species and their habitats to protect their diversity.

Key words: *Hakkinds protected area, dragonfly species, diversity, habitat protection*

Corresponding Author: *chamindakumara03@yahoo.com*

Influence of Stream Characteristics on Diversity and Distribution of Benthic Algae in Gongawwaela in Kottewa Rainforest, Galle, Sri Lanka

W.A.A.S. Chandrathilaka [a], H.B. Asanthi [a, *], T.G. Dayananda [b] and R. G. Gunasekera [b]

[a] Department of Limnology and Water Technology, University of Ruhuna.
[b] Department of Botany, University of Ruhuna

Abstract

Influence of stream characteristics on diversity and distribution of benthic algae was studied at four sampling sites located at 1.5km distance in the Gongawwaela stream located in Kottewe rainforest from September to November, 2016. Water quality parameters pH, conductivity, Temperature, Dissolved Oxygen (DO), Total Suspended Solids (TSS), Total Dissolved Solids (TDS) and nitrate and phosphate, were measured. Substrate types were categorized by sieve analysis and grain size distribution curves. pH, conductivity, nitrate, phosphate and % organic matter of soil were measured as its chemical properties. Benthic algae were sampled by Line Transect method. Most important stream characteristics that potentially influence the growth of benthic algae, were identified using Principle Component Analysis (PCA). Nitrate, TDS, temperature, pH, and DO of water and pH, phosphate and nitrate of substrate showed significant temporal variations. Substrate conductivity and water velocity varied significantly among the sampling sites. Species richness of benthic algae (29 genera) showed significant negative correlations with substrate phosphate ($R^2=-0.9921$, P<0.05) and substrate pH ($R^2=-0.999$, P<0.05). Well-graded substrate was observed only at the most downstream site (site 3) while other sites had poorly graded substrata consisting over 90% sand. Bacillariophyta was the most abundant algal division and the abundance of *Flagilaria* sp*., Pinnularia* sp*., Stigeoclonium* sp*.,* and *Pediastrum* sp*.* showed significant temporal variations. *Pinnularia* sp*., Synedra* sp*., Anabaena* sp*.* and *Navicula* sp*.* were possible indicators of the upstream characteristics, while *Cosmarium* sp*., Pinnularia* sp*., Surirella* sp*., Tabellaria* sp*., Synedra* sp*., Closterium* sp*.* and *Navicula* sp*.* were possible indicators of the downstream characteristics. PCA showed that DO, conductivity, TSS, pH, nitrate and discharge of water, and conductivity, nitrate, phosphate, % organic matter, pH, and % canopy cover of the substrate influence the growth of benthic algae.

Key words: benthic algae, rainforest, stream characteristics, water quality, water discharge.

*Corresponding Author: asanthi@fish.ruh.ac.lk

Extreme Weather Events Driven (Summer Droughts; Winter Sea Floods) Salinization of Freshwater Coastal Ecosystems: Possible Impacts on Genetic Diversity of *Brachionus calyciflorus* Populations

L. Wijewardene [a, b, *], R. Ribeiro [c], C. Venâncio [d] and I. Lopes [d]

[a] Department of Limnology and Water Technology, University of Ruhuna, Matara, Sri Lanka.
[b] Department of Life Sciences, University of Coimbra, Portugal.
[c] Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Portugal.
[d] CESAM & Department of Biology, University of Aveiro, Portugal.

Abstract

Increased evaporation, low flow regimes together with climate change induced sea level rise and higher frequency of extreme weather events intensify the salinization of coastal freshwater ecosystems. Salinization of freshwater ecosystems through extreme weather events such as summer droughts and winter sea floods are prominent in temperate countries. This salinization may compromise the resilience of natural populations inhabiting coastal regions by decreasing their genetic diversity. This work intended to understand the effects of salinization on the genetic diversity of populations of the rotifer, *Brachionus calyciflorus* under different temperature regimes. Six lineages of *B. calciflorus* (D, G, P, N, F, H) differing in lethal sensitivity to salinity were selected and lab-populations of each clonal lineage were maintained under optimal conditions until reaching a steady state (carrying capacity). At this point, they were exposed to predetermine salinity level (9.7 mS/cm) which was LC_{70} of most tolerant genotype (H), for at least 30 days. Population densities were monitored across the exposure period. These long-term assays were conducted under 3 temperatures: (i) 17 ± 1°C to simulate salt water intrusion during winter; (ii) 20 ± 1°C the optimal temperature (control), since organisms were cultured in the laboratory at this temperature and (iii) 23 ± 1°C to simulate seawater intrusion in freshwater ecosystems during summer. Continuous exposure to 9.7 mS/cm salinity level affected survival and reproduction of *B. calciflorus*, leading to extirpation of some genotypes after long-term exposures. Under 17°C, F, H and P were the first three genotypes disappeared, and their LT_{90} were 229 ± 11.35h, 276.7 ± 35.53h and 282.2 ± 19.19h respectively. H, G and N genotypes showed an LT_{90} of 418.5 ± 34.35h, 536.6 ± 71.82h and 555.7 ± 78.90h respectively at 20°C. Under 23°C; F, D, and H genotypes disappeared first and their LT_{90} values were 405.1 ± 64.77h, 458.9 ± 68.00h and 460.2 ± 36.81h respectively. These different patterns of sensitivity observed due to long-term exposures, could be most probably due to acclimation-driven population recovery. Temperature differences influenced response to salinity. These results and its consequences at the population

level was discussed in the light of the genetic erosion hypothesis, through natural selection due to small within-genotype variability

Key words: *acclimation, genetic Erosion, long-term exposure, population recovery, salinization.*

Corresponding Author: *nisansalawijewardene@gmail.com*

An Appraisal of the Ancient Concept of Positioning the Tank System in Walawe River Basin

K. Sanjaya [a], *, T. Priyadarshana [a] and N. Wijerathna [b]

[a] Department of Limnology and Water Technology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Department of Civil Engineering, University of Moratuwa, Sri Lanka.

Abstract

The Walawe River Basin (WRB) extends over 2500 km^2 through varying climatic zones from Wet to Arid. The antecedents evidence that WRB was once a prosperous area having a well-planned irrigation system. However, it is always important to have scientific proof on tank placement and water availability for proper functioning of the ancient system. In this study, our main focus was the tank placement. A tank distribution map was created by digitizing one inch to one-mile maps of survey department, Sri Lanka (1930s survey data). The soil map and the geological map were created with the aid of literature. The current climatic zone map (Meteorological department) of Sri Lanka was used as the source climatic map of the basin. The slope map of the basin was created with 5 m contour data. GIS analyses were conducted with Arc GIS 10.1 software package and tank locations were verified by field data. As per the analysis, the dams of the two major tanks (Hambegamuwa and Mahagama tanks) had been placed on hard Granite or biotite bedrocks. The majority of the tanks (66 %) were located on the reddish brown soil. Moreover, the highest tank density (36 tanks per 25km^2) was observed in the Intermediate climatic zone, while the lowest (3 tanks per 25 km^2) was observed in Semi-Arid zone. About 50 % of the land area of the basin was less slopy (<4%) and 99% of the tanks have been positioned on this low slope ground. Therefore, it could assume that proper soil type and the geology has been concerned when placing tanks. The Intermediate zone where the precipitation exceeds the evapotranspiration has mostly been used as the storage zone. Low slope land stripes have been used for constructing the tanks and it is fair to assume the concern of dam safety against breach at floods. Accordingly, it is fair to assume that the ancient tank system has followed the geology, soil type, slope and the climatic factors. However, the water availability to function the whole ancient system at once will need to be highly concerned in future studies.

Key words: ancient irrigation system, geology, tank positioning, Walawa basin, water resources.

Corresponding Author: hlksanjaya85@gmail.com

Comparative Assessment of GnRH and LHRH on Artificial Insemination and Embryonic Development of Stinging Catfish, *Heterpneustes fossilis*

E.S.P. Ekanayaka [a], W.S. Weerakkody [b, *], W.P.R. Chandrarathna [c] and K.H.M.A. Deepananda [b]

[a] University College of Anuradhapura, University of Vocational Technology, Sri Lanka.
[b] Department of Fisheies and Aquaculture, University of Ruhuna, Sri Lanka.
[c] National Aquaculture Development Authority, Sri Lanka

Abstract

Freshwater Stinging catfish, *Heteropneustes fossilis* that have a supra branchial air breathing organ is one of the ideal commodity for aquaculture, due to omnivorous feeding habit and high survival capacity. Present study evaluates the potential applicability of commonly used hormones to induce breeding in fish GnRH (a complex of salmon GnRH and domperidone) and LHRH, comparing their efficacy when used on artificial insemination and embryonic development of *H. fossilis*. Wild caught *H. fossilis* were acclimatised to cement tanks for one-month before using them to induce spawning using GnRH and LHRH. Selected females (n=8) were with a total weight and length ranged from 22.4 ±0.05 cm to 22.6 ±0.05 cm and from 105 ± 0.65 g to 106 ±0.57 g, respectively. And, males (n=16) were with a total length and body weight ranged from 21.3 ± 0.05 cm to 22.3 ±0.05 cm and 85.6 ± 0.50 g to 85.8 ± 0.57g, respectively. Females and males were injected with LHRH at dosages of 30 IU/ 100g body weight and 15 IU/ 100g body weight, respectively. Another group of females and males (8 and 16 respectively) of the same length and weight ranges were injected with GnRH, at a dosage of 0.16mg /100g body weight and 0.08mg /100g body weight respectively. Each hormone was injected in two portions, and 2/3rds of the total dosage were given 8 hours after the first injection. After 8 hours from the second injection, eggs were collected by stripping the females, and they were fertilised with sperms collected by scarifying the males. Incubation of eggs was done at room temperature (27-28℃), and development of embryo were observed and photographed using an Oxin trinocular microscope. Successful spawning was observed in both experimental groups, and Chi-square test revealed no significant differences (p>0.05) in the rates of ovulation, fertilization and hatching between two experimental groups. However, ovulation rate and fertilization rate (100% & 92.8% respectively) were higher in LHRH injected fish than GnRH injected fish (90% & 79.6% respectively). Hatching commenced 24 hrs after fertilization and the development frequency and time and percentage hatchability of eggs were not significantly different (p>0.05) between two experimental groups. Hatchlings had a mean length of 2.3 ± 0.05 mm, and yolk was completely absorbed and exogenous feeding started within four days of hatching. Present study concludes that there is a

high possibility to enhance the seed production of *H. fossilis*, using GnRH and LHRH hormones, and LHRH being more effective over GnRH.

Key words: *fertilization rate, GnRH, Heteropneustes fossilis, LHRH, ovulation rate*

Corresponding Author: *sanjaya.fmst.uor@gmail.com*

Current Extent and Distribution of Mangrove Cover in the Southern Coastal Belt of Sri Lanka - A Field Validated Remote Sensing Study

S.K Madarasinghe [a], K.K.A.S. Yapa [a, *], B. Satyanarayana [b], P.M.P. Udayakumara[c], K.A.S. Kodikara[d] and L.P. Jayatissa [d]

[a] Department of Physics, University of Ruhuna, Sri Lanka.
[b] Institute of Oceanography and Environment, Higher Institution Centre of Excellence in Marine Sciences, Universiti Malaysia Terengganu-UMT, KualaTerengganu, Malaysia.
[c] Sri Lanka Survey Department, Colonbo, Sri Lanka
[d] Department of Botany, University of Ruhuna, Sri Lanka

Abstract

Mangrove forests are valued ecosystems owing to their ecological services and economic benefits. Available estimation on mangrove cover in Sri Lanka varies in a broad range, 6000-12000 ha, implying that accuracy of such estimates may be low and accepted standard methods may not have been followed properly. Accurate and accepted methods need remote sensing work based on standard images (i.e. aerial images or satellite images) with high resolution, incorporating field verifications and error estimations. This study is aimed at achieving an accurate estimate of total current mangrove area in the southern province using proper and standard GIS techniques. Google earth 2017 images covering coastal areas of Galle, Matara and Hambantota districts in southern province were used to prepare GIS layers to show the mangrove distribution using ArcMap10.1 software. Each mangrove site was visited for ground-truthing and information regarding socio-economic aspects were collected through a questionnaire survey. Accordingly, the total mangrove cover of Galle, Matara and Hambantota districts were estimated as 338.0 ha, 41.8 ha and 790.1 ha, respectively, with 1169.9 ha in total for the Southern Province. Number of separate mangrove sites identified for the three districts are 8 in both Galle, and Matara and 7 in Hambantota. The largest mangrove forest in the southern province is Kalametiya with 428.3 ha. Comparison of the current extent of the mangrove cover estimated under this study with available past records of estimates was done and possible reasons for variability are discussed. A net increase of mangrove forests in Southern Province over last decade has been observed and it can be attributed to the dramatic mangrove increase recorded in Kalametiya lagoon and replanting programs in Galle and Madu Ganga introduced after Tsunami in 2004.

Key words: mangrove forest distribution, southern coast, Sri Lanka

Corresponding Author: kanthi@phy.ruh.ac.lk

Perception of the Workers in the Cinnamon Industry on Seasonal Variations of Peelability of Cinnamon (*Cinnamomum verum* J.Presl) Plants

K.A.S. Hansika [a], K.A.S. Kodikara [a], A.A. Wijeweera [b] , K.G.G. Wijesinghe [b] , G. Senanayake [c] and L.P. Jayatissa [a, *]

[a] Department of Botany, Faculty of Science, University of Ruhuna, Sri Lanka
[b] Cinnamon Research Centre, Pallolpitiya, Sri Lanka.
[c] Department of Agricultural biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka

Abstract

Cinnamon is a native spices which provides a major contribution to the Sri Lankan economy. Commercially important product from cinnamon plant is the dried bark of stems. However, cinnamon plants show a seasonal variation in the peelability and hence interrupts the continuous harvesting of cinnamon. Therefore, the main purpose of this study was to get the perception of workers in the cinnamon industry on the seasonal variations in the peelability and its consequences. A survey based on a questionnaire was carried out using 50 individuals selected randomly from among people who are engaged in cinnamon industry in different areas,. where cinnamon is a staple economic crop. A higher percentage (73%) of the respondents stated that newly cultivated plants reach the maturity stage suitable for first peeling, approximately after 3 years. According to respondents, there is no particular season of the year for leaf flushing and it takes place whenever rain commences after a dry period. The young leaves are red in color initially and then converted to yellow and greenish yellow, reaching a green color at the maturity. All (100%) the respondents stated that peeling of cinnamon is difficult during the flushing with red or yellow leaves, which diminish gradually with the maturity of leaves. Furthermore, all the respondents verified that the peeling of cinnamon becomes difficult once again during the flowering and fruiting periods; which also diminish with the maturity of fruits. In other words, there is no difficulty in peeling of cinnamon during the periods, without leaf flushing, flowering, and appearance of young fruits. The above information should be checked through a phenological survery incorperated with peelability measurements and if verified, the anatomical differences of cinnamon stems during the relevant stages also should be studied.

Key words: Cinnamon industry, flowering, harvesting, leaf flushing, peelability

Corresponding Author: lpj5745@gmail.com

Medicine and Allied Health Sciences

Effect of Aphasia on Health Related Quality of Life of Patients with Stroke - Preliminary Study Findings

P.N. Kariyawasam [a], *, K.D. Pathirana [b] and D.C. Hewage [c]

[a] B.Sc. Nursing Degree Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Department of Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Department of Physiology, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka

Abstract

Health Related Quality of Life (HRQOL) reflects the impact of a health state on a person's ability to lead a fulfilling life. One of the main consequences of stroke is aphasia, which can affect HRQOL of patients significantly. It has been shown that 21-38% of patients with stroke suffered from aphasia. Assessment of HRQOL is particularly important to evaluate the rehabilitation interventions for patients with long term disabilities. This study was conducted to compare the HRQOL between stroke patients with and without aphasia, in order to determine the effect of aphasia on quality of life of patients with stroke. A descriptive cross sectional study was conducted involving 61 patients with stroke (3 months after hospital discharge) in neurology clinics and medical clinics in Teaching Hospital, Karapitiya. Mississippi Aphasia Screening Test (MAST)-Sinhala version was used to screen patients in order to detect aphasia. HRQOL were evaluated using the proxy version of Stroke Aphasia Quality of Life generic (SAQOL-39g- Sinhala) scale. The mean age of the patients with stroke was 65.26 (SD ± 12.83, range 33-81), of which 67.2% (n=41) were males. 83.6% (n=51) of them having ischemic strokes and 39.3% (n=24) having aphasia. Patients without aphasia obtained higher overall HRQOL scores (M=3.94, SE=0.114) than patients with aphasia (M=2.65, SE=0.144). This difference was significant t (59) = (-7.06), $p < 0.05$. The mean scores for all three domains (communication, psychosocial and physical domains) were significantly lower ($p < 0.05$) in patients with aphasia (2.26, 2.80, 2.68) than in patients without aphasia (4.40, 3.85, 3.79). HRQOL is significantly poor in patients with aphasia affecting all three domains when compared with patients without aphasia following stroke. This need to be taken into account when planning for rehabilitation.

Key words: Aphasia, quality of life, SAQOL, stroke

*Corresponding Author: pnirmanikariyawasam@gmail.com

Adriamycin Induced Nephropathy in Wistar Rats: An *in vivo* Model to Screen Nephroprotective Activity of Natural Products

A.M.S.S. Amarasiri [a,*], A.P. Attanayake [b], K.A.P.W. Jayatilaka [b] and L.K.B. Mudduwa [c]

[a] BSc. Medical Laboratory Science Degree Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Department of Biochemistry, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Department of Pathology, Faculty of Medicine, University of Ruhuna, Sri Lanka

Abstract

Animal models of renal disease are important in the development of novel nephroprotective agents in terms of their predictive value for humans. The objective of the present study was to develop adriamycin (ADR) induced nephropathy in Wistar rats in order to use it as a model for screening natural products with proposed nephroproetcive activity. Healthy male Wistar rats (10-12 weeks of age, 200±25g) were used in the experiments. Fasted Wistar rats (8h) were divided into four groups (n= 6/ group). Group one served as the control group ; received normal saline. Group two, three and four were test groups, received a single dose of ADR (17, 20 and 23 mg/kg b. wt, ip) respectively. The experimental animals were sacrificed on the 7th day after the administration of ADR. Blood was collected from all Wistar rats for the estimation of selected biochemical parameters in order to assess renal damage. Hematoxylin and Eosin stained sections of the kidney tissues were used for the histopathology assessment. The dose of 17 mg/kg b. wt in rats showed mild changes in biochemical parameters and the 23 mg/kg b. wt dose resulted in an increase in mortality of rats. There was an increase in serum creatinine concentration (117%,158%, 259%) and blood urea nitrogen level (11%, 26%, 41%) in rats treated with the selected doses of ADR ($p < 0.05$). Serum concentration of total protein and albumin were reduced with the increase in the dose of ADR. Histopathological changes of acute tubular necrosis was clearly observed in the kideny tissues of ADR (20 mg/kg b. wt) treated rats. ADR at a dose of 20 mg/kg b. wt was selected as the optimum dose for the development of nephropathy model. The selected dose will be used in the investigation of acute nephroprotective activity of natural products *in vivo*.

Key words: Adriamycin induced nephropathy, nephroprotective activity, Sri Lankan medicinal plants, Wistar rats

*Corresponding Author: amssamarasiri@gmail.com

Protective Effect of *Murraya koenigii* Leaf Extract Against Doxorubicin Induced Cardiotoxicity

J.A.N. Sandamali [a, *], R.P. Hewawasam [b], K.A.P.W. Jayatilaka [b] and L.K.B. Mudduwa [c]

[a] BSc Medical Laboratory Science Degree Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka
[b] Department of Biochemistry, Faculty of Medicine, University of Ruhuna, Sri Lanka
[c] Department of Pathology, Faculty of Medicine, University of Ruhuna, Sri Lanka.

Abstract

Anthracyclines, including doxorubicin, are considered as the most effective anticancer treatment ever developed. The successful use of doxorubicin is hampered by toxicities such as hepatotoxicity and nephrotoxicity, yet the most feared side-effect is cardiotoxicity. Doxorubicin-induced cardiomyopathy is strongly linked to an increase in cardiac oxidative stress evidenced by reactive oxygen species-induced damage. It has been reported that *Murraya koenigii* (Karapincha) leaves have strong antioxidant potential. Objective of this study was to determine the protective effect of *Murraya koenigii* leaf extract against doxorubicin induced carditoxicity in Wistar rats at different dosages. Wistar albino rats were divided into seven groups of 10 animals in each. Group 1: normal control; Group 2: doxorubicin control (18 mg/kg, ip, after 16 hour fast on the 11th day); Groups 3-7: five doses of freeze dried aqueous leaf extracts (0.125, 0.25, 0.5, 1.0, 2.0g/kg, orally, daily for 14 days). Animals were sacrificed on the 15th day and blood was collected for estimation of serum concentrations of cardiac troponin I (cTnI), AST and LDH and myocardial tissues were collected for histopathological assessment. Mean cTnI concentrations of groups 1-7 were 0, 161.9, 88.51, 74.41, 34.54, 17.62 & 15.31pg/mL. In groups 1-7, mean AST activities were 26.82, 68.1, 42.52, 41.38, 28.69, 27.4 & 25.89U/L and LDH activities were 1166.13, 2428.84, 1285.31, 1204.09, 1195.66, 1177.45 & 1161.58U/L. A significant difference (P<0.05) between group 2 and groups 3-7 was evident in the mean concentration of all three cardiac biomarkers. A dose dependent reduction in the histopathological evidence of myocardial toxicity was observed with increasing dosage of plant extracts. According to the biochemical and histopathological assessment, *Murraya koenigii* leaf extract was protective against doxorubicin induced cardiotoxicity and administration of 2 g/kg dosage of the extract showed the highest effect.

Key words: cardiotoxicity, doxorubicin, Murraya koenigii

Corresponding Author: jansandamali@ymail.com

Acetylcholine Esterase Inhibitors from Sri Lankan Medicinal Plant Extracts

A.P. Attanayake [a],* and K.A.P.W. Jayatilaka [a]

[a] Department of Biochemistry, Faculty of Medicine, University of Ruhuna, Sri Lanka

Abstract

Medicinal plants are being recognized as promising sources of drug leads in the development of novel pharmaceutical agents for the management of Alzheimer's disease (AD). Approaches to enhance cholinergic function in AD have included prolonging the availability of acetylcholine (ACh) released into the neuronal synaptic cleft by inhibiting ACh hydrolysis via AChE inhibitors. In addition, strong experimental evidences have shown that the oxidative damage plays a major role in neurological degeneration in the pathogenesis of AD. The objective of the study was to determine the acetylcholinesterase (AChE) inhibitory activity and antioxidant activity in selected Sri Lankan medicinal plants. AChE inhibitory activity of the selected medicinal plant extracts was determined using the Ellman's method. The antioxidant activities were determined by four *in vitro* methods namely DPPH assay, FRAP assay and NO assay. The contents of total polyphenol and flavonoid were determined quantitatively. Out of the ten selected medicinal plant extracts the leaf extracts of *Abrus precatorius* (Olinda), *Centella asiatica* (Gotukola), *Ricinus communis* (Erandu) and fruit extract of *Strychnos nux-vomica* (Goda Kaduru) showed IC_{50} values < 200 µg/mL for AChE inhibitory activity. A high antioxidant activity was shown in the aerial extract of *C. Halicacabum* and in leaf extracts of *C. asiatica* and *R. communis* in three selected antioxidant assays. The total polyphenol content and total flavonoid content were in the range of 0.55-7.30 mg/g dry weight and 19.08±0.29-1283.08± 0.09 µg/g dry weight respectively. The extracts of *A. precatorius*, *C. asiatica*, *S. nux-vomica* and *R. communis* are deserved to be as potent sources of AChE inhibitors as well as natural antioxidants. Considering the complex multifactorial etiology of AD, these plant extracts would be apt candidates for the development of novel pharmaceutical agents in the management of AD.

Corresponding Author: anoja715@yahoo.com

Subclinical Atherosclerosis Among Individuals with Pre-diabetes

A.T.I.M. Amarasinghe [a, *], S. Lekamwasam [b] and T.P. Weerarathna [b]

[a] Department of Pharmacology, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Department of Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka

Abstract

Pre-diabetes is a stage between normoglycemia and diabetes mellitus. Subclinical atherosclerosis is not adequately explored among pre-diabetes in local setting. Carotid artery intima media thickness (CIMT) and elevated high sensitivity C-reactive protein (hsCRP) are recognized surrogates of subclinical atherosclerosis and inflammation, respectively.Present study investigated the excistanceof subclinical atherosclerosis and inflammation among persons with pre-diabetes compared to those with normal glucose tolerance. Healthy adults, aged 20-65years were screened with 75g-Oral glucose tolerance test (OGTT). Anthropometric measurements, fasting blood sugar (FBS), lipid profile, hsCRP and CIMT (in anterior and posterior walls of both common carotid arteries using duplex ultrasound) were compared in 101 individuals with impaired glucose tolerance (pre-diabetes) and 29 individuals with normal glucose tolerance. Mean (±SD) age of normoglycemia (n=29) and pre-diabetes (n=101) were 44(±8) and 45(±8) years, respectively. Mean(±SD) of body mass index, systolic blood pressure, dyastolic blood pressure, Hs CRP, total cholesterol, right anterior and left anterior CIMTs were not different between participants with normoglycemia and pre-diabetes [{ 25.7 (4.5), 25.8 (4.2), p=0.88};{120 (11), 124 (12), p=0.13};{76 (9),78 (7), p=0.26};{3.1 (3.4), 3.4 (3.5), p=0.71};{ 213 (38), 211 (45), p=0.86};{0.538 (0.11), 0.564 (0.11), p=0.29}; { 0.561 (0.09), 0.551 (0.11),p=0.67}] respectively. Right and left posterior wall CIMTs were significantly different between individuals with normoglycemia and pre-diabetes [{0.522mm (0.11), 0.578 mm (0.11), p=0.016}; {0.529 (0.11), 0.578 (0.13), p=0.051]. This study shows significantly increased right and left posterior CIMTs among pre-diabetes compared to normoglycemic participants. It provides evidence for the excistance of subclinical atherosclerosis in pre-diabetes requiring early intervention to reduce adverse atherosclerotic cardiovascular outcomes.

Key words: Atherosclerosis, CIMT, Pre-diabetes

Corresponding Author: amarasingheisuru@med.ruh.ac.lk

Search for Novel Disinfectants: Could Silver Nanoparticles Synthesized by *Argyreia populifolia* be a Promising Agent?

W.S.G. De Soyza [a], M. Napagoda [a, *], W.M.D.G.B. Wijayaratne [b] and S. Witharana [c]

[a] Department of Biochemistry, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Department of Microbiology, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Faculty of Engineering, Higher Colleges of Technology, United Arab Emirates.

Abstract

Routine surface disinfection with antiseptics containing antimicrobial compounds is adopted as an important preventive measure against the transmission of nosocomial infections in healthcare settings. A variety of chemical agents have been currently employed as disinfectants, however, the recent evidence discloses the emergence of microbial resistance as well as the health concerns and environmental issues related to the long-term usage of these chemicals. Thus, the exploration and development of novel disinfectants, which are highly effective and less toxic, as alternatives to the existing agents is of great demand. Therefore, the present study was undertaken to synthesize silver nanoparticles from *Argyreia populifolia* (Girithilla); a plant widely utilized in antimicrobial remedies in Sri Lankan traditional medicine and to evaluate the antimicrobial and disinfectant properties of the nano-preparation. Sliver nanoparticles were synthesized after treating an aqueous solution of silver nitrate with an aqueous extract of *A. populifolia*. The antimicrobial activity of the silver nanopreparation was evaluated by broth microdilution method against *Staphylococcus aureus*, *Staphylococcus saprophyticus* and four different strains of methicillin resistant *Staphylococcus aureus*. A minimum inhibitory concentration value of 125 μg/mL and a minimum bactericidal concentration of 250 μg/mL were detected for most of the organisms tested. Thereafter, the quantitative surface disinfectant assay was employed with slight modifications to determine the disinfectant potential of the nano-preparation against *S. aureus* on smooth and rough surfaces at the concentration of 250 μg/mL. Briefly, the different surfaces were treated with the test preparation and thereafter inoculated with microbial preparations of different dilutions and observed the growth of colonies after 48 hours. Interestingly, not a single colony of microorganisms had grown on swab cultures obtained from the smooth and rough surfaces inoculated with *S. aureus* after exposure to the nanopreparation. However, a profuse growth of bacteria was observed on swab cultures obtained from these surfaces inoculated with *S. aureus* without the exposure to the nano-preparation. These preliminary results suggest that the silver nanoparticles synthesized from *A. populifolia* has a high potential to be developed into a novel disinfectant. Thus, the experiments are in progress to further confirm its disinfectant potential, mechanism of action and also to exclude the possible cytotoxic effects on human.

Key words: Antimicrobial, Argyreia populifolia, Disinfectant, Silver nanopreparation
Corresponding Author: mayurinapagoda@yahoo.com

Molecular Epidemiology of Colonizing Methicillin-Resistant *Staphylococcus aureus* in Patients Admitted to Teaching Hospital, Karapitiya

M.R.P. Kurukulasooriya [a], W.M.D.G.B. Wijayaratne [a, *], L.G. Tillekeratne [b], C.K. Bodinayake [a], M.D. Rajapakshe [a], B.G.J. Umesha [a], A.D. de Silva [c], B.P. Nicholson [b], T. Østbye [b], C.W. Woods [b] and A. De S. Nagahawatte [a]

[a] Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Duke University, Durham, North Carolina, USA.
[c] Faculty of Medicine, Kotelawala Defense University, Sri Lanka

Abstract

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a pervasive multi-drug resistant pathogen. Acquisition of resistant genes and virulence mechanisms have become the major concerns. Microbiological identification gives an adquate insight regarding these mechanisms. Robust identification is required for planning an effective antimicrobial therapy against the pathogen. The study was aimed to describe the molecular epidemiology of MRSA isolates collected from the Teaching Hospital, Karapitiya. Patients were enrolled from orthopaedic, medical and surgical wards for six months from September 2016. Nasal swabs were collected from anterior nares within 24 hours of admission and 48 hours prior to discharge. MRSA isolates were identified based on cefoxitin resistance as in Clinical and Laboratory Standard Institute guidelines. Identification of *mecA*, *femB* and Panton-Valentine Leucocidin (*PVL*) genes and Staphylococcal Cassette Chromosome *mec* (SCC*mec*) types were performed using polymerase chain reaction. A total of 502 patients were enrolled on admission. Of them, discharge samples were collected from 360 patients. Patients colonized with MRSA on admission and at discharge were 31 (6.2%) and 24 (6.7%), respectively. All 55 isolates were positive for *mecA*. Of those, 7 (22.5%) and 6 (25%) isolates were positive for *PVL* and 30 (96.7%) and 23 (95.8%) isolates were positive for *femB*. SCC*mec* typing indicated SCC*mec* type IV (18, 58%), V (3, 9.6%), I (3, 9.6%) and III (7, 22.5%) on admission and SCC*mec* type IV (16, 67%), V (3, 12.5%) and III (2, 8.3%) including three none-typable isolates at discharge. Molecular profiles confirmed that all MRSA isolates were positive for *mecA.* Around one-fourth of them were positive for *PVL*. More than half of the isolates carried SCC*mec* type IV and V. Isolates positive for *PVL* gene carrying SCC*mec* type IV and V may cause more virulent infections compared to the others. Molecular epidemiology provides a better insight for planning effective antibiotic therapy.

Key words: Molecular epidemiology, MRSA, PVL, Resistant genes, SCCmec types

Corresponding Author: gayabw@yahoo.co.uk

Quality of Life of Breast Cancer Patients Treated at Teaching Hospital Karapitiya, Sri Lanka

E. Weeratunga [a], *, M. Hettiarachchi [b] and U. Ekanayaka [c]

[a] Nursing Degree Programme, Allied Health Sciences, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Neuclear Medicine Unit, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Teaching Hospital, Karapitiya, Sri Lanka

Abstract

Cancer is the second leading cause of death in the world. Breast cancer (BC) is the second most common cancer among women globally as well as in Sri Lanka. Quality of Life (QOL) is a subjective perception a person has of their position in life and it includes various aspects of domains like physical, psychological, social and environment. Aim of this study was to assess QOL among BC patients treated at a tertiary care hospital in Southern Sri Lanka. Ninety-seven patients from the oncology unit of the Teaching Hospital Karapitiya were included in this cross-sectional study. Data were collected using an interviewer-administered questionnaire (World Health Organization – Quality of Life- Brief) and extracts from patient notes after obtaining informed consent from each subject with sufficient physical and mental stability to assess the quality of life among study subjects. Age ranged from 31 to 71 years with a mean of 52 years (SD=9). Localized tumor (T stage) was presented in 84% patients at the time of diagnosis and the rest were on severe stages (node and metastasis). The mean±SD score of overall QOL was 248±34 in this study subjects. Further, the physical domain (mean±SD) had 61±12, psychological domain had 64±12 and environmental domain had 69±9 levels respectively. However, it was evident that the lowest score in the social domain with mean score (±SD) of 48±14. Further subjects with metastasis and resultant disabilities had low mean QOL scores when compared with those who had localized tumor and no disabilities respectively. Cancer patients have many psycho-social needs which should be fulfilled in addition to improving quality of life which is an important aspect of modern health care. QOL measures have become a vital part of health outcomes and are very important aspect of chronic diseases which are not curable. Therefore, QOL measurements provide a meaningful way to determine the impact of health care services.

Key words: Breast cancer, Psychosocial factors, QOL, WHOQOL-BREF

*Corresponding Author: eranthiweeratunga@yahoo.com

Doxycycline Usage for Prevention of Leptospirosis Among Farmers and the Reasons for Failure to Use Chemoprophylaxis: A Descriptive Study from Southern Sri Lanka

C.L. Fonseka [a,*], C.M. de Silva [b], A.A.B. Athukorala [b], P.R. Goonawardena [b], A.P. Karunathilake [b], I. Rajapakse [c] and A.S. Dissanayake [a]

[a] Department of Internal Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] University Professorial Unit, Teaching Hospital, Karapitiya, Sri Lanka.
[c] Department of Psychiatry, Faculty of Medicine, University of Ruhuna, Sri Lanka

Abstract

Leptospirosis causes substantial morbidity and mortality in Sri Lanka. Health authorities have implemented a chemoprophylaxis programme for farmers for the prevention of disease. 39% of general population is aware about chemoprophylaxis for Leptospirosis. The extent of chemoprophylaxis usage among this risk population and the reasons for non-usage was uncertain. Cross-sectional descriptive study was conducted on paddy farmers in the community setting in the Galle District. Multi-stage cluster sampling method was used. Out of the seventeen MOH divisions of Galle district, nine divisions were randomly selected and individuals who do farming as the main source of income were selected. Details on demographics, knowledge on leptospirosis and Doxycycline usage were obtained through an interviewer administered questionnaire. From those who has not taken chemoprophylaxis, the reasons for non-usage were explored by semi quantitative interviews. 319 farmers were recruited (77% males) to the study. Eighteen (5.6%) has already had Leptospirosis. Majority (86.8%) of farmers were aware that Doxycycline can be used to prevent the disease occurrence. Only 31% knew about the correct usage recommendations of chemoprophylaxis adopted by the national guidelines. 91 (28.5%) used Doxycycline prophylaxis as a preventive measure for Leptospirosis. Out of those, only 60 (65.9%) farmers continued the prophylaxis throughout the contact. Themes responsible for non-usage were elicited such as, lack of knowledge, false sense of security from the disease by perceived 'immunity', low prevalence of disease, lack of motivation, lack of availability of medication and fear of side effects. Awareness of leptospirosis is better among farmers compared to the general population. Usage of chemoprophylaxis among farmers were highly inadequate. Individual and health system related hypotheses and myths exist for non-usage of chemoprophylaxis. Thus, an urgent concerted campaign aimed at increasing awareness within the target group through education and making medicines freely accessible, is essential for better prevention of the disease.

Key words: Chemoprophylaxis, Doxycycline, Leptospirosis

Corresponding Author: lakmalfonseka@med.ruh.ac.lk

Interventions Done by Health Care Professionals for Patients with Problem Drinking Admitted to Teaching Hospital Karapitiya

N.H.D.P. Fonseka [a, *], I.H. Rajapakse [b] and A.S. Dissanayake [c]

[a] BSc Nursing Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Department of Psychiatry, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Department of Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka.

Abstract

Problem drinking (PD), namely alcohol dependence (AD) and alcohol abuse (AA) are associated with major medical, social and economic adverse consequences. The aim is to determine the nature of interventions done by healthcare professionals (HCPs) for patients with PD admitted to a tertiary-care hospital in Southern Sri-Lanka. Two-hundred consecutively admitted male patients with a history of alcool consumption receiving care in medical and surgical wards in Teaching-Hospital Karapitiya were assessed. Validated J12 questionnaire of the Mini-International-Neuropsychiatric-Interview (MINI) was administered to determine frequency of PD. Semi-structured interviews were conducted to determine the nature of interventions i.e. whether they were brief interventions or long-term treatment and follow up interventions, and also to determine who the intervening HCPs were. PD was noted in 63 (31.5%) participants. Of them, 55.5% were never advised on PD behavior despite frequent encounters with the HCPs. Among those who had interventions, 67.9% had 'very brief interventions', where the HCP provided information on adverse health effects of alcohol consumption and requested patients to reduce or abstain from drinking. Medical officers (MOs) were involved in 85.7% of instances and nursing officers (NOs) in 14.3%. In 32.1% with PD, referrals were made to specialist psychiatry services for long-term treatment and follow up. A high proportion of those who consumed alcohol had PD. Though the problem drinkers require intensive, focused alcohol cessation interventions, most did not receive interventions at all or received only very brief interventions which are unlikely to help overcome PD. Though in many countries alcohol cessation services are manned by members of the medical team other than doctors, such as nurses, their involvement was minimal in the hospital in Southern Sri Lanka considered for the present study.

Key words: alcohol abuse, alcohol dependence, health care professionals, Interventions, problem drinking

Corresponding Author: diroshiprathimaf@yahoo.com

Prevalence of Sarcopenia in a Group of Middle Aged Women from Galle, Sri Lanka

N. Rathnayake [a], *, G. Alwis [b], J. Lenora [c] and S. Lekamwasam [d]

[a] Department of Nursing, Faculty of Allied Health Sciences, University of Ruhuna, Sri Lanka.
[b] Department of Anatomy, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Department of Physiology, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[d] Department of Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka

Abstract

Sarcopenia is a syndrome characterized by progressive loss of muscle mass, muscle strength and physical performance. Relative appendicular skeletal muscle mass index (RSMI), hand grip strength (HGS) and gait speed (GS) are the established measures of sarcopenia correspond to muscle mass, muscle strength and physical performances. This cross sectional study was aimed to evaluate the prevalence of low muscle mass, muscle strength, physical performance, sarcopenia, its severities and sarcopenic obesity in a group of healthy middle-aged women selected from Galle, Sri Lanka. Randomly selected 270 community dwelling women aged 41.0-60.0 years were studied. Appendicular skeletal muscle mass (ASMM=sum of skeletal muscle mass of all four limbs in kg) and fat mass (kg) were determined by DXA scan. ASMM adjusted for height (ASMM/height square) was referred as RSMI (kg/m^2). HGS (kg) and GS (m/s) were measured and fat percentage was calculated. Prevalence of low muscle mass, muscle strength, physical performance, pre-sarcopenia, sarcopenia, severe sarcopenia and sarcopenic obesity were determined using cutoff values obtained from previous studies. Mean(±SD) age of the participants was 52.2(±5.84) years. Out of 270 study participants 166 (61%) were postmenopausal and mean (±SD) age of menopause was 48.25(±3.98) years. Overall group prevalence of low RSMI, HGS and GS were respectively 5.9%, 10.4% and 15.9%. Prevalence of pre-sarcopenia, sarcopenia, severe-sarcopenia and sarcopenic obesity was observed; overall group – 3.0%, 2.2%, 0.7% and 3.0%, postmenopausal women – 4.2%, 3.0%, 1.2% and 4.2% and premenopausal women – 1.0%, 1.0%, 0.0%, and 1.0%. Prevalence of these sarcopenic conditions was higher among women in 51-55 years age group (5.7%, 4.3%, 2.9%, 7.1%) compared to other age groups while women in group 41-45 years did not have any of above sarcopenic conditions. This study revealed a reasonable prevalence of sarcopenia among healthy community dwelling middle-aged women and menopause play a significant role in increasing of prevalence.

Key words: Middle aged women, Prevalence, Sarcopenia, Sri Lanka

Corresponding Author: *nirmala.priyanthi@email.com*

Tyrosinase Inhibitory Potential in Selected Medicinal Plants in Sri Lanka

M. Napagoda [a, *], M. Kumari [b], M.M. Qader [c], U. Samaranayake [b], S.G. De Soyza [a] and L. Jayasinghe [c]

[a] Department of Biochemistry, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Allied Health Science Degree Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] National Institute of Fundamental Studies, Hantana Rd., Kandy, Sri Lanka

Abstract

"Fair skin" is a desire of most of the women in Asian countries that demands the availability of skin-whitening cosmetic preparations. Tyrosinase is the key enzyme in the mammalian melanin biosynthesis and has been a long-term target in the field of cosmetics for skin whitening purposes. Although a variety of tyrosinase inhibitors are reported, only a few of them are being marketed due to various safety concerns. Therefore, as a safer alternative, there is an increased interest for plant-based natural skin lightening agents. Hence, the present study was undertaken to evaluate the tyrosinase inhibitory activity of methanol-water/methanol extracts of eight medicinal plants (*Acorus calamus, Averrhoa carambola*, *Clitoria ternatea*, *Sesbania grandiflora*, *Nyctanthes arbor-tristis*, *Tagetes erecta, Leucas zeylanica* and *Mukia maderaspatana*) in Sri Lanka that have been widely employed in traditional medicine to improve the complexion and as treatment options for various skin diseases. The skin whitening effect of the extracts was determined by *in vitro* tyrosinase inhibitory assay while the antioxidant activity was evaluated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. Among the tested extracts, methanol extract of *T. erecta* and methanol-water extract of. *N. arbor-tristis* inhibited the tyrosinase enzyme $\sim$ 50% or higher at the initial concentration of 333.3 µg/mL in a micro-well. Except *A. calamus* and *M. maderaspatana*, all the other extracts have displayed an inhibition of the enzyme in the range of 10-27% at this concentration. The dose response study revealed an IC_{50} of 48.27 µg/mL for the most potent *T. erecta* extract. In addition, this extract has displayed strong antioxidant activity with an EC_{50} value of 14.82 µg/mL suggesting a possible correlation between tyrosinase inhibition and antioxidant activity. These preliminary findings revealed that Sri Lankan medicinal plant preparations have a high potential to be used as natural skin whitening agents. The identification of secondary metabolites in the active extracts and incorporation of the active extracts into topical formulation for further studies are in progress.

Key words: Antioxidant, Medicinal plants, Skin whitening, Tyrosinase

*Corresponding Author: mayurinapagoda@yahoo.com

A Potent Aromatase Inhibitor from the Leaves of *Croton oblongifolius* Roxb

K. Wijesekera*

BPharm Degree Program, Faculty of Medicine, University of Ruhuna, Sri Lanka

Abstract

Croton oblongifolius Roxb. is one of the plants that belongs to family Euphorbiaceae. Several species have been used in the traditional medicine systems in Asia, Africa and South America including *Croton tiglium* in Aurveda medicine in Sri Lanka. The plant used in the current study, *C. oblongifolius* has a long history in traditional Thai medicine for many applications such as for dysmenorrhea, as a purgative and to treat dyspepsia and dysentery. Diterpenoids are the major type of secondary metabolite found in this plant and they exhibited various structures, which include cembrane, labdane, clerodane, halimane, *ent*-kaurane, and neocrotocembrane. Many diterpenoids isolated from this plant possess interesting biological activities such as, cytotoxicity and Na+ K+-ATPase inhibitory activity. In the current study, a clerodane type diterpene, 15-Hydroxy-cis-*ent*-cleroda-3,13(*E*)-diene was isolated from a leaf extract of *C. oblongifolius* using several chromatographic techniques. Structure of the compound was elucidated by analysis of spectroscopic data (1D and 2D NMR, IR, UV, and MS). Antibacterial and cancer chemoprevention activities including aromatase inhibitory activity (AIA) and measurement of oxygen radical absorbance capacity (ORAC) were evaluated using standard procedures. The compound was inactive as an antibacterial agent even at a concentration of 100 μg/ mL. However, it exhibited aromatase inhibitory activity (AIA) with an IC_{50} value of 2.6 μM, which was in line with Ketoconazole, the reference drug with an IC_{50} value of 2.4 μM. Therefore, this compound is a promising drug candidate for the treatment of breast and ovarian cancers.

Key words: chromatography, cytotoxicity, diterpenoids, ORAC

Corresponding Author: kdwijesekera@gmail.com

Overweight and Obesity in a Group of Patients Awaiting Coronary Artery Bypass Graft

E.H. Silva [a], *, C.M. Wickramatilake [b], S. Lekamwasam [c], L.K.B. Mudduwa [d] and R. Ubayasiri [e]

[a] B.Sc. MLS Degree Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[b] Department of Biochemistry, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[c] Department of Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[d] Department of Pathology, Faculty of Medicine, University of Ruhuna, Sri Lanka.
[e] Teaching Hospital, Karapitiya, Sri Lanka.

Abstract

Obesity is one of the major risk factor of coronary artery disease (CAD). This study assessed the proportion of patients with overweight or obesity in a group of patients with CAD awaiting coronary artery by-pass graft (CABG) and its association with the duration of the disease. This was a cross-sectional study. A group of 32 consecutive males awaiting CABG, between the period of May 2017 to December 2017 at Teaching Hospital, Karapitiya was enrolled in the study. Their height, weight, waist and hip circumferences were measured using standard protocols. Body composition was estimated by Dual Energy X-ray Absorptiometry (DEXA). Mean age of the group was 55 (SD$\pm$7) years, with a mean body mass index (BMI) of 24.5 (SD$\pm$3.4) kgm-^{2}. Mean waist circumference (WC), hip circumference (HC) and Waist to hip (W/H) ratio were, 86 (SD$\pm$7.5) cm, 91.3 (SD$\pm$6.4) cm and 0.9 (SD$\pm$0.04) respectively. Duration of the disease ranged from 4 to 192 months. No significant relationships were observed between the duration of the disease and the different indexes measured (BMI, WC, HC, W/H, percentage body fat content). Thirteen (40.6 %) were overweight (BMI $\geq$25) and 1 (3.13%) was obese (BMI $\geq$ 30) according to WHO International classification of BMI, while 10 (31.2 %) were overweight (BMI $\geq$23) and 13 (40.6 %) were obese (BMI $\geq$25), according to the Asian BMI cut-off values. Eleven (34.4 %) had WC > 90cm, 27 (84.4 %) had W/H ratio of > 0.9 and 12(37.5%) showed percentage fat $\geq$30%. A considerable proportion of patients awaiting CABG are either obese or overweight despite the life style modifications advised. The prevalence varies according to the index used to define the overweight and obesity.

Key words: Body fat content, Body mass index, Coronary Artery Disease, Coronary artery bypass graft, Waist circumference

*Corresponding Author: eranga.silva@yahoo.com

Agriculture and Environmental Sciences

Host Defence Inductıon and Growth Promotıon of Chilli Using Eight Bacterial Antagonısts

H.B.P. Sandani [a], N.P. Ranathunge [b, *], G. Degrassi [c], P.L.N. Lakshman [d] and W.M.W. Weerakoon [e]

[a] Faculty of Graduate Studies, University of Ruhuna, Sri Lanka.

[b] Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

[c] ICGEB Laboratory, Buenos Aires, Argentina.

[d] Department of Food Science and Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

[e] Field Crop Research Institute, MahaIlluppallama, Sri Lanka.

Abstract

Plant defence induction and growth promotion are two main indirect mechanisms of microbial involvement in plant disease biocontrol. As the first approach, induction of the expression of three defence related enzymes Phenylalanine ammonia lyase (PAL), Peroxidase (PO) and Polyphenoloxidase (PPO) by an antagonistic *Bacillus* sp. was assessed in the *Capsicum annuum- Colletotrichum truncatum* patho-system. Four hundred chilli seeds, pre-treated with the antagonist were placed in a sterilized potting medium, and 200 of them were inoculated with *C. Truncatum* after 15 days, while the rest were not inoculated. In another separate set of chilli seeds, 200 were inoculated only with the pathogen and another 200 seeds were maintained as the control without any treatment. Chilli seedlings were sampled after 1,3,5,7 and 10 days of inoculation and tested for activity of PAL, PO and PPO. The second approach was to evaluate phosphate solubilisation, Indole Acetic Acid (IAA) production, siderophore production, exopoly saccharide production, swimming and swarming abilities of eight selected antagonists of *C. truncatum* as plant growth promoting traits. IAA production was assessed both qualitatively and quantitatively while other traits were assessed through qualitative plate assays. According to the results, the PAL, PO and PPO activities in all three treatments showed a significant enhancement ($p<0.05$) compared to the control. This implies that both antagonist and the pathogen are capable of inducing latent host defence mechanisms in chilli seedlings. A significantly higher induction of PAL and PO enzymes ($p<0.05$) was observed only in the seedlings, which were emerged from seeds pre-treated with the antagonist and challenge inoculated by the pathogen. An enhancement of the enzyme expression with significant differences among treatments, could be observed since the 7th day of inoculation. Results of the growth promoting traits revealed that, *Burkholderia arboris*, *Burkholderia rinojensis* and *Stenotrophomonas maltophilia* could solubilize phosphates. All eight antagonists of *Burkholderia* sp., *Bacillus* sp., *Pseudomonas* sp. and *Stenotrophomonas* sp. produced significant amounts of IAA. The two antagonists, *Pseudomonas aeruginosa* and *B. rinojensis* also produced iron chelating siderophores. None of the antagonists produced exopolysaccharides while

all the antagonists showed various degrees of swimming and swarming abilities. It can be concluded that bacterial antagonists used for this study have an ability to induce host plant defence with respect to *Colletotrichum truncatum* infection while promoting the growth of *Capsicum anuum* under the tested conditions.

Key words: *Bacillus sp., Capsicum anuum, C. truncatum, Defense induction, Growth promotion*

Corresponding Author: *nalika@agbio.ruh.ac.lk*

Evaluation of Properties of Extracellular Antifungal Metabolites Secreted by Four Antagonistic *Burkholderia* Strains for the Control of *Colletotrichum truncatum*

H.B.P. Sandani [a], N.P. Ranathunge [b, *], P. Ranasinghe [c], P.L.N. Lakshman [d] and W.M.W. Weerakoon [e]

[a] Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.
[b] Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.
[c] Industrial Technology Institute, Colombo, Sri Lanka.
[d] Department of Food Science and Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.
[e] Field Crop Research Institute, MahaIlluppallama, Sri Lanka.

Abstract

In the replete of biological disease management strategies, microbial antagonism is becoming a promising disease control tool used by scientists. Among various mechanisms extended by antagonists, production of extracellular antifungal substances is of greater interest. Properties of cell-free culture supernatants of four antagonistic *Burkholderia* sp. against chilli anthracnose causal agent, *Colletotrichum truncatum* was assessed in this study. These antagonists were found to produce diffusible antifungal substances for antibiosis against *C. truncatum*. Cell-free culture supernatants of six days old nutrient broth cultures, which were centrifuged twice at 12000 rpm for 20 minutes and filtered through a 0.22 μm millipore membrane were used for the study. The effect of each of the extracts on *C. truncatum* mycelial growth and spore germination was evaluated and their heat stability, durability at both 4 ºC and room temperature and their minimum inhibitory concentrations were also studied. All the selected antagonists were capable of producing and accumulating extra cellular antifungal compounds inhibiting the growth of *C. truncatum* within a five-day incubation period. Cell free culture supernatants contained 11.0 mg/ml total soluble solids. Culture filtrates of *Burkholderia multivorans* and *B. gladioli* isolates showed a remarkable thermostability at 120 ºC, while *B. arboris* and *B. rinojensis* culture filtrates were thermally stable up to 100 ºC. Cell-free culture supernatants of the antagonists retained their antifungal properties up to a maximum of 2 months at room temperature and up to 3 months at 4 ºC. Minimum inhibitory concentrations of culture filtrates of *B. multivorans*, *B. arboris*, *B. gladioli* and *B. rinojensis* were 4.85 mg/ml, 1.62 mg/ml, 7.42 mg/ml and 6.59 mg/ml respectively. Antifungal metabolites biosynthesized by *Burkholderia* sp. were mostly organic solvent soluble molecules, which could be extracted into ethyl acetate. The ethyl acetate fraction of the culture supernatant showed a minimum inhibitory concentration of 2 mg/ml on *C. truncatum* mycelial growth suppression. These properties of cell-free culture

supernatants produced by the antagonistic *Burkholderia* strains provide an excellent opportunity for chilli anthracnose disease management.

Key words: *Antagonists, Antifungal, Biological control, Burkholderia sp., Cell-free culture supernatants*

*Corresponding Author: nalika@agbio.ruh.ac.lk

Effects of Municipal and Agriculture-based Waste Composts on Crop Yield Response in an Ultisol of Low Country Wet Zone

I.S.U. Rupasinghe and D.A.L. Leelamanie *

Department of Soil Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

Abstract

Composting of wastes has become popular worldwide because it provides an organic fertilizer, when considering the continuous flow of municipal waste. Although municipal solid waste compost (MSWC) is commonly used for agriculture in many countries, Sri Lankan farmers are still reluctant to use it. On the other hand, the use of agriculture-based waste compost (AWC) is highly popularized. The objective of this study was to compare MSWC and AWC considering their effects on short-term crop yield response in an Ultisol. Seven MSWC samples (S1–S7) and two AWC samples (S8, S9) were used in the field at rates of 10 and 20 Mg ha^{-1}, with chemical treatment (inorganic fertilizer recommendation/Department of Agriculture) and a control (no amendment). Bush bean (*Phaseolus vulgaris*) was used as the crop. The average expected yield (Y$_{EX}$) of bush bean in Sri Lanka is reported to be 6000–10000 kg ha^{-1}. At the low application rate (10 Mg ha^{-1}) in most treatments including the chemical (except in S5, S7, S8), the yield of bush bean showed >50% of the Y$_{EX}$. Six of these treatments did not show any significant differences in yield ($p< 0.05$), where the highest yield was about 65% of the lower level of Y$_{EX}$ (6000 kg ha^{-1}). Considering the yields at both 10 and 20 Mg ha^{-1} rates, the highest yield obtained was about 60–65% of the lower level of Y$_{EX}$. Results revealed that the yield of bush bean with compost treatments were well below the lower level of Y$_{EX}$, in almost all the treatments. The P requirement of bush bean is not met as the available P levels in composts were originally low. The original available soil P levels were also low (1.84 mg kg^{-1}). Therefore, low P levels in compost might be the reason for the very low yield levels in all the treatments. However, when compared to recommended chemical fertilization, the compost application did not lower the yield, which might be a result of high leaching of nutrients due to sandy nature of soils. The 10 Mg ha^{-1} rate seemed sufficient to obtain substantial yield for bush bean at home garden levels under tested soil conditions. No significantly higher yields ($p< 0.05$) were observed with AWC compared with MSWC. Basic analysis of composts showed that the nutritive characteristics (N, P, K) of MSWC were not lower when compared with that of AWC. The study revealed that MSWC has performances comparable to, or better than, AWC, in contrast to the widely acknowledged opinion of Sri Lankan farmers on higher nutritive value and better crop productivity of AWC.

*Corresponding Author: *leelamanie@soil.ruh.ac.lk*

Soil Profile Moisture Distribution in Relation to Water Repellency in an Upcountry Eucalyptus Plantation Forest Soil in Sri Lanka

H.I.G.S. Piyaruwan and D.A.L. Leelamanie[*]

Department of Soil Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

Eucalyptus (*Eucalyptus grandis*) is grown in upcountry of Sri Lanka, with the objective of reducing the degradation of lands. In these soils, water repellency has been identified as a severe problem. Soil water repellency is a dynamic phenomenon, which is caused by organic matter present in soil and may affect all the hydrological properties and processes in soil. This study was conducted to examine the moisture content in the soil profile in relation to water repellency of soil in Eucalyptus plantations, using laboratory experiments and onsite soil moisture content determination. Soil samples were collected from 0–5, 5–10, 10–15 and 15–20 cm soil depths in four blocks (12 samples per block). Soil-water contact angles were determined by the sessile drop contact angle method using digital microscopic camera. Onsite volumetric water content (WC_V) was determined using TDR moisture meter. The soil water contact angle showed the highest value in the 0–5 cm soil layer (100±10°) and decreased gradually with the depth. The WC_V showed a range from about 10–22%. The average WC_V was high at the top (0–5 cm) layer. The WC_V first decreased with depth, and again increased, showing a moderate polynomial relationship (R^2 =0.43). The highest WC_V was observed in the 15–20 cm layer (16±2%), which was not significantly different from that of the 0–5 cm layer (15±4%). The lowest moisture levels were observed in the 5–15 cm depth (12±1%). The results revealed a moderate polynomial relationship between volumetric water content and water repellency in the soil. Eucalyptus dry litter and root exudates release high amounts of hydrophobic organic materials to the soil, resulting a water repellent feature. These hydrophobic coatings and interstitial organic substances act as barriers for free water movement through the soil pores resisting evaporation. In the lower layers, although water repellency was low due to less availability of organic materials, WC_V was high probably due to high clay content, which increased with soil depth. The restriction to removal of water from the top soil might affect the plant water uptake as well, limiting the growth of understory. Although this study was conducted during the wet season, when rainfall was abundant, water contents in the soil was very low (10-17%), confirming the impact of water repellency on the moisture levels of the soil profile.

Key words: Eucalyptus, Soil water contact angle, Soil water retention, volumetric water content

*Corresponding Author: leelamanie@soil.ruh.ac.lk

Supplementation of Rice Straw (*Oryza sativa*) Based Diet With Exogenous Xylanase: İntake, Diet Digestibility and Growth Rate of Goats

S. Sujani *, R.T. Seresinhe and I.N. Pathirana

Department of Animal Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

Abstract

The present study was conducted to examine the effect of supplementing rice straw based diet with exogenous enzyme xylanase on diet digestibility, growth performance and enteric methane production of goats. Two blocked groups of exogenous xylananse (EXY) and a control were used. The experiment was carried out for 60 days, i.e., a 10-day adaptation period, 40-day experimental feeding, 7-day total feces collection and 3-day methane measurements. Average daily gain (ADG; g / day / animal) in EXY group was significantly higher than the control group, where no difference was observed when ADG is expressed in terms of metabolic body weight. Intake of dry matter (DM; g / day / animal), organic matter (OM) and crude protein content (CP) were not significantly affected by EXY, but intake of neutral detergent fiber (NDF) improved significantly. Apparent DM, OM and NDF digestibility enhanced significantly while there was no difference observed in CP digestibility. Amount of CH_4 (ml /100 ml rumen gas) was not significantly different between EXY and control group though the value was numerically lower in EXY group. In conclusion, the supplementation of rice straw based diet with EXY for goats is beneficial in means of ADG, intake of NDF and digestibility of DM, OM and NDF.

Key words: Average daily gain, digestibility, intake, neutral detergent fibre

Corresponding Author: sujani@ansci.ruh.ac.lk

Metabolic, Ultra-Structural and Growth Responses of Nuttall's Waterweed *Elodea Nuttallii* (Planch) St. John When Subjected to Water Flow

K.S.S. Atapaththu [a]*, T. Asaeda [c, f], A. Miyagi [b], M. Kawai-Yamada [b], K. Atsuzawa[d] and Y. Kaneko [e]

[a] Department of Limnology and Water Technology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Graduate School of Science and Engineering, Saitama University, Sakura-Ku, Saitama, Japan.
[c] Department of Environmental Science and Technology, Saitama University, Sakura-Ku, Saitama, Japan.
[d] Comprehensive Analysis Centre for Science, Saitama University, Sakura-Ku, Saitama, Japan.
[e] Biology Section in the Faculty of Education, Graduate School of Science and Engineering, Saitama University, Sakura-Ku, Saitama, Japan.
[f] Research Institute of Chuo University, Kasuga, Bunkyo, Tokyo 112-8551, Japan.

Abstract

Importance of water movements on distribution and abundance of aquatic plants is well studied, but there is a dearth of information on its impacts on physiology, anatomy and biochemistry of these plants. Therefore, present study was carried out to investigate the growth, metabolism and ultra-structural changes in aquatic macrophyte *Elodea nuttallii* upon exposure to water flow (10 cm·s-1) for 30 days, compared to exposure to stagnant water as the control. Three replicates of five plants each were used for each treatment. At the end of the exposure period, shoot length of the plants were measured, and metabolic and ultra-structural changes were analyzed using capillary electrophoresis–mass spectrometry (CE-MS) and electron microscopy respectively. Shoot length appeared to be similar in both treatments but a flow oriented stream lined growth was exhibited in plants exposed to water flow. In the control group, only 12% of internodes were longer than 6 mm while in plants exposed to water flow more than 35 % of internodes were longer than 6 mm. Fructose-6-phosphate, glucose-1-phosphate, glucose-6-phosphate, phosphoenolpyruvate, ribose-5-phosphate and cinnamate contents were significantly higher in flow treated plants when compared to controls. Content of all other metabolites were similar in both treatment groups. These findings offer insights to understand the interactions between water flow regimes and the functions of aquatic plants and such information would help aquatic ecosystem management.

Key words: Elodea nuttallii, internodes, metabolites, shikimate pathway, Water flow
Corresponding Author: keerthi@fish.ruh.ac.lk

Importance of Cyclone Induced Vertical Mixing: A Case Study on Tropical Cyclones Maarutha and Mora in the Bay of Bengal

U.P.G. Pathirana [a, b], G. Chen [a], D. Wang [a] and T. Priyadarshana [b, *]

[a] State Key Laboratory of Tropical Oceanography, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China.
[b] Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.

Abstract

Time series measurements from the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) mooring at 15°N, 90°E in the vicinity of the cyclone passage Maarutha and Mora, are used to investigate the upper ocean variability, variations of the cyclone heat potential (CHP) and the importance of cyclone induced vertical mixing (VM) in the Bay of Bengal (BoB) during April-May 2017. Maarutha initially developed on 15th April 2017, intensified on 16th and dissipated at Myanmar on 17th. Mora initially developed on 27th May 2017, intensified on 28-29th and dissipated on 30th May 2017. Shallow mixed-layer depths (MLD), relatively strong stratification and high sea surface temperatures (SST) are obvious during pre-monsoon period in the BoB. The analysis revealed a large SST drop by ~1.53 °C, decrease of surface salinity ~0.19 psu, deepening of MLD and isothermal-layer depth (ILD) by ~18.1 m and ~30.9 m, respectively, due to Maarutha. A similar upper ocean response was observed during Mora. Strong turbulent mixing due to strong winds and currents led to the deepening of MLD and ILD which facilitated the VM (entrainment and vertical diffusion) of colder water. Under the influence of Maarutha and Mora, VM was enhanced by ~95.4 Wm^{-2} and ~220 Wm^{-2} and the associated cooling effect caused for the decrease in CHP by ~22.55 $KJcm^{-2}$ and ~22.29 $KJcm^{-2}$, respectively. Thus, the SST cooling associated with cyclone induced VM tended to inhibit the cyclone intensification itself and emphasized the importance of upper ocean dynamics during the passage of a cyclone. Therefore, the SST-intensity (warming/cooling) feedback and variability of CHP under the influence of VM is of practical importance for BoB cyclones. This brings the necessity of a long-term basin-scale study on the role of upper-ocean dynamics during cyclones in the BoB.

Key words: Bay of Bengal, Cyclone Heat Potential, SST, Vertical Mixing

Corresponding Author: tilakgamage@gmail.com

A Coral Based Study Reveals Extreme Paleo-oceanographic Events of the Recent Past

W.M.M. Weerabaddana [a], P.N. Ranasinghe [a, *], C. Manfrino [b] and Y.P.S. Siriwardhana [c]

[a] Department of Oceanography and Marine Geology, University of Ruhuna, Sri Lanka.
[b] Central Caribbean Marine Institute, PO Box 1461, Princeton, NJ 08542, USA.
[c] Geological Survey and Mines Bureau, Epitamulla Rd., Pitakotte, Sri Lanka.

Abstract

Northern sea of Sri Lanka is very representative of Northern Indian ocean with co-variability in the South China Sea and El-Nino region of the East Pacific, thus making Sri Lanka a desirous location for Paleo-oceanographic studies. North of Sri Lanka is highly influenced by the oceanographic changes of Bay of Bengal and harbour imprints of extreme oceanographic events of the past. Long lived corals carry images of its environment where it had been living, in terms of geochemical imprints. Hence skeleton of corals are diagnostic in determining past environmental conditions. This particular study used coral growth rate, Sr/Ca ratio and Mg/Ca ratio in determining extreme events of the recent past of Northern Indian Ocean. A coral core of 50cm was drilled through the main growth axis of a massive *Porites lobata* head at Point Pedro (PP). It was sliced into a 6mm slab along the growth axis and its X-radiograph revealed a continuous chronological history of 36 years from 1981 to 2016. Micro samples of 2mg weight were collected from each annual growth band and analysed in an ICP-OES for stable isotopes. Sea Surface Temperature (SST) derived from Sr/Ca and Mg/Ca paleo thermometric proxies were observed against time. A sudden increase of SST was observed during 1997/1998 followed by the death/bleaching of the coral which started regenerating/recolonizing in 2001. It was clearly identified as the strongest El-Nino of the century which affected Indian Ocean during 1997/1998 period which was responsible for mass bleaching and death of many coral reefs around Sri Lanka. During the 1980's average growth rate of *Porites lobata* was 15.63 mm/yr and it has been decreased up to modern average growth rate of 13.3 mm/yr. Increase in SST over the past must be the reason for reduced growth.

Key words: Corals, El-Nino, Growth rate, Sea Surface Temperature, Sr/Ca

*Corresponding Author: nalakaranasinghe@hotmail.com

Possible Application of *Bacopa monnieri* to Treat Wastewater with Textile Dye at Moderately High Salinity Conditions

E.P. Hapuarachchi, R.A. Maithreepala * and U.A.D. Jayasinghe

Department of Limnology and Water Technology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.

Abstract

In general, textile dying process release a large amount of waste water with high pH and salinity as during the process considerably high amount of salt is added. Moreover, salt is further added to wastewater along with coagulating agents to increase the precipitation of dye-stuff during the chemical treatment process. Bitter salt (Magnisum sulphate), a by-product of salt inductry is known to increase precipitation in textile dye effluents. As *Bacopa monnieri* (Lunuwila) can grow at considerably high salinity levels, this research checked the possibility of using *B. monnieri* as a phytoremediation agent for the treatment of wastewater from textile industry. Two laboratory level treatment setups were prepared using $FeSO_4$ (Ferous alum) and $MgSO_4$ (bitter salt) for comparing the treatment efficiencies of *B. monnieri*. The preliminarily treated dye effluent was used in the experimental treatment setups. Batch system experiments were conducted by using hydroponic system in black coloured trays (size 35 cm*128 cm) and messed trays (size 18 cm*25 cm) with *B. monnieri* under ambient condition for a period of five weeks. In order to determine the optimum amount of coagulating agent a simple jar test was done. Three replicates each for ferrous alum treatment and bitter salt treatmentswere prepared. Heavy metal (Cu^{2+} and Pb^{2+}) concentrations, and chemical oxygen demand (COD) of effluent before and after phytorededediation were determined. Maximum salinity level that the plant could grow was 6.97 g/L. Maximum heavy metal removal efficiency for Pb^{2+} was 18 % and 11.5% in Ferrous Sulphate and bitter salt treated systems, respectively. Maximum Cu^{2+} removal efficiency was 65% and 85%, respectively. Further, the maximum COD removal efficiency was 70.18% and 69.7%, respectively. These findings suggested that the use of B. monnieri in high salinity hydroponic systems is effective for reducing heavy metal (Cu, Pb) and COD levels in effluents from textile dying process.

Study on Geological and Chemical Factors Controlling Calcite Deposition in Natural Waters (Tufa) at Handagiri Ella, Balangoda, Sri Lanka

G.E.D. Jayalath [a], R.A. Maithreepala [a, *] and G.R.L. Kodikara [b]

[a] Department of Limnology and Water Technology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Department of Oceanography and Marine Geology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.

Abstract

Imbulamure and Godakumbura are main springs that generating two creeks parallel to each other and joining at the downstream for feeding Handagiri Ella water fall located at Kalthota in Ratnapura district. Handagiri Ella is the only water source for the down stream vilage called Handagirigama where people use the surface water from streams and shallow wells fed by Handagiri Ella. However, there are several proposals to set up a minihydropower project constructing a dam at upstram of water fall and release water to downstream village bypassing the water fall. The objective of this study was to investigate the chemical processes and geological aspects affecting the natural cleaning process at the water fall system. Two cross section maps were drawn for both creeks to determine the gradient of the flow path. Fifteen sampling sites for Imbulamure creek and nine sampling sites for Godakumbura creek were selected. Physico-chemical parameters including pH, conductivity, temperature, dissolved oxygen concentration, alkalinity, total hardness and flow rate of water were measured. Total Fe, Mn, Mg, Ca and Cu concentrations of pre-acidified water samples and digested soil samples were measured by using atomic absorption spectroscopy. The crystalline structures of depositions in the upstream, downstream areas and two caves located in the mid stream sites were tested by XRD-analysis. The calcite saturated level of water was derived using the Langelier Saturation Index.The results indicated that the springs contain high bicarbonate concentrations (4-10 ppm) bringing out mineral rich ground water. The springs contained high iron concentration (7.13 ppm) and deposited as oxidized form near the springs giving yellow-brown color soon after having exposed to the atmospheric oxygen. The water in the upstream sites were below the supersaturating state (< 0.5 Langelier Saturation Index) with respect to the $CaCO_3$ saturation. Ca^{2+} and HCO_3^- concentrations of water at upstream (Godakumbura 63.85, 4.00ppm and Imbulamura 61.00, 10.00ppm) was higher than downstream (Godakumbura 45.28, 1.6ppm and Imbulamura 21.3, 2.8ppm). This decrease of concentrations perhaps was due to calcite deposition at the midstream sites at the water falls. A statistical analysis showed that water conductivity, bicarbonate and iron concentrations had a positive correlation with the calcium concentration whereas pH had a negative correlation with the iron concentration. At the

supersaturated state, the activity of iron on active sites of calcite might inhibit the deposition at the upstream. Therefore, a thick calcite layer could be observed at the cascade system and in the water falls compared to the upstream. This result revealed that there was a natural purification process occurring within the midstream. If the upstream water would be pumped directly to the down stream by a minihydropower project, mineral rich water without purification will be there in the downstream.

Key words: Calcite depositions, Iron oxides, Langelier Saturation Index, Supersaturating state

Corresponding Author: maithree@fish.ruh.ac.lk

Spatial and Temporal Patterns of Drought in Hambantota District Using the SPI Index

P.H. Amaraweera [a, *], J. De Silva [b] and S.K.M. Ali [a]

[a] Department of Geography, University of Ruhuna, Sri Lanka.
[b] Department of Geography, University of Colombo, Sri Lanka.
[a] Department of Geography, University of Ruhuna, Sri Lanka.

Abstract

Drought is a natural hazard that has significant socio-economic and environmental impacts and it is universally acknowledged as a phenomenon associated with scarcity of water. The Standardized Precipitation Index (SPI) can be used to indicate the associated spatial and temporal rainfall variation. The objective of this study is to assess the drought in Hambantota district using SPI index with three-time scales. The study used monthly precipitation data collected from 17 meteorological stations in the district for the period from 1961 to 2014. The data were analysed using the SPI calculator (SPI SL 6.exe) introduced by the National Drought Mitigation Centre (NDMC). The results have shown in terms of spatial distribution of drought frequency, the temporal pattern of occurrence, duration, magnitude and intensity of drought. The findings revealed that frequency in occurrence of drought was increasing over the time scale within the district. The persistent low rainfall, high rainfall variability and erratic rainfall, which were identified throughout the district have influenced significantly for the continuous occurrence of droughts in the Hambantota district. There have been mild, moderate, severe and extreme drought events and it revealed that there could be a higher probability of frequent occurrence of mild droughts than moderate, severe or extreme droughts in all stations. Extreme drought could be identified in western, north-western and northern parts of the district, whilst severe drought in the eastern and north-western parts and moderate droughts occurring in the central region. More frequent mild drought could be observed in northern, southern and central parts of the district. The results have also shown that there was a strong correlation between the drought duration and magnitude in the Hambantota district during the time period considered in the present study.

Key words: Droughts, Standard Precipitation Index, special distribution, frequency, Hambantota district

*Corresponding Author: palitha.amaraweera@gmail.com

Diversity and Ecosystem Health of Inland Mangrove Forest in Garanduwa Lagoon, Southern Province, Sri Lanka

K.R.G.M. Gunarathne [a], K.A.S. Kodikara [b, *], K.H.H. Niroshana [a], S.K. Madarasinghe [b] and L.P. Jayatissa [b]

[a] Department of Oceanography and Marine Geology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Sri Lanka.
[b] Department of Botany, Faculty of Science, University of Ruhuna, Sri Lanka.

Abstract

Mangrove forests along the Sri Lankan coastline have extensively been studied although Garanduwa inland mangrove forest in the southern province received very little attention. Therefore, this study was conducted to investigate the species diversity, plant density and community structure in order to understand health of this inland mangrove. The lagoon vegetation and the variation of edaphic factors were studied along seven belt transects (5 m × ~50 m) selected to represent the entire mangrove stand. The results showed that Garanduwa lagoon only consists of two true mangrove species; *Bruguiera sexangula* (Lour.) Poir.which forms larger monospecific stands and *Sonneratia caseolaris* (L.) Engl. which is sparsely distributed. Mangrove fern, *Acrostichum aureum* L. had a scattered distribution. The plant density in mangrove area was 2.2 m^{-2} and the plant diversity was low (Simpson's index: 0.019). Larger trees of the dominant species, *B. sexangula*, were rare and the mean height and girth of the plants were 2.4±0.8 m and27.5±2.9 cm respectively, indicating a higher exploitation of mangrove timber from the stand. No conspicuous stratification was observed. High seedling bank of *B. sexangula* was present in the mangrove. The mean salinity and pH of soil were 2.0±1.0 psu and 6.4±0.3, respectively and no variation of salinity and pH was recorded along transects. The lagoon is located about 3.5 km away from the sea and connected to the sea through a narrow 1 km long canal, Udupila Ela. Presently, the canal is almost blocked due to the establishment of settlements and dumping of waste. This completely restricts tidal inflow, forming a freshwater dominated lagoon which is further confirmed by the low saline regimes, recorded. These hydrological changes may have caused low saline species to be dominant over the true mangrove species. Unless, necessary actions are taken to facilitate natural recruitment in the lagoon (restoration of hydrology), it will be difficult to restore new plant species in order to increase bio diversity of this stand.

Key words: Ecology, human pressure, hydrology, plant density, species diversity

*Corresponding Author: sunandaruh@gmail.com

Use of Coastal Morphometrics for Determination of Spatial Changes and Damages from Tsunami of 2004 on Southern Coastal Area of Sri Lanka

S. Wijeratne *

Department of Geography, University of Ruhuna, Sri Lanka.

Abstract

Morphometric features are important to differentiate the tsunami process and the damages due to tsunami waves. Three specific parameters affect such changes and they can be categorized as indentedness, plan curvature of the coastline and orientation of the coast. The indentedness of a coast basically forms various kinds of coastal features such as, pocket beaches, baylets, lagoons, estuaries, Islands, headlands and sea cliffs. Depending on these natural features, the force of waves is refracted or reflected. Natural shape of a coastline may be arcuate, straight or irregular where there are bed rocks or other interferences. Arcuate may be concave or convex. Convexity and concavity can be recognized spatially, in the indentedness coastlines. According to the location of morphological features such as, bedrocks, headlands, sand dunes, sea cliffs and estuaries, the plan curvature would be different, and it was concave, convex or straight. These morphological features influence the function of tsunami waves as well as normal sea waves. Orientation is significant in terms of the direction of a wave that approach. This can be determined by measuring the direction in which perpendicular seaward to a straight line that link adjacent headlands or coastline protuberances is aligned. Coastal orientation affects the directional incidence of tsunami waves as well as normal sea waves and winds. Therefore, approaching waves are refracted or reflected depending on the angle of waves, that is created by the orientation of the coastline and it causes to change direction of wave refraction approaching by various directions. The function of these three factors caused to change the tsunami process and the impacts have been analyzed using IKONOS Satellite Images and GIS Techniques. "I" index is used to measure indentedness value, which is the main morphometric characteristic that influence to change the tsunami process quantitatively. It was determined by using the formula $I=(L/Dx100)-100$ (Swan, 1974;1983). Beach plan curvature values in most beaches in the Southern coastal areas range from 10 to over 100 and, it has been described using the same formula as for indentedness or in terms of L/D alone. The changes of coastal orientation have been measured in degrees in order to investigate the behavior of tsunami waves on coastal areas. On the basis of these analyses, the level of damages and changes of tsunami were identified and according to them the level of the damages or changes, have been classified as high, moderate, low, not affected or not damaged.

Key words: Morphometrics, tsunami, plan curvature, indentedness, orientation

*Corresponding Author: samanwijeratne@yahoo.com

Relationship between Crop Yield and the Aggregate Stability of Organic Manure Amended Red Yellow Podzolic Soils

T.D.P. Liyanage[*] and D.A.L. Leelamanie

Department of Soil Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

Soil aggregate stability is identified as an important ecosystem property, which can directly affect the crop yield through facilitating the plant growth. However, some researchers have shown that the aggregate stability is not a useful and reliable predictor of primary productivity of crops. The objectives of the present study were to explore the relationship of stability of soil aggregates to the crop yield and the harvest index of the organic manure amended red yellow podzolic soils. A field experiment was conducted by establishing bush beans (Variety: Thai Bush) in different organic manure amended plots. Each plot was amended with 5% (dry basis) of cattle manure, goat manure, *Gliridicidia sepium* leaves, and recommended chemical fertilizer mixture separately. A non-amended (control) plot was also prepared. Another set of plots were prepared by mixing 2% of *Cassuarina equisetifoloia* (CE) leaves with 5% of each manure type separately in order to increase the aggregate stability via hydrophobic effects compared with only 5% organic manure amended plots. At the end of the crop growth, the fresh yield was measured. The harvest index was calculated using the dry matter of shoot and root biomasses. The stability of soil aggregates was determined using the wet sieving apparatus (Eijkelkamp). Data were statistically analyzed using ANOVA. According to the results, the yield of the tested samples showed a positive polynomial relationship ($R^2 = 0.67$) with the stability of soil aggregates. The regression output of the two variables were statistically significant at 0.05 probability level. The yield, aggregate stability, and the harvest indices of almost all the samples with 2% CE were significantly higher than those with only 5% corresponding organic manure. This might be because the addition of 2% CE increased the aggregate stability of soils due to its hydrophobic effects as explored by number of previous studies on Sri Lankan soils. The harvest index of the samples also increased with the increasigng aggregate stability. It can be concluded that the increased aggregate stability could have a positive influence on the economical yield and it could be a good predictor of yield in the context of organic manure amended red yellow podzolic soils. Further, it is noted that CE is a good agent for promoting aggregates.

Key words: aggregate stability, harvest index, red yellow podzolic soils, yield

Corresponding Author: liyanage@soil.ruh.ac.lk

Effect of Different Colchicine Concentrations and Durations on Shoot Regeneration from Callus of *Exacum ritigalensis* (Binara)

P.C.D. Perera[*]and N. Dahanayake

Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

The mitotic inhibitors, colchicine and oryzalin, can be used for callus formation, adventitious bud production, and tetraploid plant initiation in floriculture industry. The callus from *Exacum ritigalensis* (0.5 cm^2) explants were introduced to Murashige and Skoog basal medium (MS) containing 2 mgL^{-1} 6-Benzylaminopurine (BAP) with different colchicine concentrations (0, 10, 20, 30, 40 and 50 mgL^{-1}) and durations of 0, 12, 24, 36 and 48 hours. After treatments, they were transferred to MS basal medium containing 2 mgL^{-1} BAP without colchicine. All treatments in the experiments were arranged in Completely Randomized Design (CRD) with five replicates. Numbers of days to shoot formation, number of shoots per callus and mean height of shoot (cm) were recorded after eight weeks. Statistical analysis was carried out using Duncan's multiple range test of SAS software (version 9.1.3). The results showed that the calluses exposed to all colchicine concentrations for longer durations (48 hours) turned to brown colour after three to four days without regeneration of shoots. The treatment of 24 hours in 40 mgL^{-1}, 36 hours in 30 mgL^{-1} and 40 mgL^{-1} colchicine did not produce shoots. Except the time duration of 12 hours in 10 mgL^{-1} colchicine and the control, other treatments took more than 22±1 days for shoot regeneration. The results revealed that increased colchicine concentration and duration of exposure, significantly decreased the shoot regeneration ability from the callus of Binara

Key words: callus, colchicine, Exacum ritigalensis, regeneration ability

Corresponding Author: chathura@agbio.ruh.ac.lk

Non-destructive and Rapid Detection of Paddy Hardness by Using Shortwave Near Infrared (SW-NIR) Spectroscopy

M.G.G Awanthi [a], [*], B.M.S Jinendra [a], S.B. Navaratne [b] and C.M. Navaratne [a]

[a] Department of Agricultural Engineering, Faculty of Agriculture, University of Ruhuna, Sri Lanka.
[b] Department of Food Science and Technology, Faculty of Applied Science, University of Jayawardhanapura, Sri Lanka

Abstract

Quality of rice depends upon large number of factors in a paddy production and processing line-up from farm to table. Hardness of paddy is one of the primary indicators for rice which holds the integrity to be performed better during milling process preserving quality and the quantity. Most of the prevailing methods for detecting paddy hardness where the impact force at the breaking point of grain is measured, are destructive and time consuming. This study evaluates Near Infrared (NIR) Spectroscopy, which has been successfully employed in quantifying various physiochemical properties of rice in rapid and non-destructive mode for detection of paddy hardness. Samples were obtained from AT-362 rice variety stored under four different temperatures (26^0C, 30^0C, 34^0C, 38^0C) for 6 months. Total number of 1152 spectra were obtained through a SW-NIR Spectrometer FQANIR Gun (588-1100nm) using 12 samples per treatment per month, which included 4 replicates. Digital force gauge (Model-500B) with electric vertical stand (SJX-2KV) was used to measure the reference paddy hardness. The experiment was repeated for 20 individual paddy grains for validation. The acquired spectra were first evaluated by Principal Component Analysis (PCA) to remove possible outliers. Then filtered spectra were introduced into Partial Least Square (PLS) calibration model in Pirouette 4.5 software to construct the prediction models for hardness. It was found that lowest standard error of calibration (SEC) as 1.222 and highest correlation coefficient of calibration, (R^2) =0.9407 could be obtained when using mean-centred pre-processing and align math transformation in the software. Further, validation results were obtained as standard error of validation (SEV= 1.304) and correlation coefficient of validation (R^2=0.934). The regression vector coefficients indicated that wave bands; 645, 707, 709, 981, 987and 997nm highly contributed for hardness prediction. As such, this research has successfully demonstrated the potential possibility of using NIR spectroscopy as a non-destructive and rapid detection tool to detect paddy hardness.

Key words: Hardness, Near Infrared, Non-destructive, Paddy, Spectroscopy

*Corresponding Author: mggawanthi@gmail.com

Nitrogen Mineralization Dynamics in an Ultisol of Sri Lanka with Two Different Organic Amendments and a Microbial Inoculant

S.R. Amarasinghe [*], **K.A. Nisansala and S.D. Wanniarachchi**

Department of Soil Science, Faculty of Agriculture, University of Ruhuna. Sri Lanka.

Abstract

Organic amendments can be used in sustainable soil fertility management. These amendments are profoundly affected by different microorganisms, which help to convert nutritionally important elements such as nitrogen (N) and phosphorus (P). In agricultural lands the N availability is often limited. Hence, it is important to introduce microbial inoculum with organic amendments as these are mineralized by microorganisms to release N. This study was conducted to understand the N mineralization dynamics in soil after adding different organic amendments and a microbial inoculant which was prepared using cow dung. Two organic amendments were used with and without microbial inoculant. To compare the results urea was used as a treatment. A soil classified as the order Ultisol and a red yellow podzolic soil which was collected from the Faculty of Agriculture, University of Ruhuna. The air-dried and sieved soil was pre-incubated in 60% of the field capacity for 2 weeks before implementing the treatments. Eight treatments were tested with the mixing rates of compost10 t/ha with and without inoculum, *Gliricidia sapium* 5 t/ha with and without inoculum, and urea 100 kg/ha with and without inoculum. The microbial inoculant was used at the rate of 500 L/ha for each treatment. The control soil was incubated without incorporating any amendments or inoculum. Statistical analysis was done using SAS package. The N mineralization of each treatment was determined by analysing NH_4^+-N and NO_3^--N during 2, 5, 7, 14, 21 and 36 days after incubation in a laboratory study. The highest total mineral nitrogen was released from *Gliricidia* amended soil (37.6 mg N kg^{-1}) during the 36 days of incubation, while control soil released the lowest amount of total mineral nitrogen. The total mineral nitrogen increased with time in soils irrespective of the treatment except during the 5th day and 14th day of incubation. The highest net mineralization has occurred during 14 days of incubation in all the treatments, with the highest value reported in *Gliricidia* amended soil without microbial inoculum. Differences in N mineralization was attributed to the differences in characteristics and composition of the amendments added. Further field experiments are required to confirm the results of the above laboratory incubation study as in field conditions, micro-organisms may change mineralization according to other field factors.

Corresponding Author: *rajika@soil.ruh.ac.lk*

Performance of Phosphate Solubilizing Bacteria by Their Effects on Lead (Pb) Toxicity

R.H.A.N. Hettiarachchi and B.C. Walpola *

Department of Soil Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

Lead (Pb) is regarded as a potent occupational toxin and its toxicological manifestations are well known. The non-biodegradable nature of Pb compounds is the prime reason for its prolonged persistence in the environment. When the soil is contaminated with Pb, plants would absorb it as it's a persistent contaminant. Being a heavy metal, Pb is causing severe adverse effects through concentration at the ends of the food chains. Pb poisoning can be managed by using physical, chemical and biological methods. Biological detoxification is defined as enzymatic degradation or transformation of toxins that directs to less toxic products. However, a complete understanding of how these detoxification mechanisms influence metal tropic transfer is lacking. Microorganisms play an important role in the environmental fate of including Pb. Among the heavy metals, arsenic and lead are considered to be extremely toxic to all form of life. Harmful influences of heavy metals were observed on the physiological activity of microorganisms in natural habitats. Phosphate Solubilizing Microorganisms (PSMs) have specialized attributes for conversion of insoluble forms of phosphate to soluble forms via methods such as mineralization and solubilization. This study was conducted to identify the ability of the PSMs to grow in the presence of Pb. The agricultural soil was used to isolate the Phosphate solubilizing bacteria and isolation was done by using National Botanical Research Institutes Phosphate (NBRIP) medium. Fourteen phosphate solubilizing bacteria isolates were found and their resistance to Pb was tested in media having 100 ppm, 200 ppm, and 400 ppm lead concentrations in compound of lead acetate $(CH_3COO)_2Pb.Pb(OH)_2$. Survived isolates of bacteria were extracted and used to determine the phosphate solubilization under Pb toxicity. Bacterial isolates were re-inoculated into NBRIP broth medium. Phosphorus solubilization, growth, and pH were monitored after 1, 3 and 5 days. Among 14 isolates 11, 10 and 7 isolates were survived in 100 ppm, 200 ppm and 400 ppm Pb concentrations respectively. Seven isolates from 400ppm Pb toxicity level were used for further analysis of Phosphorus solubilization. Among them, PSB-8 isolate showed a vigorous growth under highest Pb concentration and has solubilized 72.02 ppm phosphate.

Key words: Lead toxicity, Soil bacteria, Phosphate Solubilization, toxicity tolerance

Corresponding Author: buddhiwalpola@yahoo.com

Social Sciences and Management

How Gender of the Consumer Shapes the Purchase Intention of the Celebrity Endorsed Crisis Brand after Product Harm Crises: A Case Study in the Faculty of Agriculture, University of Ruhuna

G.C. Samaraweera *

Department of Agricultural Economics and Extension, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

Celebrity endorsement as one of the product harm crises management strategies is emerging in the business world today. Company spends Millions of Dollars for celebrity endorsers to enjoy the financial benefits from a particular product or a brand. In recent years, usage of celebrities is increasing at an accelerating rate in order to regain the financial sustainability particularly during a sudden and unexpected financial loss. Therefore, the main objectives of the current study are to explore how celebrity endorsement shapes the purchase intention of the crisis brand after a product harm crisis and to work out how gender shapes this link after a product harm crises. A self-administrated, pre-tested questionnaire survey was conducted for the sample of 51 final year undergraduate marketing and business management specializing students of the faculty of Agriculture, University of Ruhuna, Sri Lanka. Questionnaire explained about two situations; control and the experiment. First, fictitious product harm crisis scenario related to the fictitious yogurt brand was documented as a control, followed by consumer purchase intention questions. Then in the experimental situation, the same purchase intention questions were documented in conjunction with celebrity endorsement, where the celebrity was used to resell the crisis brand. Data were analyzed using SPSS (version 20.0). Results of the AVOVA revealed that celebrity endorsement is an effective strategy that a wounded company can use in order to enhance the purchase intention of the crisis brand especially with respect to female consumers. Female consumers exhibited higher purchase intention (M= 5.67) than their male counterparts (M=3.36) with high significant level (p=.000). Therefore, the present study reveals the significance of using celebrity endorsers particularly in women specific brand crisis. This study is partcularly of great significance to the crisis managers, marketers and policy makers.

Buddhist Teachings and Modern Consumption Theories in Economics

N. Keembiyahetti [*]

Department of Economics, University of Ruhuna, Sri Lanka

Abstract

Buddhist economics is a spiritual approach to economics. It examines the psychology of the human mind to clear the confusion about what is harmful and beneficial in the range of human activities involving production and consumption, and ultimately tries to make human beings ethically mature. On contrast, modern Economics tries to improve material wellbeing of the people. Modern economic theories attempt to maximize even mental satisfaction of the people known as utility subject to availability of tangible physical resources. Thus Buddhist economics and modern economics are different both in ultimate goal and the strategies used to achieve the targets. Despite such differences, a careful study will reveal that a considerable portion of modern economics theories have been borrowed from Buddhist philosophy. This study argues that the well-established consumption theories of modern economics have been conceptually originated in the essence of Buddhist philosophy 2600 years ago and are not novel as interoperated by western economists. In economics doctrine, it is accepted that the first ever consumption theory has been developed in 1930s by John Maynard Keynes, a British economist. In the early 1950s, Franco Modigliani and his student Richard Brumberg developed Life Cycle Theory of Consumption. Modigliani's life-cycle theory is a fine piece of theory, supported by many years of empirical work. Nevertheless, this paper logically argues that the origin of those consumption theories dates back to 2600 years where the Buddha preached *"Singalowada Suthra"*, in which he stated "*ekena bhoge Bhunjeyya, Dvihi kamman payojaye, thathuchchancha nidapeyya, apadasu bhavissathi"*. By analyzing phrases from the *Singalowada Suthra* the researcher shows that how the concepts of consumption, savings and dissaving in modern consumption theories comply with Buddhist teachings.

Key words: *Consumption, Savings, Life Cycle Theory, Buddhist Philosophy, "Singalowada Suthra"*

Corresponding Author: *nandasiri2007@gmail.com*

Dynamic Linkages between Government Budget Deficit and Trade Deficit: Evidence from Sri Lanka

U.N. Kariyawasam *

Department of Economics, University of Ruhuna, Sri Lanka

Abstract

The current account deficit and the government budget deficit have been important characteristics of Sri Lankan economy over the past decades. Positive significant relationship between budget deficit and current account deficit, which is termed as the Twin Deficit Hypothesis has been empirically tested for both developing and developed country contexts. Few researchers have examined this relationship for Sri Lanka using different approaches. However, there is a gap of a recent study on the co-movement of these two important macroeconomic variables. Therefore, this study aimed to test the validity of twin deficit hypothesis in Sri Lankan economy for the period of 1977 to 2016. Secondary data for current account deficit, government budget deficit and savings and investment balance are collected from annual reports of Central Bank of Sri Lanka. Unit root tests followed by the ARDL bounds test for Co-integration and Granger Causality test have been used for data analysis. Results of the ARDL co-integration test confirm the existence of a significant equilibrium relationship between government budget deficit and current account deficit in Sri Lanka, during the study period. It emphasizes the role of budget deficit in the determination of the current account deficit in Sri Lanka. Therefore, this research suggests policy makers to focus on fiscal consolidation and tightening as a powerful tool for correcting current account problems in Sri Lankan economy.

*Corresponding Author: udari.niranjala@yahoo.com

Contribution of Migrant Workers to Overcome the External Imbalance Crisis in Sri Lanka

K.K.S. Udaya Kantha[*] and S.K. Derwin

Department of Economics, University of Ruhuna, Sri Lanka.

Abstract

This study attempts to investigate the contribution of migrant workers to overcome the continuing external imbalance crisis in Sri Lanka. Migrant workers' remittances have become increasingly a significant source of foreign financing in Sri Lanka over the past few decades. Increase in remittances flows have greatly assisted Sri Lanka to minimize the difficulties arising from shortages of foreign financing. It has mainly offset the trade deficits in externally on the one hand and support to achieve the stability of several macro-economic variables in the economy internally on the other. In the long-run however, dependence on worker remittances to manage economy would be a risky strategy, when considering the modern global economic trends and negative social impact on the migrant families. Data gathered by the Central Bank of Sri Lanka suggest that the remittances are two fold higher than the tea export earnings and 20% higher in garment exports. The study further found that value of the remittances is over the value in foreign loans, grants and foreign direct investment (FDI) by 6%, 2% and 7% respectively. These findings suggest that with the exception of larger amount of foreign remittances the external finances of the country would be in a far more serious crisis than the current situation. When analyzing the relationship between remittances and key macro-economic variables, it was found that the growth of remittances has continually assisted to reduce difficulties faced by macroeconomic variables in Sri Lanka during the recent past. The consequent economic instability would setback economic growth. However, uncertainties in the world economy has experienced today and negative social impacts faced by migration workers and their families, policy makers have to be paid more to diversify the country's export structure, and to improve the trade balance than that of the rest of the balances in the current account balance of the payments.

Entrepreneurial Behavior and Business Performance of Tourism SMEs: A Study Based on the Southern Province of Sri Lanka

E.K. Jayampathi *

Department of Management and Entrepreneurship, Faculty of Management and Finance, University of Ruhuna, Sri Lanka

Abstract

Entrepreneurship is recognized as one of the most powerful economic weapons in developing countries. In Sri Lanka, the tourism sector has been recognized as one of the most pressing business sectors, which can have multiplier effects on local community. Tourism is considered as one of the main foreign exchange earning sources for any country and it has been recognized as a significant contributor for the social and economic development of the country. The succession of any firm depends on the entrepreneurial behavior of the business. The main focus of this study was to identify the impact of entrepreneurial orientation on the performance of tourism SMEs. Galle, Matara and Hambanthota districts (Southern province, Sri Lanka) have been selected as the research site for the present study. As the study population, the SME tourism entrepreneurs who are registered at the Chamber of Commerce and Industries of Matara, Galle and Hambanthota districts were selected. Out of the total population, 120 SME tourism entrepreneurs were selected as the sample using systematic probability sampling technique. A self-administered questionnaire was used to collect primary data and secondary data sources. Pearson correlation and regression analysis were applied to analyze the data. As per the study reveals, there is small to medium relationship between entrepreneurial orientation and tourism entrepreneurial performance (r=0.312). Risk taking, innovativeness, proactiveness and competitive aggressiveness are the key factors, which affect the entrepreneurial performance, where effect of autonomy is less. The study identified the necessity of introducing awareness programs and stimulation programs towards entrepreneurship for youth groups. Facilitating entrepreneurs with financial and non-financial resources would stimulate them towards entrepreneurial activities. Creating linkages between local tourism and local goods manufactures will provide more benefits to local communities. The government needs to create a legal platform to protect local Small and Medium scale tourism entrepreneurs from large scale direct investments.

Key words: Entrepreneurial Orientation (EO), Performance, Tourism entrepreneurs

Corresponding Author: jayampathi2k@gmail.com

Does Voluntary Reporting of Intellectual Capitals Affect Firm Value?

G.K.C. Jeewantha *, T.M.A. Tennakoon and H.A.C. Jeewanthi

Department of Accounting and Finance, University of Ruhuna, Sri Lanka.

Abstract

Traditional financial reporting framework is not adequate to report information on intangible assetsthis leads to an information gap between management and other stakeholders. Eemerging market is demadning more information on intellectual capitals for their decision making. This study investigates the relationship between corporate Iintellectual Capital Disclosures (ICD) and the firm value to provide new insights on voluntary ICD in the Sri Lankan context. Annual reports from 2010 to 2015 of sixty non-financial companieswere selected based on market capitalization and were scrutinized to collect data on ICD. Market related information was gathered from the data library of Colombo Stock Exchange. Panel data regression was employed due to time series and cross sectional nature of data. The ICD were catergorized into external capital, internal capital and human capital by scholars. The ICD collected from the annual reports were quantified using disclosure index developed based on literature. İnformation on intellectual capitals in annual reports were reviwed by using the idex and gave the marks from zero to three by considering their nature such as qualitative and quentitative. Firm value is measured by using the Tobin's Q ratio. Further, organizational characteristics such as leverage, profitability and firm size were used as control variables. Findings suggest that ICD is one of the strong diterminent of the firm value in companies listed in Sri Lanka. Moreover, leverage positively influence the firm value. Firm size does not have a statistically significant impact on the firm value. However the profitability does not have any impact on the value of the Sri Lankan listed companies. In conclusion, the value relevance of intellectual capital disclosures is higher in the Sri Lankan context. As a result, fewer agency conflicts between shareholders and managers were observed. The findigns of ths study contradicts with the argument of the increased disclosure adversely affect competitiveness. The findigns of this study would facilitate framing guidelines and principles for ICD and motivate managers to adopt better disclosure practices.

An investigation of Factors Affecting the Implementation of SLPSAS in Sri Lanka: A Comparative Study between Government Universities and Divisional Secretaries in Galle District

A.G. Deepal *

Department of Accounting and Finance, Faculty of Management and Finance, University of Ruhuna, Sri Lanka

Abstract

One of the main objectives of applying the accounting standards is to furnish a framework and basis for improving governmental accountability through improved accounting and financial reporting in the public sector institutions, which are currently using cash basis accounting instead of accrued basis accounting. Though some of the countries in the world have been able to fully implement these accrued based accounting systems, Sri Lanka has not been able to fully comply with such a system yet. Hence, the problem of the study can be identified as "what are the factors affecting the implementation of Public Sector Accounting Standards (SLPSAS) in Sri Lanka?". Therefore, the objectives of this study are to identify the factors affecting the implementation of SLPSAS, to measure the level of compliance and to find out the impact of the factors affecting the level of compliance in implementation of SLPSAS in Sri Lanka. The sample of the study was derived from the total population of 19 Divisional Secretariat Offices (DSOs) in Galle district and 15 government universities in Sri Lanka, since the study focuses on both populations. A sample of 15 DSOs and 12 universities were selected randomly based on the probability proportionate sampling technique. The level of implementation was assessed by using an adoption rate of compliance with the number of SLPSAS introduced, whereas four factors for the implementation were identified as the independent variables based on literature. Four hypotheses were tested and multiple regression was used to investigate the impact of those factors on the level of implementation of SLPSAS in the selected organizations. The compliance level of implementation of SLPSAS in universities was around 27%, whereas in DSOs it was around 21%. Further, regression results indicated that only two factors, namely the Political & Beaurocratic support, reporting the betas of 0.441 and 0.418 at 99% significance level, and the Willingness to change, reporting the betas of 0.402 and 0.401 at 95% significance level show significant impacts on the Degree of implementation of SLPSAS in universities and divisional secretariets respectively. Hence, it is concluded that adoption of SLPSAS in the public sector is at an infant stage (below 30%) at present in case of implementation of SLPSAS and the commitment on the government side (Political and Beaurocratic support) as well as attitudinal changes from the employees' side are paramount importance to improve the level of implementation of SLPSAS. These findings are most valuable for both policy makers and practitioners to understand the cultural and structural issues and current developments and influential aspects

of the implementation of SLPSAS broadly in Sri Lanka. The sample of this study was limited to, government universities and divisional secretaries in Galle District and a larger sample including DSOs in other districts would enhance the generalization of the results, which could serve as a direction for further research.

Corresponding Author: *deepalguru@gmail.com*

Young Consumer Reaction to Product Harm Crisis with Respect to a Processed Dairy Product: A Case Study of the Faculty of Agriculture, University of Ruhuna

H.M.P.M. Dayarathne and G.C. Samaraweera *

Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna, Sri Lanka

Abstract

Product harm crises are discrete, well-publicized incidences, where the products are found to be defective or dangerous. They are extremely undesirable and unforeseen events regularly accompanied by different companies and this can be devastating for the brand, company and the product. Present study used a fictitious product harm crisis scenario related to the fictitious yogurt brand in order to investigate young consumer reactions towards such a crisis. Ninety (90) undergraduates of the Faculty of Agriculture, University of Ruhuna were selected by simple random sampling technique. A survey questionnaire was administered to collect primary data for the study. Results showed that consumers view the culpability of product harm crisis in different eyes. Among respondents, 62% identified product harm crisis as a company fault, while 48.3% of the respondents identified it as a brand fault. Moreover, 36.67% of them recognized it as a consumer fault. In addition, majority of the respondents were not willing to pay for the crisis brand by means of their repurchasing decision. This alarms the threat of incautious business processes with insufficient inspections. However, 35% of the respondents mentioned that the past brand performance is important when re-purchasing a particular brand, while 40.03% stated such crises will not negatively impact on the brand trust which have been already built by them. Moreover, respondents were demanding a compensation for the crisis. Hence based on the results, the present study suggests, conducting cautious business processes with sufficient inspections of its operations, because majority views product harm crises as a company fault. Moreover, companies should pay more attention towards creating brand performance and brand trust to recover the financial loss midst of product harm crises.

1978 ආණ්ඩුක්‍රම ව්‍යවස්ථාවේ 19 වන සංශෝධනය මඟින් ජනාධිපතිධුරය සම්බන්ධව සිදුකළ වෙනස්කම් පිළිබඳව විශ්ලේෂණාත්මක අධ්‍යයනයක්

ඊ.ජී. විජේසිරි

රාජ්‍ය ප්‍රතිපත්ති අධ්‍යයනාංශය, මානව ශාස්ත්‍ර හා සමාජීය විද්‍යා පීඨය, රුහුණ විශ්වවිද්‍යාලය, මාතර

සාරසංක්ෂේපය

මෙම පර්යේෂණයේ අරමුණ ශ්‍රී ලංකාවේ 1978 දෙවන ජනරජ ආණ්ඩුක්‍රම ව්‍යවස්ථාවට එකතු කරන ලද 19වන සංශෝධනය මඟින් ස්ථාපිත කරන ලද දේශපාලන ප්‍රතිසංස්කරණයක් වන පූර්ණ විධායක ජනාධිපතිධුරය සම්බන්ධ වෙනස්කම් පිළිබඳව විශ්ලේෂණය කිරීමය. 2015 මැයි 15 දින බලාත්මක කරන ලද 19වන ආණ්ඩුක්‍රම ව්‍යවස්ථා සංශෝධනය දේශපාලන හා පරිපාලන වශයෙන් දෙයාකාර වේ. මෙම ප්‍රතිසංස්කරණයට අනුව දේශපාලනික වශයෙන් විධායක ජනාධිපති ධුරයේ බලතල හා කාර්ය භාරය පිළිබඳව වෙනස්කම් රාශියක් එමගින් සිදු කර ඇත. ජනාධිපතිධුරය යම් යම් සීමාවන්ට යටත් කිරීමට මෙමගින් විධිවිධාන සපයා ඇතිමුත් ඒ සම්බන්ධව ස්වාධීන හා විශ්ලේෂණාත්මක අධ්‍යයනයක් මෙතෙක් සිදුකොට නොමැති තරමුය. මෙම අධ්‍යයනයේ ඉලක්කය වන්නේ එම සීමා කිරීම් මෙන්ම ඒවායේ සැබෑ ක්‍රියාකාරීත්වය විභාග කිරීමය. දීර්ඝ කාලයක් යටත් විජිතයක්ව පැවති ශ්‍රී ලංකාව 1948 පෙබරවාරි 04 වනදා නිදහස ලබාගනී. 1948, 1972 සහ 1978 යනුවෙන් ආණ්ඩුක්‍රම ව්‍යවස්ථාවන් තුනක් මෙම කෙටි කාලය තුළ ක්‍රියාත්මක කරන ලදි. එහෙත් මෙම කිසිම ආණ්ඩුක්‍රම ව්‍යවස්ථාවකින් ශ්‍රී ලංකාවට ගැළපෙන ආණ්ඩුක්‍රමයක් ස්ථාපිත කරගැනීමට නොහැකි විය. විශේෂයෙන්ම 1978 ව්‍යවස්ථාවේ ජනාධිපතිවරයාගේ භූමිකාව පිළිබඳ ප්‍රශ්න රාශියක් උද්ගත වී තිබුණි. එනම්, ජනාධිපතිවරයාට ලබාදී තිබූ බලය හා කාර්යභාරය පිළිබඳව විවේචන පැවතුණි. ඒ නිසා මෙම ධුරය අහෝසි කළයුතුය, නැතිනම් සංශෝධනය විය යුතුය යන්න විවිධ අවස්ථාවලදී ප්‍රකාශ විය. එහි උච්චතම අවස්ථාව වන්නේ 2015 ජනාධිපතිවරණයයි. එහිදී ප්‍රකාශ වූයේ මෙම ධුරය අහෝසි කිරීම හෝ ව්‍යවස්ථාදායකයට වගකියන ආකාරයට සංශෝධනය විය යුතුය යන්නයි. 2015 ජනාධිපතිවරණයෙන් පසුව බිහිවූ නව ආණ්ඩුව 2015 මැයි මස 15වනදා 19වන ආණ්ඩුක්‍රම ව්‍යවස්ථා සංශෝධනය සම්මත කරන ලදි. එම සංශෝධනය මඟින් පූර්ණ විධායක ජනාධිපතිධුරය සම්බන්ධව සංශෝධන කිහිපයක් සිදුකළේය. ඒවා එළඳැයි වීම හා නොවීම පිළිබඳව විශ්ලේෂණාත්මක අධ්‍යයනයක් මෙතෙක් සිදුකර නොමැත. මෙම පර්යේෂණය මඟින් අපේක්ෂා කරන්නේ ඒ පිළිබඳ ගැඹුරු අධ්‍යයනයක් කිරීමය. මෙම පර්යේෂණය සඳහා ද්විතීක දත්ත උපයෝගීකර ගන්නා ලදි. එහිදී පොත්පත්, සඟරා, පර්යේෂණ ලිපි ආශ්‍රයෙන් 19වන ව්‍යවස්ථා සංශෝධනය සම්බන්ධ දත්ත ලබාගෙන ඇත. මෙම පර්යේෂණ පත්‍රිකාව කොටස් කිහිපයකින් යුක්ත වේ. එහි පළමු කොටස මඟින් 19වන සංශෝධනයේ පසුබිම, දෙවන කොටස මඟින් ජනාධිපතිධුරයේ බලතල සම්බන්ධව කළ සංශෝධන හා විධිවිධාන, තෙවන කොටස මඟින් එහි අපේක්ෂිත අරමුණු හා පරමාර්ථ ඉටුවුවා ද යන්න පිළිබඳ ප්‍රායෝගික විශ්ලේෂණයක් කරනු ලැබේ.

ප්‍රමුඛ පද: ආණ්ඩුක්‍රම ව්‍යවස්ථා, කොමිසම, පූර්ණ විධායක, ප්‍රතිසංස්කරණ, ව්‍යුහයන්

* සමායෝජක කතෘ : ejwijesiri@gmail.com

Emanating Southern Epistemologies: Some Epistemological Considerations of Grounded Theory in Social Research

K.A.S. Udayanga *

Department of Sociology, University of Ruhuna, Sri Lanka

Abstract

Epistemology which is the way in which the knowledge is generated has vital importance to social research since it gives the light to reveal ontology, the reality (of being), in a philosophically accepted way. Until recently, theoretical understanding of epistemologies predominantly depended on western ideologies, but now social theorists argue that southern epistemologies also must be considered when carrying out contextually specified social research. So far, grounded theory is the methodology, which has been employed to understand human action (*but not the behaviour*) with deep qualitative interpretations, without considering deontology, due to its inherent methods and theoretical perspectives. This research, therefore, strived to find out possibilities of integrating contemporary southern epistemologies with grounded theory approach and to identify some of the grass-root methods that increase the scientific validly of the data. Moreover, the research endeavours to understand some of the possibilities in contextualizing the assumptions of grounded theory approach into Sri Lankan context. Researching about a research methodology is a high-level endeavour and hence constructing grounded theory was employed with comparative case studies. Systematic coding was used as a method of analysis with iterations. The analysis indictes that the way of understanding any social phenomenon in Sri Lankan context by laypersons need a contextually relevant epistemological tradition. Grounded data are difficult to be interpreted with analysis, which requires a high level of synthesis. The whole picture or the *gestalt,* represents a completely different picture of the analyzed particles or each individual occurrence. The laypersons' interpretations of data are of vital importance than that of the deliberately given interpretations by the externalities (e.g: a researcher). Furthermore, beforehand sample identification has been identified as a false assumption in grounded theory, but the findings will be more sustainable if the sample is emerged intrinsically within the field without any interference by the researcher. The data on the other hand, cannot be considered clearly objectified or cleansed from societal interference, but are linked with social strata in a complex manner. Sometimes, when people are interviewed the questions asked are not specific and not really directed since the cultural difference, or the questions asked are misinterpreted in accordance with cultural beliefs without considering the researcher's intention. Answers given are therefore culturally funnelled. In conclusion, it is argued that emanating contextual epistemologies be integrated with grounded theory assumptions in order to strengthen the validity of data, and that will result in a sustainable research which gives a justified true belief.

ගාලු කොටුව ආශ්‍රිතව ක්‍රියාත්මකවන පෞරාණික භාණ්ඩ වෙළෙඳපොළ පිළිබඳ විමර්ශනාත්මක අධ්‍යයනයක්

උපේක්ෂා ගමගේ, ඩී . සී . චිත්‍රානන්ද, එන්. ඒ. එස්. තිලකරත්න, ඒ. ඒ. බණ්ඩාරනායක

ඉතිහාසය සහ පුරාවිද්‍යා අධ්‍යයනාංශය, රුහුණ විශ්වවිද්‍යාලය, මාතර

සාරසංක්ෂේපය

වර්තමාන අන්තර්ජාතික පුරාවස්තු සහ සංස්කෘතික ප්‍රඥප්තීන්හි සඳහන් වන පරිදි අවුරුදු සියයකට වඩා පැරණි භාණ්ඩ පොදුවේ පෞරාණික භාණ්ඩයක් යනුවෙන් හඳුන්වනු ලබයි. මෙය අර්ථ නිරූපනය කිරීමේ දී ඒවාට ආවේණික ලක්ෂණ, අයත් වන යුගය, කලාත්මක බව, දුර්ලභත්වය, ස්වභාවය, උපයෝගීතාව, නිර්මාණය කළ අමුද්‍රව්‍ය, මානවයා සමඟ පැවති සම්බන්ධතාව සහ ආවේණික අනිකුත් ලක්ෂණ යන කරුණු මේ සඳහා පාදක කරගෙන ඇත. සංස්කෘතික දේපළ හා සම්බන්ධ ප්‍රඥප්තීන්ට අනුව පෞරාණික භාණ්ඩ සංස්කෘතික දේපළ ලෙස සලකා ඒ යටතේ ආරක්ෂා කිරීමට කටයුතු කර ඇත. ශ්‍රී ලංකාවේ ඇති පෞරාණික භාණ්ඩ ඒවා අයිති පුද්ගලයින්ගේ දැනුවත්කම යටතේ ම නීති විරෝධී ලෙස විදේශිකයන් විසින් මිලදී ගනු ලැබේ. පැරණි භාණ්ඩ මේ ආකාරයට විදේශගත වීමෙන් පසුව එම භාණ්ඩ පිළිබඳ කිසිදු සටහනක් හෝ සාක්ෂියක් ශ්‍රී ලාංකිකයන් සතු නොවන තරම් ය. මෙම අධ්‍යයනය සඳහා ගාලු කොටුව ආශ්‍රිතව පවතින පෞරාණික භාණ්ඩ වෙළෙදපොළ කෙරෙහි අවධානය යොමු විය. ගාලු කොටුව සංචාරක පරිශ්‍රයක් වීම මෙන් ම එහි පෞරාණික භාණ්ඩ වෙළෙදපොළ පුළුල් ලෙස ව්‍යාප්තව තිබීම ගාලු කොටුව තෝරා ගැනීමට හේතු විය. පැරණි භාණ්ඩ වෙළෙදපළ තුළ පෞරාණික භාණ්ඩ සම්බන්ධව තත්ත්වය සහ ඒ සම්බන්ධව පවතින නීතිමය තත්ත්වයන් පිළිබඳ මෙන්ම පෞරාණික භාණ්ඩ වෙළෙදපොළ තුළ අලෙවි වන පෞරාණික භාණ්ඩ වර්ග සහ මිල ගණන්, වැඩියෙන් අලෙවි වන පෞරාණික භාණ්ඩ පිළිබඳ මෙම අධ්‍යයනය මගින් විමර්ශනය කර ඇත. ගාලු කොටුව තුළ පෞරාණික භාණ්ඩ සහිත පෞද්ගලික කෞතුකාගාර පවත්වාගෙන යමින් එම භාණ්ඩ විදේශීය සංචාරකයන්, විදෙස් රටවල ජීවත් වන ශ්‍රී ලාංකිකයන්, දේශීය ධනවතුන් මෙන් ම පැරණි භාණ්ඩවලට ඇලුම් කරන්නන් වෙත අලෙවිය සිදු කරන බව මෙම අධ්‍යයනය මගින් හඳුනාගත හැකි විය. අන්තර්ජාතික සහ ජාතික වශයෙන් විවිධාකාරයේ අණ පනත්, සම්මේලන ප්‍රකාශන, සම්මත කරගත් නීතිරීති සහ ආචාරධර්ම පැවතිය ද වර්තමානය වන විට එම නීතිරීති නිසියාකාරයෙන් ක්‍රියාත්මක වීමක් දැකිය නොහැකිය.

ප්‍රමුඛ පද : පෞරාණික භාණ්ඩ, පෞරාණික භාණ්ඩ වෙළඳපළ, ගාලු කොටුව, සංස්කෘතික දේපළ, ප්‍රඥප්තීන්

* සමායෝජක කතෘ : upeksha_gamage@yahoo.com

Liberal Peacebuilding Policy to Recover the War Affected Community: A Study on a Selected District in the Northern Province, Sri Lanka

A. Samarakoon [a, *], I.R. Priyantha [b] and M.N. Kularathne [c]

[a] Department of Development Studies and Global Planning, University of Agder, Norway.
[b] Department of Public Policy, University of Ruhuna, Sri Lanka.
[c] North South University- Dhaka, Bangladesh.

Abstract

Since 2009, Sri Lanka has been in a process of sustaining peace and reconciling ethnically fragmented societies. The agenda of peacebuilding and reconciliation in Sri Lanka has developed on the dominant ideology of liberal peace. The Government of Sri Lanka (GOSL) designs, liberal peace policy to build up democracy and reach to development ends. The focus of liberal peace policy, thereby, turns to 'development through peace. In the liberal sense, development deviates to the dimensions of freedom, liberty, rights, justice and equal representation and distribution. The ultimate goal of liberal peace in Sri Lanka is to construct a liberal society. The liberal society is the structure of supporting to prevail 'truth' and 'just' and to represent the grassroots. The ultimate objective of the liberal peace project is to establish a truth and just society where the grassroots can represent their needs. The question is, "Does liberal peace of Sri Lanka articulate and represent the interests of grassroots in the programs?" Does the liberal peace of the country ensure rights and freedom of grassroots? The paradox is that liberal peace recipients are at the grassroots, but they are on a passive resistance against liberal peace which has been contextualized since 2009. The research problem of the study is that, "Despite the liberal peace reforms and liberal policies have been introduced to establishing sustainable peace in Sri Lanka, why the passive resistance of the mothers of the disappeared have not been considered in such policy implementation? Two research questions have formulated to guide the problem solving; "How the disappearances happened before and after the war ended?" and "How the mothers of the disappeared have been organizing the struggle for justice of disappeared?" The study is on the qualitative data. The primary data of the research have been collected through the unstructured interviews and through focus group discussions. The 40 mothers of the disappeared at a passive resistance in Vavuniya have been selected for the interviews and two focus group discussions were conducted for gathering primary data. Library research was used to collect the secondary data of the research. The participants of the sample are Tamil women from Jaffna, Killinochchi, Mulativu and Mannar districts. The methodology of discourse analysis was utilised to analyse the testimonies of the interviewee. The mothers of the disappeared have met with the highest officials in the GOSL and international civil organisations. The meetings have not produced effective outcomes except passed and the president signed the office of Missing

Persons Act (OMP). The act now has been implemented though, the mothers of the disappeared are still on the protest in Vavuniya. 35 Mothers in the sample said that their children disappeared since they handed over to the Sri Lankan army at the end of the war. Although the Office of Missing Persons Act passed and the office is yet to be set up, the mothers have no faith in the government. The respondents mentioned that the meetings with the leading government figures and the visit of the Executive President to the protesting places were not the answers to the simple question of "What happened to our children?" The key argument of the research is that in the process of contextualising the universal concept of liberal peace, it has subjected to local politics. As Arendt mentions that the blending of politics and truth in governing structure has caused to ignore the real representation of grassroots in the liberal peace.

Key words: *Government of Sri Lanka, Liberal Peace**, Mothers of Disappeared**, Politics and Truth and Representation*

Corresponding Author: *arunisamarakoon@gmail.com*

Cultural, Commercial and Geo-political Significance of the Bay of Bengal region: An Archaeological Reading

W. Bohingamuwa *

Department of History and Archaeology, University of Ruhuna, Sri Lanka.

Abstract

The Indian Ocean (IO) has been a key region in the development of early civilizations in the world. The Bay of Bengal (BOB) was a vital sea link that connects the eastern and northern parts of the IO with its western segment. Cultural-commercial networks have been operating across the bay linking the regions in South and Southeast Asia, at least since mid-first millennium BCE. These networks penetrated the fragmented landscape and political boundaries of the BOB region forming a distinctive culture amongst diverse communities. The emergence of strong states such as Maurya and Srivijaya brought about political integration in the region at many times before the arrival of the Europeans. During the rule of the western powers, the Bay of Bengal region was politically and economically inter-linked more strongly than ever before in history and the traditional economy was transformed into commercial agriculture. Large-scale human migrations, meant for these cultivations and new industries, transformed the socio-cultural landscape of the region. The collapse of the British Empire led to economic and political disintegration; however, the significance of the region was retained. The geo-political and economic significance of the BOB is rapidly increasing, primarily for its location connecting the rising world economic powers of Asia and the Pacific as well as the Western Indian Ocean, the main source of world's energy. Sri Lanka sits in the middle of these networks and its history has been shaped by and is destined to affect from the developments that take place in the ocean around her. Although, textual evidence for early interactions across the BOB are typically late, archaeological evidence such as the circulation of Indo-Pacific beads and Rouletted Wares date them to Pre-Christian times. This paper, based on historical sources and archaeological findings, evaluates the significance of BOB region within wider IO maritime networks.

Corresponding Author: *wbohingamuwa@yahoo.com*

Human Population Increase and Their Socio-Economic Status Affected to Mangrove Resource Degradation in Southern Coastal Area

W.K.V. Dayalatha *

Department of Geography, University of Ruhuna, Sri Lanka

Abstract

This paper presents the findings of a study on human activities and their socio-economic status that affect mangrove resource degradation in southern coastal belt of Sri Lanka. Southern coastal area from Dondra to Ambalangoda was selected for the study. The main objective of the study is to examine the mangrove resource degradation due to the increase in human population and their socio-economic status. Specific objectives are to examine the causes and activities of coastal human population that affect the mangrove resource degradation and why this resource is subjected to degradation by people. Mainly, primary and secondary data were used for this study. Questionnaire-assisted interviews were conducted on 2154 households to identify their socio-economic status and activities that have changed mangrove ecosystems. Population increase was determined based on data from the Department of Census and Statistics. The human impacts on mangrove forests during the last three decades were also examined. For investigations on the temporal changes of mangrove lands from 1994 to 2017, aerial photographs were used and maps were prepared using GIS. Polwatumodara River mouth area and Mahmodara lagoon area were selected to estimate the changes in mangroves due to human activities. Analysis of data indicates that the mangrove cover decreased in both areas from 1994 to 2017 and suggests that, in both study areas, increase in coastal population is the mainfactot that seriously affected on the degradation of mangrove resources. Due to the impacts from human activities, mangrove cover has decreased in the study areas. For two other cases, increased accessibility to mangrove land of the rural areas is also a factor responsible for the decline in quantity of mangroves and area covered by them due to their different usages. This study supports the idea that modern coastal developmental initiatives and activities of coastal communities should be carefully monitored to ensure that they do not undermine the importance of the mangrove species, particularly in the areas of Southern coast, where a large proportion of the population and animals rely on coastal land resources for their survival.

Why GIS is an Essential Tool to Manage the Schools Distribution Issues: Study based on Colombo District of Sri Lanka

W.K.N.C. Withanage * **and G.P.T.S. Hemakumara**

Department of Geography, Faculty of Humanities and Social Sciences, University of Ruhuna, Sri Lanka

Abstract

Even if there are a large number of schools established in Colombo District of Sri Lanka by government or other stakeholders, it is very difficult to find a school for the children, which is also a major burden issue faced by Sri Lankan parents. In Sri Lanka, however to overcome this issue, it is required to adopt spatially manageable location database of schools, which is found through different analyses in the literature in most of the other countries. School management system and its supervision have been controlled by the Education Zone (EZ) offices. Due to lack of applications of the Information Communication Technology (ICT) in the education management system in Sri Lanka, many problems can be identified in school management process. Especially there is a high potentiality to apply Geographic Information Systems (GIS) for education management and administration. Nowadays, popular schools gained more competition in the process of grade one student selection. Thus the schools use manual distance calculation system using with maps printed on papers because there is no common computerized system such as GIS. There is a contrastive difference between Colombo urban schools and schools in the outskirt of Colombo. Within the Colombo metropolitan area, the number of 1AB schools are higher than the other areas of the country and the outer core of Colombo. There are 36 national schools and totally 405 government schools are situated in the Colombo district. Moreover 16 out of 36 National schools are located in the Colombo metropolitan area. In the present study GIS operations and anlyses were carried out using Arc GIS 10.1 version. To perform GIS operations spatial data in 1:50,000 scale maps, which were obtained from the Survey Department of Sri Lanka were used. Most of the attribute data were obtained from the Ministry of Education, Department of Census and Statistics and also from the Central Bank of Sri Lanka. The study is devoted to discuss what factors have been contributed towards the variations in spatial distribution of schools in the Colombo district. Identifying the spatial variations of school distribution in the district, determining the school hinterland areas and population statuettes were among specific objectives of the study. Accordingly, we suggest that Sri Lankan school system can use the GIS for their selection process as well as other management matters, especially distance calculation within a specific proximity area. This study has analysed the school clusters by using spatial autocorrelation and multi-distance spatial cluster analysis (Ripley's K Function) tools. The study had proven that the schools in Colombo district are spatially distributed as clusters. Accordingly, the main finding is that, most of the school clusters (about 60 %) are

located in the core areas of Colombo Metropolitan areas, where students have to day to day travel from their residences.

Key words: *GIS, School Management, Proximity Analysis, Location Analysis, Spatial Database*

Corresponding Author: *neelgisrskln2017@gmail.com*

නායකත්ව කළමනාකරණයේ බෞද්ධ ප්‍රවේශය පිළිබඳ හැඳින්වීමක් (සූත්‍ර පිටකය ඇසුරින්)

ආර්. මලවි පතිරණ

පාලි හා බෞද්ධ අධ්‍යයනාංශය, රුහුණ විශ්වවිද්‍යාලය, මාතර

සාරසංක්ෂේපය

යම් කාර්යයක් මැනවින් ඉටු කිරීම මගින් අපේක්ෂිත ප්‍රතිඵල සාධනයේ දී නායකත්වය නමැති සංකල්පයෙහි උපයෝගීතාව පිළිබඳව ඉතා වටිනා ආදර්ශයක් බුද්ධහමෙහි අන්තර්ගත ය. එනම් බුද්ධසසුන නැමැති සංවිධානය නිර්මාණය කළ බුදුරජාණන් වහන්සේ නැමැති ශ්‍රේෂ්ඨ නායකයා එය මැනවින් කළමනාකරණය කළ බැවින් අද දක්වා ම එම සංවිධානය අබණ්ඩව පැවතීම යි. පවුල නැමැති කුඩා සමාජ සංස්ථාවේ මෙන් ම ජාත්‍යන්තර වශයෙන් ව්‍යාප්ත වන විවිධ සංවිධානවල කළමනාකරණ ක්‍රියාවලියේ දී වැදගත් වන ප්‍රායෝගික මූලධර්ම බුද්ධහම තුළින් අධ්‍යයනය කළ හැකි ය. නූතන කළමනාකරණ ක්‍රියාවලියේ ප්‍රධාන අංශ 4ක් දැකිය හැකි ය. එනම් සැලසුම්කරණය, සංවිධානකරණය, මෙහෙයවීම හා පාලනය යනුවෙනි. මෙහි මෙහෙයවීම යනු නායකත්වය හා සම්බන්ධ ශූත්‍ර ක්‍රියාවලිය යි. එනිසා නායකත්වය යනු එම ක්‍රියාවලියේ ඉතා වැදගත් අංශයකි. දුර්වල නායකත්වය සමස්ත කළමනාකරණ ක්‍රියාවලියේ ම අසාර්ථකභාවයට හේතු වේ. විශේෂයෙන් ම නායකයෙකු තුළ තිබිය යුතු ගුණාංග පිළිබඳව බුද්ධහම තුළ ගැඹුරින් සාකච්ඡා කොට ඇත. දීඝ නිකායේ මහා පරිනිබ්බාන සුත්‍රය, අංගුත්තර නිකායේ ව්‍යග්ඝපජ්ජ සුත්‍රය, මජ්ඣිම නිකායේ සෝණදණ්ඩ සුත්‍රය, සල්ලේක සුත්‍රය හා කරණීයමෙත්ත සුත්‍රය ආදී සූත්‍ර දේශනාවලත් ථෙර, ථේරී ගාථාවලත් ධම්මපදයේත් ජාතක කතාවලත් ඒ පිළිබඳව උපදෙස් ඇතුළත් ය. අංගුත්තර නිකායේ ව්‍යග්ඝපජ්ජ සුත්‍රයේ නායකයෙකු සතු විය යුතු ප්‍රධාන ලක්ෂණ පහක් දක්වා ඇත. එනම්, දක්ෂවීම, අලස නොවීම, උපායශීලී භාවය, පූර්ණ කාර්යක්ෂමතාව ඇත්තකු වීම හා අන්‍යයන් මෙහෙයවීමේ, සංවිධානය කිරීමේ හැකියාව ඇති අයෙකු වීම යි. බුද්ධහම අගය කරන්නේ පරමාදර්ශී නායකත්වය යි. ස්වකීය නායකත්ව පෞරුෂය ගොඩනගාගන්නට වෙර දරන්නෙකුට මෙම උපදෙස් බෙහෙවින් වැදගත් වේ. මේ අනුව බටහිර කළමනාකරණ ක්‍රියාවලිය තුළ තවමත් අවධාරණය නොකළ නායකත්ව මූලධර්ම පිළිබඳව බුද්ධහම අවධාරණය කර ඇත. නායකත්ව කුසලතා වර්ධනය කර නොගෙන නායකත්වයට පත්වන නායකයා නිතර මෝහයෙන් කටයුතු කරයි. එබැවින් ඒ පිළිබඳ සංසන්දනාත්මක ව කරුණු හෙළිකර නායකත්වය පිළිබඳ බෞද්ධ මූලධර්ම ඉස්මතු කිරීම මගින් නූතන කළමනාකරණ ක්ෂේත්‍රයට එහි ඇති උපයෝගීතාව හඳුන්වාදීම මෙම පර්යේෂණ පත්‍රිකාවේ අරමුණ යි.

ප්‍රමුඛ පද: කළමනාකරණය, නායකයා, නායකත්වය, කුසලතා, බෞද්ධ මූලධර්ම

* සමායෝජක කතෘ: mpranjanee@gmail.com

Academic Performance of Undergraduates of Three New Degree Programs as Affected by Gender and, A/L Study Stream and Subject Performance

S.K.K. Mudalige [a], N.S.B.M. Atapattu [b], *, N.P. Dharmadasa [a]

[a] Deans' Office, Faculty of Agriculture, University of Ruhuna, Sri Lanka.
[b] Department of Animal Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

Academic perfromance of undergraduates is highly influencecd by the university entry level acadecmic performance. Acording to the proceedure adopted for the selection of undergraduates to State Univrsities in Sri Lanka, students who followed either Biological Science or Agriculture stream for the GCE Advanced Level (A/L) are elegible to apply for all three new degree programs introduceed by the Faculty of Agriculture, University of Ruhuna. Above situation along with district quota system of student selection has resulted in a huge variation in students' university entry level academic background and performance. Objective of this study was to determine the academic performance of undergraduates of three new degree programs as affected by gender, A/L stream and performance in different subjects. Semester grade point averages (SGPA) over eight semesters and overall grade point averages (OGPA) of 239 undergraduates who followed BSc in Green Technology (GT), Agricultural Recourse Management and Technology (AT) and Agribusiness management (AB) were analyzed. 30%, 8% and 62% of the students who followed Agriculture stream during A/L had been selected to GT, AB and AT programs, respectively. The contributions of Physics, Chemistry and Biology to performance of the students who followed Biology stream at the final A/L examination were 30, 33 and 37%, respectively. Among those who have followed agriculture, the contribution from Chemistry (22%) to the final A/L achievement was significantly lower than that of Biology stream students, while the contribution from Agriculture was 44%. After sitting eor examinations conducted for one or up to three semesters, 9% of the students have dropped the programs, while another 20% have failed to complete the courses within the four year period. Among those followed Agriculture for A/L out of the numbers repeated the examinations, males were significantly higher. Among students having first or second (upper division) classes at the final examination 87 and 65% respectively were females. Clear increases in SGPA values were seen from 6th semester in GT program and from 4th semester in AB and AT programs. SGPA values in eighth semester were similar across three programs. There was a significant linear relationship between OGPA and fourth semester SGPA (r^2=0.90, p=0.000). The study concludes that students who follow Agriculture stream for A/L have an advantage over those who follow Biology stream, during university admission for the degree programs offered. Academic performance of female and, of those who followed Biology stream at A/L were found to perform better than the males and those who have followed Agriculture. Low rate of competion of the four-

year degree programme, high drop-out rate and gender inequality in academic performance are identified as the critical issues to be addressed.

Key words: *Academi, perforemance, undergraduates, gender, SGPA, OGPA.*

*Corresponding Author: *nsbm@ansci.ruh.ac.lk*

An Empirical Study on Contributory Factors of Fatal Road Accidents

I.G.S. Kumari [a, *], E.V.D. Dilhani [a], A. Gamage [a] and T.L.D.S. Karunanayake [b]

[a] Department of Economics, Faculty of Humanities and Social Sciences, University of Ruhuna, Sri Lanka
[b] Department of Public Policy, Faculty of Humanities and Social Sciences, University of Ruhuna, Sri Lanka

Abstract

Road Transportation is the major transportation method in Sri Lanka. Many steps have been taken to develop road facilities in order to build up an economically and socially beneficial road transportation system in Sri Lanka by all the governments during last three decades. Though, road transportation helps to Sri Lankan Socio-economic growth in many ways, it is essential to discuss about the negative influence caused by road accidents. Today, according to Sri Lankan traffic police reports traffic accidents have become one of the major causes to death and injuries. This study reviews about Fatal Road Traffic Accidents (FRTA) occurred between 1989 and 2015. Fatal accident statistics from year 1989 to 2015 have been taken and analysed in order to get results for this study. Based on statistics published by Department of Census& Ststistics and Sri Lanka traffic police, number of deaths were tbulted with respect to the user of the road. According to the results of this study pedestrian deaths are higher than other types of fatal accidents before the year 2000. Deaths of drivers' have become higher than that of passengers' deaths and pedestrians after the year 2000. There is an upward trend of fatal accidents in Sri Lanka. Furthermore, the study reveals that the young men in the 16- 29years age group are the major victims for eaths through road accidents and majority of them are bike riders and three wheeler drivers. This is a serious issue that can influence the socio economic growth of the country. According to the data from 1989 to 2015 it could be clearly identified that the number of accidents are in vulnerable state even though the road quality has been increased. Therefore, government and the policy makers should consider this matter and necessary measures should be taken in order to prevent this situation.

*Corresponding Author: *gamagesulakkana@gmail.com*

Application of Multilevel Fuzzy Analytic Hierarchy Process Assessment on the Performance Quality Evaluation of Websites

K.H. Ramanayaka [a, *], X. Chen [a], B. Shi [a] and G.A.J. Hemmali [b]

[a] The School of Computer Science & Technology, Wuhan University of Technology, Wuhan, China
[b] Library, University of Ruhuna, Sri Lanka.

Abstract

Websites are mainly used as a virtual image and promotional platform of the organization that display all information and services given by them. There is a necessity for successive monitoring of the condition of the website to give a strong Internet-based information delivery and communication to the community, while performance quality is a good indicator to find out where the specific website is on the web, how good the content is and how it relates to the other parties. Moreover, high performance creates a strong and positive corporate image on the Internet and to convert it to attract visitors to the website and to encourage them to return. Building on this need, this paper engages in a scientific discussion on feasibility of an intelligent, fuzzy preference, and multicriteria decision making framework integrating with Analytical Hierarchy Process (AHP) to evaluate the performance quality of websites, which include various multidimensional technological and logical factors. The study conducted an extensive literature review of academic journals, conference proceedings, and web documents along with discussions with experts to identify the criteria that affect the performance of a website and how to measure these criteria. The framework for evaluating performance of websites was developed based on the fuzzy AHP technique, while research into the mathematics underlying the fuzzy theories and AHP was carried out using books and studies published as research papers. A case application shows the applicability of this framework in providing a valuable tool in the performance quality evaluation process in websites. It is expected that this approach may provide an effective, scientific, and objective measure to evaluate the performance in websites. Additionally, this study proposes a systematic framework of the fuzzy approach in the group decision-making environment. The proposed framework can be used for organizations to examine the strengths and weakness points of their websites and to have an ability to maintain a user friendly and informative website. Applying this framework also can help to get an accurate solution with a high degree of consensus.

Key words: Web performance, FAHP, Webometric, Website ranking

Corresponding Author: *kramanayaka@gmail.com*

Public Attention on Research Publications of University of Ruhuna: An Alternative Metric Analysis.

P.G. Nishantha*, J.J.G. Arachchige, K.T.S. Pushpakumara and S.L. Gammanpila

Main Library, University of Ruhuna, Sri Lanka

Abstract

Attention towards online access to scholarly publications has been dramatically increased during last two decades among various scholars and professionals. Publishing of articles in online resources has also been highly increased. Research institutions and universities are encouraging their professionals to publish more in internationally recognized online publishers as the citation count can impact on the standards of the institution. The evaluation of scholarly publication and impact measures are completed with several quantitative and qualitative methods. The purpose of the study is to measure and analyze the online impact of articles published by the University of Ruhuna (UoR) in Scopus database during 2012-2017. Citation count was used as the filtering tool and 100 articles were selected from 697 publications of Scopus database. The PlumX metrics with five different categories of data (usage, captures, mentions, social media and citation metrics) were separately collected as alternative metric for data collection on 24.08.2017. Among the results, top ten articles from the top ten subjects were used for analysis. As a result, 697 publications were cited in Scopus database and highest number of articles appeared for physics, medicine and agriculture. Physics and medicine exhibited a strong Pearson's correlation (r=0.981, P=0.003/r= 0.998, P=0.036) with citation count and social media. Articles of medicine resulted a higher PlumX metrics with all metric types by online interaction. Scopus and CrossRef citation counts represented similar citations for selected publications. The study concludes that, University of Ruhuna has published a quite higher number of publications among other universities in Sri Lanka. Physics, medicine and agriculture related subjects were highly appeared in publications. Topics related to health gathered more attentions in online communities. This study confirmed that, CrossRef DOI aggregation of publications were relevant to prediction of article citation counts.

Key words: CrossRef, PlumX metrics, Scholarly publications, Scopus, Social media

*Corresponding Author: nishantha84@lib.ruh.ac.lk

Impact of Financial Performance on Share Price: With Special Reference to Manufacturing Sector in Sri Lanka

T.S. Vithanawasam [a] and M.S. Nanayakkara [b]

[a] Department of Accounting and Finance, University of Ruhuna, Sri Lanka.
[b] Department of Accounting and Finance, University of Ruhuna, Sri Lanka.

Abstract

The financial performance as an indicator of the success of the firm can be used as a benchmark for making investment decisions. The studies on financial performance in determining share prices has been developed throughout the time period and various studies have been presented contradictory findings, most of which were undretaken out side the Sri lankan context. Manufacturing companies which are listed in Colombo Stock Exchange (CSE) represent significant portion, when considering the market capitalization of the stock market. Therefore it is useful to identify how the share prices fluctuate over the period of time. But, no sufficient empirical studies have been undertaken in the area under investigation particularly in the Sri Lankan context. Even the available studies do not represent the manufacturing sector and selected sample sizes are not at acceptable level. The objective of this study was to identify the impact of financial performance on share price of listed manufacturing companies in CSE. In this study, twenty manufacturing companies were selected from a population of 42 manufacturing companies to collect data using annual reports for the period from 2013 to 2016. Financial performance was measured by Return On Assets (ROA) and Earning Per Share (EPS). Average Share Price (ASP) was calculated by using the average share price throughout the year. Firm size was used to avoid extraneous effects. Regression analysis has been utilized to find out the impact of firm performance on share price. According to the results of the study there is an impact on share price by ROA and EPS. Furthermore r^2 values reveal that firm performance is the determining factor of the share price and firm size didn't prove to be an important explonatory variable of share price.It is suggested for future studies to expand the study into other industry in CSE.

Key words: Colombo Stock Exchange (CSE), financial performance, manufacturing companies, share price

*Corresponding Author:

Engineering and Technology

Automatic Density Cluster Generation and Visualization Method Based on Overlapped Data Points

K.K.L.B. Adikaram [a,b,c,*], M.A. Hussein [a], M. Effenberger [b] and T. Becker [a]

[a] Group Bio-Process Analysis Technology, Technische Universität München, Weihenstephaner Steig 20, 85354 Freising, Germany.
[b] Bavarian State Research Center for Agriculture, Institute for Agricultural Engineering and Animal Husbandry, VöttingerStraße 36, 85354 Freising, Germany.
[c] Computer Unit, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

Abstract

Handling overlapped data points is a challenging task in data visualization because overlaps prevent identification of data points, especially, when the data density is very high. Removing, reducing, and reformulating are the most common techniques that used to overcome overlapping. Instead of removing, reducing, or reformulating overlap, a new method that uses overlap to generate colour-coded density clusters on a bitmap was proposed. The basic unit of a bitmap is a pixel which has n bits. Individual pixel is capable of holding 2^n number of colours. Because each colour of a pixel can be converted in to a unique integer, a bitmap is a matrix of pixels as well as a matrix of integers. These integer values of a pixel can be mapped with values of a certain variable. Therefore, a pixel can be used as a single knowledge cell. In the present method, plotting area is a bitmap and the size and the shape of the marker (graphical symbol of a data point) will be selected in a manner that they can be overlapped. When there is an overlap, colour of such overlapped area can be added. If there is no overlap, keep the initial colour of the marker. Addition of the colour of overlapped area creates new colour that is different from original colours and colour value is proportional to the data density. This resembles an updating of knowledge. More overlapping (high density) make colour of the intersected area identical, even can be identified by a naked eye. Existing cluster analysing techniques need separate algorithm for finding clusters and visualizing technique for representing identified clusters. In contrast, the new method automatically creates clusters (without separate algorithm) by automatically generated colour lines which can be considered as isoclines. 35620 data points were mapped with a new method and the results showed very clear cluster formation over heat map and contour plot approaches

Key words: Big Data; Cluster Identification; Continuous Learning; Knowledge representation; Outlier Detection

*Corresponding Author: lasantha@agricc.ruh.ac.lk

A Fixed Neighbourhood based SPH Approach for Faster Numerical Simulation of Fluid Domains Having Low Reynolds Number Flow Conditions

K.G.P. Hansani, B. Sumith and H.C.P. Karunasena[*]

Department of Mechanical and Manufacturing Engineering, University of Ruhuna, Sri Lanka

Abstract

Meshfree methods have become popular over grid-based numerical methods for solving many critical problem domains due to the advantage of using no fixed grids to discretise the simulation domain. Smooth Particle Hydrodynamics (SPH) is such meshfree technique mainly used for modelling fluid dynamics problems. It discretises a given fluid domain using a set of particles, which can move according to the governing equations where the properties of the fluid particles can be calculated using a unique kernel estimation. There, the Nearest Neighbouring Particle Searching (NNPS) process critically influences both the accuracy, and the computational time of the SPH based computation. Compared to conventional techniques used for this purpose, this research proposes a novel approach mainly targeting to reduce the computational time of SPH-based fluid dynamic simulations regarding plant tissues involving low Reynolds number flow conditions. Here, for a given fluid particle in the SPH scheme, particles located within a fixed distance range of three times the SPH smoothing length (h) are treated as neighbours, compared to dynamically computing the neighbours by searching the whole problem domain done in conventional approaches. This novel approach was tested on SPH-based plant tissue models having cell fluids, satisfying above flow conditions, and 33% to 44% computational time saving was observed, without compromising the model consistency for fresh tissues. The proposed approach has a higher potential of application for any meshfree-based fluid dynamic modelling application under above flow conditions, aiming to speedup the simulation process.

Key words: *Meshfree Methods, Nearest Neighbour Particle Searching (NNPS), Plant Cell Modelling, Reduction of Computational Time, Smooth Particle Hydrodynamics (SPH)*

*Corresponding Author: chaminda@mme.ruh.ac.lk

Forecasting Electricity Demand in Sri Lanka Using Artificial Neural Network and Time Series Method

M.H.M.R. Dilhani

Department of Interdisciplinary Studies, Faculty of Engineering, University of Ruhuna, Sri Lanka.

Abstract

Electricity load forecasting is one of the most critical factors for economic operation of power systems because daily global demand of the energy increases rapidly. In Sri Lanka energy usage with respect to the electricity demand is getting higher (Generation Expansion Plan - 2016, Ceylon Electricity Board Sri Lanka). Load forecasting has two-dimensional concept such as consumer and utility based forecasting system. Consumer based forecasting use to optimize network planning and investment and it reduces operational costs. Also, it immensely helps to reduce and manage the risk for electricity demand forecasting. Fundamental operations for the power plant needs to assist strategic decisions with regards to unit commitment. Therefore, forecast is dealt with the total power load system. This is normally performed by utility companies. However, the forecasting is a difficult challenge due to its complexity of future demand. Electricity forecasting is a process of predicting the magnitude of the electricity consumption for a particular area over different time horizons. There are three levels of forecasting methods, namely short term forecasting, medium term forecasting and long term forecasting. Short term forecasting is usually from one hour to one week, medium term forecasting is for a week to a month and long term forecasting can be extended for several months or years. In addition, the long term and medium term forecasts are used to determine the capacity of generation and transmission, distribution system additions, planning and annual hydrothermal maintenance scheduling. Long term forecasting is common as they are used in the planning and operation of electric utilities. In this research work, the long term electric load forecasting based on Artificial Neural Network (ANN) is implemented using MATLAB. Results are compared together with Moving Average (MA) and Exponential Smoothing (ES) method. Monthly electricity generating data are collected from Central Bank Annual Reports of Sri Lanka from 2004 to 2016. The choice of the inputs for ANN and time series method is based on the historical load demand. The data set is divided into two parts, as training data set (the data which is used for building the model) and testing data set (the unseen data which is used for forecasting and measure the goodness of the model). Forecasting accuracy of each model is performed by Mean Absolute Percentage Error (MAPE). The results show that the accuracy of forecasting using ANN is better, compared to MA and ES. Monthly MAPE for ANN is between 0.1 and 4.5 except in April. April has the highest forecasting error for all methods due to the highest electricity

consumption. However, ANN has the lowest forecasting error throughout the forecasting year.

Key words: *load forecasting, neural network, system-type architecture, time series methods*

*Corresponding Author: *rasika@is.ruh.ac.lk*

Development of Direct Heating Solar-Electric Hybrid Hot Water System for Domestic Usage

K.D. Sooriyaarachchi, M.G.H.P. Ekanayake, G.A.S.P. Gangodaarachch, K.T.K.M. Desilva and H.C.P. Karunasena*

Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka

Abstract

The energy generation and consumption in both, industrial and domestic level, is rapidly increasing in the world. Moving away from the existing reliance on fossil fuels and towards a more secure, clean and sustainable energy portfolio is a popular trend in the industries. Solar-based energy systems can be used to deliver not only electricity, but also hot water, space heating and even cooling, depending on the requirements. This study focused on the domestic hot water supply system with a new improvement of electric hybrid system. The objective of this study was to develop a solar-electric hybrid hot water system that can supply hot water at a constant temperature. In this study, a solar collector was used to collect the solar energy to heat up the water. Two kinds of experiments were conducted: Direct heating, where hot water coming out from the solar collector is directly sent to a storage tank and Indirect heating, where heat exchanger is used to exchnage the heat from hot water coming out from the solar collector to a storage tank water. Experimental results show that direct heating is suitable for water heating using solar energy, since it showed higher temperature increment from 8.30 am to 11.30 am with a temperature increment rate of 43% compared to the indirect heating. Wide variety of Solar-Electric hybrid hot water systems are available in the world for industrial usage as well as domestic usage. This kind of systems are mostly used for indusrial purposes in Sri Lanka. Solar hot water systems and electric hot water systems are widely used for domestic purposes. However, the domestic usage of Solar-Electric hybrid hot water systems are minimum in Sri Lanka. The aim of this study is to develop a Solar-Electric hybrid hot water system, which is domestic level usage suitable for Sri Lanka.

Key words: *Hybrid system, Domestic water heating, Hot water, Solar energy.*

*Corresponding Author: *chaminda @mme.ruh.ac.lk*

Spectroradiometry-based Rapid Detection of Leafroll Disease in Grapevines of North America

A.P. Rathnayake [a, *], R.R. Singha [b, c], L.R. Khot [b, c] and R. Naidu [d]

[a] Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka.
[b] Department of Biological Systems Engineering, College of Agriculture, Human and Natural Resource Sciences, Washington State University, Pullman, USA.
[c] Centre for Precision and Automated Agricultural Systems, Irrigated Agriculture Research and Extension Centre, Washington State University, Prosser, USA.
[d] Department of Plant Pathology, Irrigated Agriculture Research and Extension Center, 24106 N. Bunn Rd, Prosser, WA 99350, USA

Abstract

Grapevine Leafroll Disease (GLD) is a widely spread disease and major threat in grapevine (*Vitis vinifera* L.) cultivation. This causes reduction in yield and results poor quality fruits. Therefore, the GLD has become an intense area of research with great importance among the viticulture scientists and even with respect to ecology and management aspects. Several studies have been carried out using various techniques in order to find the appropriate remedial solutions for this virus infection. In order to control and minimize the impact of GLD, the early and accurate detections are essentially required. The use of optical sensing/imaging techniques for exploring biological activities has become very effective and hence popular due to promising results with high accuracy where the unseen world could be seen with more clear visuals. Several advanced optical sensing techniques are being used for precision agricultural applications especially for plant disease. Spectroradiometry is one of the fastest and accurate techniques based on light radiation, which enables to obtain the spectral reflectance patterns of the samples. The potential use of spectral reflectance techniques on detecting plant diseases have been verified by several studies. The accuracy of the method mainly depends on the spectral feature selection and analysis techniques. In our study, spectral data were collected from healthy and GLD infected grapevine leaves (both symptomatic and asymptomatic) on three different sampling days in the growth period of the grapevine. On each sampling day 60 spectra of healthy and infected leaves were obtained. Suitable feature extraction using stepwise linear regression and stepwise discriminant analysis reported significant visible differences between the healthy and infected plants (526, 626 nm) and near infrared (826, 901, 951, 976 nm) regions. The results from this study will be helpful in developing a low-cost field-portable sensing system for early detection of virul diseases of plant leaves.

Key words: Grapevine Leafroll Disease, Rapid Detection, Reflectance, Spectroradiometry, VIS-NIR
Corresponding Author: anura@mme.ruh.ac.lk

Effect of the NACA 2412 airfoil orientation on the performance of Darrieus Type Vertical Axis Wind Turbines

E.A.D. Kumara [*] and B.L.S. Thilakarathne

Department of Engineering Technology, Faculty of Technology, University of Ruhuna, Sri Lanka

Abstract

Vertical Axis Wind Turbines (VAWT) play vital role in renewable energy at present. There are two distinct types of VAWT. They are Savonius type VAWT which works on drag force and Darrieus type VAWT which works on lift force. The use of the NACA airfoil has attracted researchers to design wind turbines. This paper focuses on the selection of the best NACA 2412 airfoil orientation, which gives the maximum performance of a Darrius type VAWT by comparing the net moment coefficient acting on the turbine at various angles of attacks. As a prototype, 1.6 m diameter wind turbine with three blades, which has NACA 2412 airfoil cross section was studied. The aim was to design the turbine enabling the Darrius VAWT to operate with its maximum efficiency. For the analysis, number of models with different NACA 2412 airfoil orientations were analysed from oncoming air velocity $1ms^{-1}$ to $10 ms^{-1}$. Airfoil orientation was changed by 2.5 degree in the range of 0 degree to 30 degrees. Above mentioned parameters were analysed using Computational Fluid Dynamics (CFD) software package and the ultimate design was obtained in accordance with the results. Boundary layer & Rotating region were designed by using Solid Works and saved the designed files as step files. After that, the selected step files imported to ANSYS 14.5 and generated the mesh files. Hereafter, mesh files exported to FLUENT 14.5 for the simulations. Pressure based 2D planar space was used in the analysis and K-epsilon viscos model was studied under transient time base. It was observed that 5-degree angle orientation of the NACA 2412 airfoil blades with reference to the oncoming air flow line, gives the highest net moment coefficient on the turbine with respect to the wind speeds. Net Moment Coefficient is a dimensionless value. So, study about the dimensionless parameters gives us a universal solution. That means the results from this research addresses all scales of Darrieus wind turbines which has NACA 2412 airfoil cross section.

Key words: *Darrieus Wind Turbine, VAWT, Wind Power, CFD, NACA 2412 Airfoil*

*Corresponding Author: *dinesh@etec.ruh.ac.lk*

Conversion of Waste Polypropylene into Hydrocarbon Fuel – Analysis of Combustion Ability of Yield Hydrocarbon in Direct Injection Internal Combustion Engine.

E.P. Rohan, S. Baduge* and L.K.T. Srimal

Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka

Abstract

Recycling of plastic waste has gained increasing attention as land filling and incineration become more expensive and less accepted due to environmental impacts. More attention is thus being given to new recycling methods which are more environmentally attractive. Pyrolysis is one such promising method for the treatment of mixed and contaminated plastic wastes. In pyrolysis, plastics are thermally degraded to produce liquid hydrocarbons. Pyrolysis of waste plastics was investigated in a reactor system which consists of a semi batch reactor, a condenser and a liquid-gas separator. Liquid fuel obtained by the process was found to consists of light and middle distillate in the range of C_5 to C_{12} hydrocarbons with higher concentrations of C_7, C_8 and C_9 fractions. Non-condensable gas obtained was chemically equivalent to the LP (liquid petroleum) gas. The calorific value of liquid and gaseous fuel was found to be 43.5 MJ/kg and 42.5 MJ/kg respectively. In order to investigate the combustion ability of yield hydrocarbon fuel from waste Polypropylene (PP), experiments were conducted in a direct injection, compression ignition, internal combustion engine. Fuel derived from waste PP blended with diesel by the percentages of 10%, 20%, 30%, 40%, 50%, 60%, 70% and 80% were used in the experiments. The engine was able to run without any deviation in performances and vibration paterns up to 50% blend and small deviation were observed at 60% blend. A major deviations in performances, vibration paterns and sustaining engine speed was obseved with 70% blend and the engine was unable to run with 80% blend. Combustion ability of waste PP derived fuel in direct injection, internal combustion engine is at better level and the performance charasteristics of the engine when runing with fuel blends up to 50% is similar or better than that of diesel. Therefore, it can be concluded that the blends of waste polypropylene derived fuel can be used as a fuel for the diesel engines. However, purity of waste PP derived fuel fuel has to be increased to avoid negetive impact on the engine.

Key words: Combustion ability, Internal combustion engine, Hydrocarbon fuel, Pyrolysis, Waste polypropylene

*Corresponding Author: sumithb@mme.ruh.ac.lk

Investigating the Lubricating Properties of Palm Oil and White Coconut Oil

T.K.K.S. Pathmasiri [*], G.I.P. Perera and R. Gallage

Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Hapugala, Sri Lanka

Abstract

Bio-lubricants are prospective substitutes for the conventional mineral oil based lubricants because they provide good lubricating properties as mineral oils with the characteristics of being renewable, biodegradable and non-toxic. Reports indicate that global market value of bio-lubricants was nearly USD 2.01 billion in 2016 and is expected to reach USD 2.64 billion by 2020. Altering regulations of lubricant industry towards the bio lubricants makes it an industry with high future growth prospects. Generally, bio lubricants are made from vegetable oils. Triglycerides are major components in vegetable oils, in which glycerol molecules with three long-chain fatty acids attached at the hydroxyl group via ester linkages. Triglyceride structure gives good qualities for boundary lubrication. Their long polar fatty acid chains interact strongly to metallic surfaces providing high strength lubricant films. The long hydrocarbon chain is oriented away from the metal surface to form a monomolecular layer reducing both friction and wear. This paper discusses the evaluation of lubricating properties of Refined, Bleached and Deodorized (RBD) Palm Oil (PO) and White Coconut Oil (WCO) with three commercial lubricating oils (SAE40, SAE30 and Hydraulic68). Kinematic viscosity, viscosity index, flash point, pour point, total acid number, copper corrosion and demulsibility of the samples were measured. Both PO and WCO were identified as good candidates to improve, but PO showed better properties compared with WCO. PO has high kinematic viscosity (@40°C=38.88cSt, @100°C=9.99cSt), high viscosity index (259) and high flash point (305°C). However, both PO and WCO showed low kinematic viscosity than commercial oils therefore suitable modification is recommended specially at low temperatures. Pour point of PO (6°C) and WCO (24°C) was considerably higher than commercial oils. Therefore, both oils, especially WCO, pour point should be adjusted using suitable additives to enable it to be used as a lubricant. Overall PO showed better performance than WCO as a lubricating oil, which is a worthy substitute for commercial oils.

Key words: *Bio-lubricant, Lubricating properties, Mineral oil, Palm oil, White Coconut oil*

Corresponding Author: *kalpani@mme.ruh.ac.lk*

Development of a PET Bottle Disposal System by Cutting Them into Strips

N.K. Hettiarachchi[*], K.D.S. Priyanath, W. Nishantha and S.B.N. Madhuranga

Mechanical & Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka.

Abstract

Empty *polyethylene terephthalate* (PET) bottles have created a serious problem when they are disposed into open environment because they will not decay for a long time. This research is aimed at developing a waste management and recycling method for PET bottles. It will effectively reduce the volume of used empty PET bottles until the material is reused. A PET bottle cutter was developed to reduce the bulky empty space occupied by the bottles to a smaller volume, or smaller pieces. The process cuts a strip of PET, wind it on a spindle to reduce the space occupied by the empty PET bottle before storage, disposal or transportation. The aim of this work is to develop a cutter which will reduce the volume of commercially used PET bottles approximately by 90% and at the same time obtain a usable PET strip. The portable cutter is proposed to be used at the places of waste generation, which will reduce the garbage volume. The PET strip has several applications as it could be woven into a sheet or spun into a yarn due to its mechanical properties. The strip wined onto a bobbin can also be effectively transported to a PET recycling factory to reuse them for production of PET bottles.

Key words: Cutting, Environment, Polyethinine terephthalate (PET), volume reduction

*Corresponding Author: nandita@mme.ruh.ac.lk

Coupled Electron-hole States at Normal-Superconductor Interface of Strained Graphene

K.G.S.H. Gunawardana [a, *] and B. Uchoa [b]

[a] Department of Engineering Technology, Faculty of Technology, University of Ruhuna, Sri Lanka.
[b] Department of Physics and Astronomy, The University of Oklahoma, Norman, OK, USA.

Abstract

Graphene is a promising material for nanoscale applications due to its exceptional electronic, thermal and mechanical properties. It has been shown recently that the electronic and thermal properties of Graphene can be tuned significantly by engineering strain. Especially the strain field may couple to the electronic degree of freedom as it does with the vector potential. A uniformly varying strain field could create an effective gauge field, which leads to a constant pseudo-magnetic field. Recent studies have shown the feasibility of achieving a constant pseudo magnetic field in Graphene nanoribbons leading to pseudo Landau level quantization. In this work electronic properties of strained Graphene layer with pseudo Landau levels is studied in the presence of a superconducting contact. It is demonstrated that the existence of electron-hole coupled states due to the injection of cooper pairs in to the superconductor.

Key words: Graphene, Landau levels, Pseudo magnetic field, Superconductor, Strain

Corresponding Author: harshadewa@etec.ruh.ac.lk

A Small Scale Wave Energy Convertor System for ocean Wave-based Electrical Power Generation

H.M.A.S. Samarakoon [a] M.S.M. Safeer [a] Y.V.L.S. Pushpakumara [a] G. V. C. Rasanga [b] and H.C.P. Karunasena [a, *]

[a] Department of Mechanical and Manufacturing Engineering, University of Ruhuna, Sri Lanka.
[b] Sri Lanka Ports Authority, Magalle, Galle, Sri Lanka.

Abstract

Ocean waves is a viable renewable energy source for Sri Lanka since the island is entirely surrounded by the ocean having almost 20 kW/m energy density. Ocean wave energy is available throughout the year and provides many advantages over many other popular renewable energy sources such as solar and wind. However, only very limited research have been conducted in Sri Lanka on practical systems, which can harness energy from the ocean for power generation. In this background, this research aimed to develop a small scale ocean wave energy convertor (WEC) system applicable to conditions of ocean around Lankan. Accordingly, a small scale ocean wave energy converter system having theoretical capacity of 50 W, based on the heave-type wave energy conversion technology was developed and tested in the ocean bordering Galle. The system composed of a100 l floater attached to a 2.5 m long oscillating structure hinged to a static base having a sprocket and chain driven mechanical system, eventually producing a rotary motion of a flywheel set. The flywheel set carries two large-diameter bicycle wheels to which eight bicycle dynamos having 3 W capacity are attached. As the dynamos rotate, the generated alternating current is sent through a rectifying circuit to produce a 9 V direct current output. The system was tested in the ocean bordering Galle and average power generation was observed to be 8.1 W, resulting in an overall ocean wave energy to electricity conversion efficiency of 30%. Future work of this research will focus more on the improvement of the efficiency and reliability of the system while increasing the generation capacity. The insights drawn from this research will be highly useful in developing much larger scale devices capable of generating electricity from ocean waves around Sri Lanka, providing a sustainable solution to the prevailing local energy crisis.

Key words: *Heave type wave energy convertor; Renewable energy; Ocean wave energy extraction; ocean wave based power generation; Wave Energy Convertors (WECs)*

*Corresponding Author: *chaminda@mme.ruh.ac.lk*

A Semi-Automatic Bottle Filling System Designed for Sri Lankan Beverage Sector

N.M.C.S.S. Abhayawardana [a] and A.P. Rathnayake [b, *]

[a] Country Style Foods (Pvt.) Ltd, No. 57, St. Anthony's Road, Kadawatha, Sri Lanka
[b] Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka

Abstract

Fruit Juice Manufacturing is one of the most prominent segments within the beverage sector of Sri Lanka. Usually, filling process of fruit juice requires critical controls under strict hygienic conditions and other critical parameters to ensure the quality of the product. Local beverage manufacturers try to achieve these perfect conditions by investing large sums of money in complex machineries. They tend to make investments even without conducting a feasibility study and cost benefit analysis. Such investments will cause losses to the company. Therefore, this project aims to design a semi-automatic bottle filling device operating with all hygienic conditions and other operating parameters. Major objectives of the project were to minimize the required labour force for processing line, to increase the efficiency of filling process, and to develop a device which is having the flexibility to use bottles with different shapes and volumes. Based on these requirements, a final decision was made to design a Semi-Automatic Filling System, which is capable of filling a nectar bottle within 6 seconds. The significance of this system is that, a single person can deliver a production capacity of 1200 bottles/hour (190 ml and 200 ml bottles). Further, when using 500 ml bottles and 1000 ml bottles, it can deliver a production capacity of 400 bottles/hour and 200 bottles/hour, respectively. As per the observations prior to the design stage, it was found that a skilled person can process 250 to 400 bottles/hour (190 ml, and 200 ml bottles), manually. Therefore, with the proposed system, there will be a comparable increase in production capacity. According to the cost calculations done prior to the design process proves that this project will lead to an increase in the efficiency of production process, while saving on manual labour related expenditure. The proposed system can be further improved by combining both the filling and capping processes, so that the overall efficiency of the process can be further increased

Key words: efficiency, fruit nectar, manual filling, semi-automatic

Corresponding Author: anura@mme.ruh.ac.lk

Adaptation of Algorithms Implemented on Mobile Robots Formation Control

J.G.V. Priyanka [a], A.P. Rathnayake [a, *] and D.H.S. Maithripala [b]

[a] Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka.
[b] Department of Mechanical Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka.

Abstract

Navigation is one of the most debated problems in the area of Robotics. From the very simplest to the most complex applications, the challenges faced in navigation are unique and have to be addressed individually based on the situation. For instance, the Automated Guided Vehicles used in material transferring (AGVs) share a different domain of governing parameters, to an outdoor navigator in surveillance or search and rescue operations. This becomes the sole study of an individual entity to provide answers to the fundamental navigation problems observed everywhere, accepting their own uniqueness. This research study is based on testing Algorithms implemented in a Leader-Follower Robot platform to examine the performance of robots in non-holonomically constrained path planning. The control algorithms in study were, Proportional Controller based model, Proportional, Integration and Derivative (PID) Controller based model and Leader's velocity based PID controller model. These control models were implemented on a multi-agent robot system developed using an Arduino based single board computer platform and assisted by a set of quadrature encoders and an ultrasonic range sensor. The Leader robot is equipped with a high accurate line sensor and is directed to navigate on a line and the follower always reads the instructions communicated by the leader via a RF (Radio Frequency) link on heading direction and speed. The testing was done on three trajectories; straight line, curved symmetric track, and curved asymmetric track. According to the instructions received, the follower tries to mimic the leader's trajectory. During the implementation stage, it was revealed that adaptability of the third control algorithm remains more accurate than the others. The standard deviation of the error records also remains very low in the third algorithm compared to the other tested algorithms. Results propose that the prospective industrial applications would satisfy the implementation of the velocity based PID controller model algorithm, because of the better performance characteristics displayed during the implementation.

Key words: Navigation, Robotics, Mobile Robots, Self-Navigation

*Corresponding Author: varuna@mme.ruh.ac.lk

Acquiring Original Data from Shredded Documents Using Neural Network

C.R. Liyanage and P.K.S.C. Jayasinghe[*]

Department of ICT, Faculty of Technology, University of Ruhuna, Sri Lanka

Abstract

Shredding is a common way to eliminate documents containing sensitive and confidential data for legal and ethical purposes in different areas such as military applications, scientific inventions, businesses and government organizational applications. Hence acquiring original data from shredded documents is an important part of investigative sciences. Performing recovering process of the shredded documents manually can result in frequent human errors. Therefore, developing a computer-based recovery algorithm is of vital importance in obtaining original data efficiently and accurately. This study investigated an approach of using Neural Network (NN) in reconstructing shredded documents, which takes a scanned image consisting of document strips and outputs the fully or partially recovered original document as another image. The model was developed on single-sided, black and white typed text documents having maximum up to 20 vertical strips from each page. The process consisted of two main steps, namely pre-processing and reconstruction. In pre-processing, paper strips were scanned into an image, and then several image processing techniques were performed to gain shreds into different images without backgrounds. In Reconstruction, a correlation vector was obtained among each shred pairs by comparing the average neighbourhood intensities for each pixel along vertical edges of shreds. This correlation vector was prepared according to the data format suitable for NN. The proposed feed forward back propagation NN model was trained and tested to automatically find the best matching adjacent shred by feeding the correlation vectors as the inputs. This model increases the ability of addressing the vagueness of the algorithm. The algorithm was validated by reconstructing a considerable number of single documents and was proved to be effective with an average resembling frequency of ∼78%. The main advantages of the proposed method over the existing approaches are the simplicity, fastness, less human intervention and increased predictive and intelligent characteristics.

Thermal Performance Evaluation of Flat Plate Solar Collector with Different States of Roughness of Absorber Plate

C.P. Rupasinghe[*] and B. Rohanadeera

Department of Agricultural Engineering, Faculty of Agriculture, University of Ruhuna, Sri Lanka

Abstract

Solar energy is an important renewable energy source. The flat-plate collector is the simplest and one of the most effective means of collecting solar energy for use in systems that require thermal energy at comparatively low temperatures. Although, flat-plate solar collector is a very important equipment in food preservation sector, appropriate performance evaluation is still not carried out in Sri Lankan conditions as far as air heating is considered. Designing of a solar collector with optimum performance is advantageous for absorbing solar radiation for receiving high thermal energy. The present study was focused to select the suitable roughness for the absorber plate of the solar collector. The size of the newly designed solar collector was 700 mm wide and 1200 mm long. Gravel sieved through 20 mm mesh was used as the roughness material, a corrugated *Amano* sheet with 0.45 mm thickness was used as an absorber plate of the solar collector and plywood sheet with polystyrene layer was used as insulating material. Transparent glass cover with 5 mm thickness was used as solar radiation receiver. Four types of absorber plates with different surface roughnesses such as 300, 550 and 850 gravel per m^2 and a surface without gravel as a control were experimentally evaluated. The temperature and relative humidity of inlet and out let of the solar collector was measured during 30 minute intervals. Air flow rate and solar radiation were measured using anemometer and pyranometer, respectively. Observed data were statistically analysed using ANOVA by Software SAS to test the for significance of experimental results. Temperature of solar collector was increased with increasing surface roughness of the absorbing plate. While the highest out let temperature of the collector was observed with 550 gravels per m^2 lowest outlet relative humidity was observed in the absorber plate without gravel. The results revealed that surface roughness affects the performance of solar collector. Solar collector with the medium roughness recorded the highest outlet temperature.

Key words: Flat plate Solar collector, Collector efficiemcy, surface roughness

*Corresponding Author: chintha@ageng.ruh.ac.lk

Reviewers of 15th Academic Sessions

Snr. Prof. M. Wijerathne, University of Ruhuna
Snr. Prof. S. A. Norbart, University of Colombo
Prof P. Hewage, University of Ruhuna
Prof Prasanna Perera, University of Peradeniya
Prof. Anoma Abeyrathne, University of Peradeniya
Prof. Bilesha Perera, University of Ruhuna
Prof. Channa Yahathugoda, University of Ruhuna
Prof. D.M. Deepthi Yakandawala, University of Peradeniya
Prof. Devika Malkanthi De Costa, University of Peradeniya
Prof. E.I.L. Silva, Water Resources Science and Technology Ltd.
Prof. G.A.D. Perera, University of Peradeniya
Prof. Jagath Weerasinghe, Postgraduate Institute of Archaeology, Colombo
Prof. Mangala De Silva, University of Ruhuna
Prof. Mangala De Zoysa, University of Ruhuna
Prof. N.S.B.M. Atapattu, University of Ruhuna
Prof. P.A. Jayantha, University of Ruhuna
Prof. S.W. Amarasinghe, University of Ruhuna
Prof. D.S.A. Wijesundara, National Institute of Fundamental Studies, Kandy
Prof. Terrence Madujith, University of Peradeniya
Prof. Upul J. Sonnadara, University of Colombo
Prof. W.U. Chandrasekara, University of Kelaniya
Prof. Wasantha Priyadarshana, Nāgānanda International Institute for Buddhist
Studies, Kelaniya
Prof. P. V. de Silva, University of Ruhuna
Prof. Upali S. Amarasinghe, University of Kelaniya.
Rev Aparekke Siri Sudhamma, University of Ruhuna
Rev Koggalle Vijitha, University of Ruhuna
Rev M. Ariyawansa, University of Ruhuna
Dr. (Mrs.) M.B. Fausl Mafasiya, University of Ruhuna
Dr. (Mrs.) T.M.A. Tennakoon, University of Ruhuna
Dr. A. J .M. Chandradasa, University of Ruhuna
Dr. Athula Naranpanawa, Nathan campus, Griffith University, Australia
Dr. Chaminda Abeysinghe, University of Kelaniya
Dr. G. Edirisinghe, University of Ruhuna
Dr. I. Renuka Priyantha, University of Ruhuna
Dr. K. Ali, University of Ruhuna
Dr. Malaka Ranthilaka, University of Peradeniya
Dr. Nandasiri Keembiyahetti, University of Ruhuna
Dr. Pushpika Masakorala, University of Peradeniya
Dr. Ranjith Dickwella, University of Peradeniya
Dr. Rev B. Dhammajothi, University of Ruhuna
Dr. Rev M. Ariyawansa, University of Ruhuna
Dr. Rev U. Mahinda, University of Ruhuna

Dr. Ruwan Jayathilaka, Edulink International Campus, Sri Lanka
Dr. S. L. J. Franando, University of Ruhuna
Dr. Sirinama Bandara, University of Ruhuna
Dr. Sivarajasingham, University of Peradeniya
Dr. Thilak Bandara, University of Peradeniya
Dr. W.M.H.K. Wijenayake, Wayamba University of Sri Lanka
Dr. M.W.S. Sanjeewa Silva, University of Ruhuna
Dr. N.C. Ganegoda, University of Sri Jayewardenapura
Dr. (Mrs) G.D.M.N. Samaradiwakara, University of Sri Jayawardhanapura
Dr. (Mrs) S. Jayakody, Wayamba University of Sri Lanka
Dr. (Mrs.) M.W. Indrani, University of Ruhuna
Dr. A.M.T.A. Gunaratne, University of Peradeniya.
Dr. Anura P. Rathnayake, University of Ruhuna
Dr. A.R. Ariyaratne, University of Peradeniya
Dr. Arjuna Thanthilage, The Postgraduate Institute of Archaeology, Colombo
Dr. Athambawe Sarjoon, University of Peradeniya
Dr. Buddhika Annasiwatta, University of Ruhuna
Dr. Chaminda Karunasena, University of Ruhuna
Dr. Champa Wijesinghe, University of Ruhuna
Dr. D. de Croos, Wayamba University of Sri Lanka
Dr. D.A.U.D. Devasinghe, Rajarata University of Sri Lanka
Dr. D.C.T. Dissanayake, University of Sri Jayewardenepura
Dr. Damith Chathuranga, University of Moratuwa
Dr. E. I. Widyaratne, University of Ruhuna
Dr. G.D.K. Mahanama, University of Ruhuna
Dr. G.I.P. Perera , University of Ruhuna
Dr. H M M Herath, University of Ruhuna
Dr. H.A.D.S.D. Perera, University of Ruhuna
Dr. H.B. Asanthi, University of Ruhuna
Dr. H.C.P. Karunasena, University of Ruhuna
Dr. J.K. Vidanarachchi, University of Peradeniya
Dr. K.J.C. Kumara, University of Ruhuna
Dr. K.M.G.G. Jayasuriya, University of Peradeniya
Dr. K.M.M. Dsanayake, University of Ruhuna
Dr. K.J.C. Kumara, University of Ruhuna
Dr. M.G.T.S. Amarasekara, Rajarata University of Sri Lanka
Dr. Mahinsasa Narayana, University of Moratuwa
Dr. Manjula K Wanniarachchige, University of Ruhuna
Dr. N Dahanayake, University of Ruhuna
Dr. N.K. Hettiarachchi, University of Ruhuna
Dr. N.S. Abeysingha, Rajarata University of Sri Lanka
Dr. Nanditha Hettiarachchi, University of Ruhuna
Dr. Nisabha D. Jayasundere, University of Ruhuna
Dr. Pradeepa Korale Gedara, University of Peradeniya
Dr. R.M.K.T. Rathnayake, University of Sabaragamuwa

Dr. R.P. P.K. Jayasinghe, National Aquatic Resources Research and Development Agency
Dr. R.S. Dharmakeerthi, University of Peradeniya
Dr. Renuka Silva, Wayamba University of Sri Lanka
Dr. Ruwan Gamage, University of Colombo
Dr. S. S. Jayasinghe, University of Ruhuna
Dr. Sayaka Yoshikawa, Tokyo Institute of Technology, Japan
Dr. Seth Mberego, Ritsumeikan Asia Pacific University, Japan
Dr. T. Pratheepan, Uva Wellassa University of Sri Lanka
Dr. Thyagi Ponnamperuma, University of Ruhuna
Dr. Thyagi Ponnamperuma. University of Ruhuna
Dr. U.G.A.I. Sirisena, Rajarata University of Sri Lanka
Dr. U.I.K. Galappaththi, University of Ruhuna
Dr. U.P.K. Epa, University of Kelaniya
Dr. W. A. Udayakantha Vitharana, University of Peradeniya
Dr. W.A. Indika, University of Ruhuna
Dr. W.C.P. Egodawatta, Rajarata University of Sri Lanka
Dr. Warshi S. Dandeniya, University of Peradeniya
Dr. W.M.C.J. Wijekoon, University of Ruhuna
Dr. (Mrs) S.A.D.H.N. Suraweera, University of Kelaniya
Dr. (Mrs) W.K.C.N. Dayanthi, University of Ruhuna
Dr. A.M.C.P.K. Attanayaka, University of Peradeniya
Eng. J.A.A.D. Jayasuriya, National Engineering Research & Development Centre
M.H.J.P. Gunarathna, Rajarata University of Sri Lanka
Mr. Hemantha Kumara, University of Ruhuna
Mr. Lal Pannila, University of Ruhuna
Mr. Saman Udayakantha, University of Ruhuna
Mr. A.L. Sandika, University of Ruhuna
Mr. G.V.T.V. Weerasooriya, Rajarata University of Sri Lanka
Mr. Jagath Wickramarathne, SLIIT
Mr. K.A.S.H. Kulathilake, Rajarata University of Sri Lanka
Mr. N.V.G.A. Hemantha Kumara, University of Ruhuna
Mr. Asanka Karunarathna, Wayamba University of Sri Lanka
Mrs. M. S. Nanayakkara, University of Ruhuna
Mrs. R.P.S.H. Hettiarachchi, Sabaragamuwa University of Sri Lanka

Author Index

Notes

University of Ruhuna
Wellamadama, Matara
Sri Lanka
www.ruh.ac.lk