Faculty of Science
University of Ruhuna
RISTCON 2015

RISTCON 2015

Integrated Research for Development

Proceedings of 2nd Ruhuna International Science and Technology Conference

January 22-23, 2015

Abstracts and Plenary Lectures

Faculty of Science
University of Ruhuna
Matara 81000, Sri Lanka

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Foreword

The 2nd Ruhuna International Science and Technology Conference, RISTCON 2015 was organized by the Faculty of Science, University of Ruhuna with the theme 'Integrated Research for Development'. The abstracts arisen from research work in diverse disciplines of Science & Technology have been peer-reviewed prior to acceptance. The abstracts have been edited to maintain language accuracy and page limits. An official electronic PDF copy of the book will be available at http://www.sci.ruh.ac.lk/conference/ristcon2015 of University of Ruhuna website. Responsibilities of the content text of the abstracts included in this publication remain with the respective authors. No part of this serial publication will be reproduced in any form.

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Message from the Vice Chancellor, University of Ruhuna

After a successful International Conference on Science and Technology (RISTCON -2014) during the last year, the Faculty of Science of the University of Ruhuna is now planning to hold another international conference "**2nd Ruhuna International Science and Technology Conference (RISTCON – 2015)**". The conferences provide an opportunity for academics to transmit the knowledge generated through their research to the scientific and industrial community. Further, conferences are considered as a vital part of academic programmes of any good university. As the Vice Chancellor of University of Ruhuna, I am happy to see that the Faculty of Science with the limited facilities available is organizing an International Conference for the second consecutive year to fulfill this essential requirement. I am also glad to learn that many academics and scholars especially from Asian continent are expected to participate in this conference. It indicates that this conference will provide a good platform for our academics to share their knowledge in the fields of Science and Technology with rest of the world. Therefore, it is with great pleasure I write this message to the proceedings of the **2nd Ruhuna International Science and Technology Conference (RISTCON – 2015)** organized by the Faculty of Science, University of Ruhuna.

First of all, I as the Vice Chancellor of University of Ruhuna wish to offer my heartiest congratulations to the Dean of the Faculty of Science of the University of Ruhuna and the organizers of "RISTCON-2015" for their efforts to make this event a success. I consider the theme of the sessions "***Integrated Research for Development***" provides an appropriate and well-timed platform for academics and researchers from various disciplines to present their findings and exchange ideas on various topics related to science and technology. This conference will also provide an opportunity for the Faculty of Science to strengthen the process of translating their new discoveries into products and services for the betterment of the community. Translation of research findings into a practical application is only made possible by linking university academics with other stakeholders in a forum

like this. Therefore, again I consider this conference will help our country to develop through integrated research.

Organizing an international research conference is a big challenge and I am confident that the Faculty of Science would hold this conference to the expectations of the world academic community. Once again I extend my congratulations to the organizers of the Conference and wish them all success. I believe this occasion will be used as a platform for our academics to strengthen their links with other universities and research institutes in knowledge generation and sharing while same time provides the necessary thrust in collaborative researches. I wish all the best for all paper presenters and participants.

Senior Professor Gamini Senanayake

The Vice Chancellor

University of Ruhuna

Sri Lanka

Message from the Dean, Faculty of Science, University of Ruhuna

It is with great pleasure that I issue this message for the 2nd Ruhuna International Science and Technology Conference, RISTCON-2015, which is a continuation of the Science Symposia of Faculty of Science started in the year 2002.

As the theme 'Integrated Research for Development' indicates, the objective of this conference is to provide a platform for scientists in different disciplines to present their findings with the expectation that immense knowledge to be integrated to solve practical problems towards development.

Especially for a country like Sri Lanka, having a vast range of natural resources and a rich traditional knowledge, both fundamental scientific knowledge as well as their application for real world problems must be utilized wisely for the economic development of the country. For example, some of the minerals available in the country, such as ilmenite, rutile, zircon, monazite, garnet, quartz and natural graphite are known to have very high quality, but exported with no value addition. It is an obligation of scientists to develop techniques adding value to such minerals before exporting. Traditional knowledge, practically used in the past with utmost success, has not been well understood in the context of modern science. Exploration of this knowledge would be an opportunity for scientists to enhance their understanding and to create new avenues. Also, it is a responsibility of the government to provide financial assistance to develop research in fundamentals of science as well as in applied science. In particular, international collaborations have to be supported so that Sri Lankan scientists could get exposure to updated knowledge in the world.

It is not an easy task to organize an event of this magnitude without the commitment of the organizing committee. I would like to take this opportunity to thank the organizing committee chaired by Prof. P.D. Abeysinghe, for their devotion and untiring effort during the last few months to make the event a success.

Professor W.G.D. Dharmaratna
Dean, Faculty of Science
Senior Professor of Physics
2015.01.22

Message from the Chairperson- RISTCON 2015

It is with immense pleasure that I send this message on behalf of the Ruhuna International Science & Technology Conference (RISTCON) 2015 organizing committee on the occasion of RISTCON 2015 organized by the Faculty of Science, University of Ruhuna, Matara, Sri Lanka. Our Faculty has a long history since 1978 and academics of the Faculty of Science have extensively contributed to research in science and related disciplines since its commencement. Many of them have received prestigious national/ international awards and were successful in obtaining significant amount of grants for research. Moreover, a large number of publications have come into limelight in national/international high quality journals and many presentations have been made locally and globally.

Sri Lankan Government and the Ministry of Higher Education have an objective to transform and rank the University of Ruhuna into the arena of one of the best performing universities of the world. Therefore, this event would contribute immensely to establish the University of Ruhuna as an internationally acclaimed institution and to establish as a center of excellence in scientific research and education in the Southern region in Sri Lanka.

Our Faculty expects to promote her academics to carry out integrated research which receives higher attention. Therefore, RISTCON 2015 is organized with the theme of 'Integrated Research for Development' to make a podium for leading academics, scientists and researchers in the country and foreign countries to exchange and share their knowledge and experience in different disciplines and further to establish global partnerships among research communities for future developments in science and technology. 'Integrated Research' is very important and this is being popularized even in Sri Lanka and is expanding in the field of science. It is an approach in which researchers from a wide range of disciplines work together to address challenges and problems to develop scientific and technological strategies for development of a country and the betterment of mankind.

Our conference anticipates more than 300 participants with keynote and invited lectures, oral and poster presentations by the eminent scientists of the world. This is an excellent opportunity for the presenters and the participants to interact with the world class scientists. Moreover, this event would be an excellent opportunity for the academic staff of this university to enhance their research reputation through presenting their research findings and establishing collaborative research partnerships with local/international scientists.

As the chairperson of the organizing Committee, I take this opportunity to thank the organizing committee and the editorial board for their cooperation, untiring effort, devotion and commitment to make this event a success. The administrative support, encouragement and the guidance given by the Dean, Faculty of Science is highly appreciated. I thank the Heads of all Departments, academic and non-academic staff members, Assistant Registrar, Faculty of Science and the Special Degree students for their cooperation. On behalf of the organizing Committee, I wish to express my gratitude to all authors and participants who contributed by submitting the papers and interested in sharing their knowledge and research in the arena of RISTCON 2015. Our special and sincere thanks go to keynote and invited speakers who came from far away accepting our request to deliver lectures. I wish all the presenters and the participants a very successful, fruitful and productive conference, RISTCON 2015. Finally I greatly appreciate the financial contribution made by the sponsors of the conference, especially the Chairperson of the UGC, and without their assistance we would not be able to organize such an event like this.

Prof. Pushpa D. Abeysinghe
Chairperson
RISTCON 2015

Message from the Chief Guest: Chiarperson- University Grants Commission

I am very much pleased to issue this message on the occasion of the Second International Conference organized by Faculty of Science, University of Ruhuna–RISTCON. I am aware that, from a humble beginning in the leased premises of the Technical Colleges at Meddawatte, Matara in 1978, University of Ruhuna has travelled a long and arduous journey, strong and united in the face of manifold challenges and hardships. The university has continuously developed over the years step by step through commitment and hard work of administrators, academics, staff & students, and have reached the present heights. I am happy to note that today University of Ruhuna has eight faculties, namely Agriculture, Engineering, Humanities and Social Science, Management and Finance, Medicine and Science, Fisheries and Marine Sciences & Technology and Graduate Studies. Being closer to the sea, it is significant to have the one and only Faculty of Fisheries and Marine Sciences & Technology.

With the progress in academic, research and outreach spheres, the University of Ruhuna has emerged not only as the intellectual pulse of the region, but also as a premier seat of higher learning in the country. It is with these achievements and accomplishment to its credit that the Faculty of Science is celebrating its Second International Conference under the theme "Integrated Research for Development". In the annals of any institution, an International Conference is a landmark event that bears special significance.

The need of the hour is to build an innovative entrepreneurial and dynamic nation with a deep sense of patriotism and national consciousness having a strong commitment to social harmony. Therefore the university should make use of the conference to sow the seeds of innovation, national consciousness in hearts and minds of our people especially youth, through appropriate research programs.

While sharing in the rejoicing of this landmark event, I am honoured to be the Chief Guest of the Conference. I am overwhelmed by the magnitude and scope of this multi – purpose and multi – faceted event. It is needless to add that an event of this magnitude cannot be successfully organized without the assistance and cooperation of the academics, administrators, non – academics, students, alumni, sponsors and other stakeholders.

I take this opportunity to commend Professor W G D Dharmaratne, Dean of the Faculty of Science, Professor G Senanayake, Vice-Chancellor for their leadership in organizing this event. I also thank the academics, administrators, other staff & students for their commitment in making this conference a success. I wish the international scholars, a productive and a memorable stay in our beautiful country.

I am sure the conference will have a productive outcome that could be applied for betterment of the society.

Professor Kshanika Hirimburegama
Chairperson
University Grnats Commission of Sri Lanka

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Keynote speech

'Socioeconomic and Environmental Sustainability through Integrated Research for Development – A Sri Lankan Focus'

Prof. Dilantha Fernando

Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada

Sri Lanka with a documented history of over 3000 years has a rich past as a civilization based on agriculture. Although only one third of its population is now engaged directly or indirectly in agriculture, it is imperative to feed its' citizens while exporting certain commodities to bring revenue to the country. As a developing country, Sri Lanka needs to focus its efforts to invigorate the socio-economic and environmental sustainability through an integrated approach through research and development. The socio-economics of a country is highly dependent on a few key indicators, such as health, income, education, housing and occupation. The health and wellbeing of its citizens are connected to the attainment of these key indicators. This presentation will focus mainly on the needs seen through the eyes of an agriculturist who works on research methods to develop sustainable approaches to the advancement of agricultural processes to gain high yields while protecting our environment.

The very nature of development requires continuous and rapid change. While agriculture has its roots around the civilization or vice versa, the island contains tropical rain forests and a diverse landscape with a high amount of biodiversity, many being endemic. With abundance in biodiversity, Sri Lanka can and should focus its efforts at protecting these valuable resources, whether it is fauna, flora or its water resources. Though development in all areas is required as a nation building on capacity, it is equally important to maintain its air and water quality while protecting the environment. On the other hand, the very nature of development dictates pollution of environment through deforestation, ozone depletion, excessive carbon dioxide emission,

threat to biodiversity, freshwater and oceans. This calls for good governance through adequate research and development.

Sri Lanka has gone through several types or periods of agricultural success. The green revolution brought high yields while using a record amount of inorganic fertilizers and pesticides (insecticides, herbicides and fungicides). While these key inputs helped the growers with high yields, it was also the beginning of pollution in air and water quality. Excess or indiscriminate use of these products needs to be monitored and if required phased out. However, we also need to be proactive in making sure that there are several strategies in place to protect our crops. Some of these are the use of natural enemies of crop pests and pathogens, also known as biological control. Biological control is an environmentally friendly alternative to the use of pesticides to reduce pests and diseases. This tri-partite interaction(s) occurs in nature as a natural phenomenon, and once well researched, could be augmented to the benefit of the host crop. Beneficial microorganisms occupy niches in the soil, rhizosphere and the phyllosphere. By creating an environment more suitable for the beneficial microorganisms, biological control of the crop pathogen could be increased. Breeding for disease and pest resistance is one of the environmentally safest and most economical methods with no costs to the grower. Understanding the genetics of the hosts, pests and their interactions, help develop resistance to these pests through conventional breeding methods. Developing disease and pest forecasting systems for major diseases is another environmentally friendly method in reducing pesticide applications. For crops such as potatoes which may require multiple applications of a pesticide (10 to 14 applications of a fungicide to control Late blight disease) could be reduced to 5 to 7 by a sound and reliable late blight forecasting system. In addition, some plants may have their defenses against pests/pathogens enhanced when challenged by the pest/pathogen (systemic acquired resistance - SAR) and at times when primed through the presence of a beneficial microorganism (induced systemic resistance - ISR). All these methods are environmentally friendly and provide adequate protection to the crop. Some microorganisms in soil are capable of increasing the nutrients in soil or directly in the plant, or by helping in the nutrient uptake (i.e. rhizobia that fixes nitrogen, vesicular arbuscular mycorrhizae in phosphorus uptake). Long term agricultural systems could be made more self-sustainable through improvement of the

soil structure, and increasing a rich abundance of beneficial microbial populations. In addition it could be further improved by amendment of soil with organic matter. A good example is tea plantations where soils could be improved through expert knowledge of the soil system. Soil amendments that increase water retention, reduction of root, stem and foliar diseases and pests should be achieved if we are to be the world leaders in the production of quality tea. The crop/soil scouting and application of chemicals as nutrients can be improved with precision farming techniques using recent advances in nanotechnology. These changes should be done to suit our Sri Lankan agricultural systems through the invention of machinery by engineers working with agricultural scientists. The reliance on inorganic fertilizers and pesticides could be reduced, and help maintain a sustainable environment while increasing yields. This can only be achieved with efforts in research and development, using conventional and modern techniques. Advancing our understanding of these processes could be further improved with modern techniques such as molecular biology techniques, and the Omics (i.e. genomics, transcriptomics and proteomics).

Agriculture, aquaculture, biodiversity and other important environmental indicators may be challenged by a new threat; that is global warming and its subsequent impact on climate change. Therefore research and development should be cognisant of this impeding challenge to nature and attempt understanding the likely changes to fauna, flora, our water capacity and the need for changes in agricultural crops and practices. Another challenge that may be posed by climate change is the activity of plant pathogens and pests. For example, groundnuts are infected by *Aspergillus* sp. that produce toxins (i.e. mycotoxins) that are capable of causing health problems including being carcinogenic in humans and animals when consumed. Production of mycotoxins on crops is mainly dependent on climatic factors such as temperature and relative humidity. Aflatoxin producing fungi are native to tropical, warm, arid, and semi-arid regions: changes in climate result in large alterations in the quantity of aflatoxin producing fungi. Therefore change in climate has a direct impact on mycotoxin production. The Intergovernmental Panel on Climate Change (IPCC) stated in its Fourth Assessment Report (AR4), published in 2007, that temperature will rise by approximately 4ºC in 100 years.

Increasing global temperatures would have significant impacts on agriculture worldwide. Increasing temperatures of 1-3°C are predicted to increase global agricultural production on the whole resulting more crops in currently cooler regions (eg: parts of Northern Europe) and fewer crops in currently warmer regions (eg: areas in Africa). Although, it is predicted that the increased temperatures can increase the global food production in currently cooler regions, a number of agricultural entities could be affected by these climatic factors, including soil quality, crop yields, and the biological environment of crops such as the abundance of beneficial microbial populations in soils, pests and plant pathogens. Among these many agricultural entities, climatic alterations may have a greater impact on plant–pathogen interactions. Most of the plant pathogens have optimum temperatures for their growth and mycotoxin production. Mycotoxins are among the major foodborne risks that are most vulnerable to climatic changes. The ability of fungi to produce mycotoxins is largely influenced by temperature, relative humidity, insect attack, and stress conditions of the plants. Additionally, it has been reported that more extreme rainfall and drought events would favour formation of mycotoxins. Therefore changes in global temperature would directly affect their growth and mycotoxin production capability. Global warming will not only act on patho-systems already present in certain regions, but will facilitate the emergence of new diseases and new pathogens because the changes in climatic factors can modify the present behaviour of pathogens and enhance the development of new mechanisms to fit into the new environment. This would ultimately result in emergence of new diseases and newer mycotoxins with novel characteristics.

In conclusion, rapid development and climate change will add new challenges to the future food production and food security; therefore it is imperative to continuously monitor the changes in climate and the environment while maintaining high standards in food production systems and food security. Significant efforts should be taken to reduce factors that enhance environmental pollution, global warming and the rate of climate change thus ensuring our fauna, flora, agricultural crops, water and biodiversity is preserved for generations to come. A country that can boast on a civilization that was built around agriculture should heed to making history again!

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Plenary lecture

Role of high technology and citizen science in conservation biology of tropical ecosystems: The rocky path from Paine and Pimm to the terragreen Network (TGN)

Professor Monte Cassim

Professor (Health, Environment and Life Science), Ritsumeikan Center for Sustainability Science, japan

Background: It is easy to fall into a utilitarian trap when science has to be mobilized for development. The agency for development, irrespective whether it is public or private, becomes the client of the scientist, whose independence can be compromised by virtue of this relationship. How can we escape from this trap as scientists and yet serve our country and its communities? Considering how expensive research has become in recent times in the natural, engineering and medical sciences, it is not easy to dismiss these external sources of research sponsorship either. I have found resolving this dilemma to be the most challenging of tasks in creating conducive research environments, where the joy of discovery can be coupled with the gratification of what it delivers to citizens. There is also another dilemma. Why have the natural sciences, especially the fundamental sciences, become so removed from the citizens at large? One does not have to be a writer to enjoy a book. Nor does one have to be a composer or accomplished pianist to appreciate good music. Why are the arts so intertwined with our lives while the sciences tend to stand aloof? This is the background to some of the thoughts I would like share with you today, viewed through the lens of a particular research endeavour in the field of conservation biology.

Beyond Paine and Pimm: The first part of this presentation relates to how a quarter century of field science led to a "eureka moment". In the passage to discovery in the field of science we are trained to review the works of our peers and mentors. My work led me to two giants in the field of conservation biology. One of them was Robert Paine, who empirically indicated the significance of "keystone species" in conserving ecological habitats. Paine showed that removal of the keystone species caused ecosystem collapse, leading to mass mortality and even extinction of species in that particular habitat. The other was Stuart Pimm, whose work on food webs was also

inspirational. How did these two scientists influence my work? I asked myself if it would be possible to regenerate biodiversity and re-create an ecosystem by re-introducing keystone species into damaged habitats. In other words, could Paine's finding be stood on its head to achieve the reverse phenomenon? This led to many questions. Many different types of keystone species had been identified. Some created optimal physical environments for many other species to reproduce. Others disposed of detritus. Yet others provided food for many. I chose to focus on this last group. Influenced by Pimm's work, I felt that if biodiversity was to be restored, the starting point would be re-establishing the food chains and webs.

Field Science: This led to empirical work in the Malesian rainforests of Sabah in North Borneo. It appeared that the giant fig, a daily provider of sustenance to a host of birds and animals, including the endangered primate, the Orang Utan, was a good candidate for one of the keystone species. The second keystone species chosen was the giant dipterocarp. With its irregular mass synchronized flowering and subsequent seeding, which could occur at any time between two to ten years or so, the dipterocarpaceae occasionally provided an abundance of food, often helping to supplement depleting species counts due to a range of environmental hardships, such as drought. The giant fig, incidentally, has a symbiotic relationship in its early life with the dipterocarp. It was walking in the rainforest, observing different stages of this relationship until the fig completely subsumes its host when the "eureka moment" came.

The "Eureka Moment": The Danum Valley Field Centre, the Sabah Foundation's rainforest research organization located in the heart of 40,000 hectares of primary forest within the Foundation-managed 1 million hectares of timber lands, conducted a series of field experiments in resurrecting biodiversity in rainforests. One of the challenges was the high mortality rate of dipterocarp seeds in damaged habitats. Another was top soil runoff and the drying of soils. Several such hurdles had to be overcome, but progress was made and good practice guidelines for sustainable forest management evolved out of this. The forest workers who managed the Foundation's timber lands were mobilized to collect dipterocarp seeds and to care for them in nurseries until they were about 60 cm high, after which they were planted in the area to be regenerated. With time, increasing insect counts and diversity indicated that nature had taken over and biodiversity regeneration was under way. The steps of the process were the enlightened outcome of the "eureka moment", viz: First, find at least two keystone species which could contribute to the restoration of food webs, then nurture them in a certain

proximity to each other and finally, be patient…until nature takes over and biodiversity begins to reappear. There was only one snag. Insect count based calculations indicated that it would take 40-60 years for the original biodiversity to be restored. I was 56 years old at the time. It was very unlikely that I would see the results of this work in my lifetime. But scientists are strange animals. There is an irrepressible desire to see the outcomes of work one is engaged in. The answer was to see if the restoration principles would hold in other habitats.

From Rainforest to Coral Reefs: I stumbled upon Don Baker, who was restoring damaged coral reefs in the Tungku Abdul Rahman National (Marine) Park just offshore from Kota Kinabalu, the capital of the Malaysian State of Sabah. Working with a wealthy hotelier who had a vested interest in transforming the coral reef around his establishment he financed Baker's dream. Baker's findings were that if the giant clam was introduced strategically into damaged reefs, the zooxanthellae that grow in the conducive environment provided by this symbiotic host flourish. As their numbers increase they are released from the giant clam and if they land where coral spores exist, a new symbiotic relationship emerges. The zooxanthellae are micro-algae which can convert sunlight into energy. They provide the coral with nutrients and their carbon capture mechanism contributes to the calcium carbonate exoskeletons of corals, the building blocks of reefs. As the coral reefs flourish, nature takes over and marine biodiversity is restored. This time, however, the process occurs in 4-6 years….the scientist's prayers were answered!

From Setbacks to Saviour: Armed with nearly a decade of data, I was ready to do the analysis when disaster struck. A thief entered my flat, stole two computers (one of which had data backed up), my video and still cameras and the tapes and negatives in the camera box. Worst of all, at the base of the camera box lay the decade of handwritten data and field notes. While I still remembered much of it, I decided to impart as much of it as I could to my students. A research group called ATE (Action for Tropical Ecosystems) was formed in my lab (the Discovery Research Laboratory, or DRL), led by an extremely able doctoral student. She went on to perform brilliantly in the professional world, first working for UN FAO and later in the OECD's Environment Unit, writing the first chapter of the environmental outlook until 2025, when disaster struck again. At the age of 32, this promising early career researcher contracted cancer and passed away. This led to a Kafkaesque situation where even I began to think that this biodiversity restoration work was full of ill omens. This was amplified

because of an incident that had led me to suspend work in the rainforests of Sri Lanka in the late 1990s. The suspicion that a bioprospecting company had infiltrated one of my research team members led me to suspend operations in Sri Lanka for ethical reasons. This was what took me to Malaysia, where I was able to start anew with better checks on such incursions. I wished to take this work to other localities and had a very animated exchange with Professor Wangari Maathai at an international conference in Abu Dhabi. We decided that her "Billion Tree" campaign could use the principles of restoration unearthed in Malaysia. However, before these thoughts could proceed much further, the good lady passed away. In a moment of weakness, I aired my tale of woe to a fresh post-doctoral fellow, Dr. Park Jung-Hwan, who had joined my lab about three years ago. In any event, I concluded, what impact would a few doctoral research fellows trained in my lab have in the face of the enormity of the task of inventorizing biodiversity or in restoring it where damaged? He said "Give me a week to think about it". Out of this modest moratorium he asked for, the TerraGreen Network (TGN) Project, subject of the second part in this presentation, was born.

Introducing TGN: This project attempts to create a plant census by integrating high technology with what is now beginning to be known as "citizen science". As primary producers, vascular plants are stalwarts in capturing, storing and disseminating energy for sustaining terrestrial life on earth. A global inventory would benefit conservation biologists tremendously, particularly in tropical ecological habitats where levels of biodiversity are highest, but the million dollar question is "how do we achieve this?" There are differing views on how diverse tropical ecosystems are, with figures for biodiversity assessment ranging from 10 million to 30 million species. If it is the former we know a little over 20 percent of them and if the latter around 7 per cent. The dilemma is that in view of the magnitude of the task, the number of professionally trained scientists is way too small. What the TGN project does is to show a modality which: (1) Mobilizes advanced technologies; (2) Has platforms and modalities for scientists to collaborate with citizens; (3) Creates an open access bio-inventory archive; and (4) Includes an educational component to mobilize and nurture "citizen scientists". A simplified image of the TGN components is indicated in figure 1 below:

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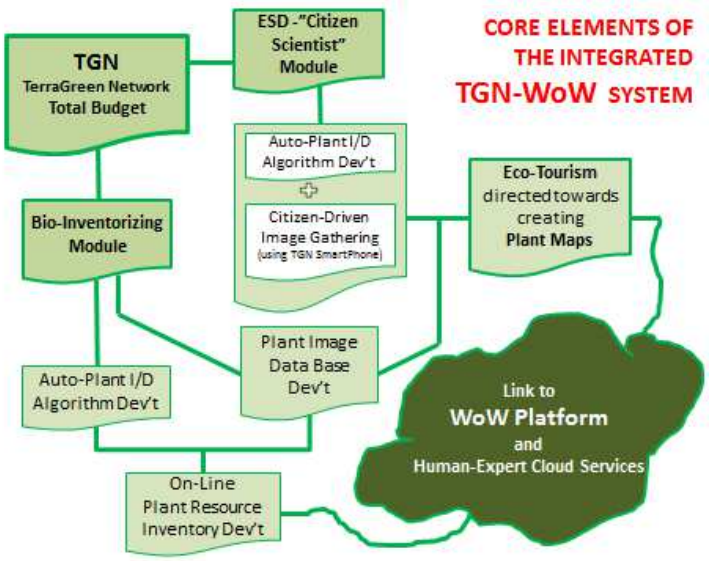

Figure 1: Core Elements of the TGN-WoW System
(Source: Author, 2013)

The Primary Tasks: There are three fundamental tasks in establishing TGN, viz: (1) Image gathering for plant identification; (2) Algorithm development for auto-identification of plant image; and (3) Online plant resource inventory development. The sub-tasks among these three are grouped into the Bio-Inventorizing Module, which requires formal scientific expertise supported by "citizen scientist" image gathering from the Education for Sustainable Development (ESD) Module, which is also where the "citizen scientist" collaborates with scientists in creating pedagogic materials. The tasks and their outcomes are linked to a "Human Expert-Cloud" (HEC) service, based on an internet platform called WoW (Web of Wisdom), which provides: (1) Imaging protocols and help lines for both scientist and "citizen scientist"; (2) Domain expertise support in conservation biology and relevant ICT aspects; and (3) A cyber archive of educational materials regarding plant characteristics and plant locations coupled with an auto-plant identification function. Work on the Bio-Inventorizing Module, leading up to auto-identification algorithm development commenced in 2011 as a Japan-Korea collaborative in temperate ecosystems. The next step is to commence pilot experiments for creating plant inventories in tropical ecosystems where the biodiversity is much richer and the need for "citizen scientist" contributions more critical. Malaysia, possibly in the North

Bornean State of Sabah, and Sri Lanka, in and around its "Man and Biosphere" reserves, have been targeted for the next stage of the project.

Capturing Sri Lanka's Biodiversity: Considering that Sri Lanka has one of the world's richest biodiversity heritages but is also a biodiversity hotspot with endangered habitats, the TGN plant census will lay the foundations for conserving Sri Lanka's forest biodiversity by training and mobilizing the "citizen scientist" to work in collaboration with scientific experts to create a plant census, where the forest habitat is seen as a living learning laboratory. Modalities employed in the pilot plant census building in Japan and Korea can be tried out in the buffer zone of the Sinharaja MAB reserve and the Knuckles Wilderness Area MAB reserve. It can be used for developing environmental educational materials around conservation zones as part of UNESCO's Education for Sustainable Development (ESD) initiative. The use of "pervasive ubiquitous computing (PUC)" devices such as smartphones, "smart papers" and digital pens will result in the development of "smart" pedagogic applications, which can be widely applied in other learning environments. This can also help in the promotion of eco-tourism and getting user feedback from the tourist, trekkers and travelers.

In Conclusion: The ultimate aim of this presentation is to inspire early career researchers and those interested in conservation biology, be they scientific experts or ordinary citizens. A large number of people can, and indeed must contribute to biodiversity conservation because our genetic heritage is at risk in this "Anthropocene Age", where Homo Sapiens appears to be a super dominant species. It is wise to remember what struck me as I walked through the Malesian and Amazonian rainforests. The species that outlasts all is not the strongest or the biggest…it is the most adaptable! Human beings must become wiser in the ways of the forests and coral reefs, which have been around for far longer on earth. I look forward to furthering the TGN project in Sri Lanka and would greatly welcome your support. I wish to thank the organizers of RISTCON 2015 for giving me the opportunity to share my thoughts with you. Young researchers, you can be sure that in a field like conservation biology there will be ups and downs in your professional career paths. Draw strength from the citizenry, like the arts have done from time immemorial, and remember Winston Churchill's words in the darkest hours of World War II for the Allied Forces: "Success is not final, failure is not fatal; it is the courage to carry on that counts!"

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The genetic control of rice yield using novel genes

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I appreciate organizers to giving me a great opportunity to have a chance to speak here. Today the talk will be about the genetic control of rice yield using novel genes.

As you all know, the population growing exponentially. To feed the ten-billion people in 2050, we should keep increasing cereals production constantly. Cereals production consists of “cultivated area” and “yield per area”. So, we should increase these parameters. Rice yield per area is determined by two component, Source and Sink size. Source can be consisted of “photosynthetic rate in leaves” and “carbohydrate translocation from leaf blade to leaf sheath or to sink”. Sink can be determined by the product of “tiller number”, “grain number per panicle” and “grain weight”. So, the yield is a product of total sink size and source ability. To increase rice yield, we should enhance both these components. If sink size was excessive, the source woughd limit the yield. If source was excessive, the sink would limit the yield. The balance of these two parameters is important to increasing rice yield.

In rice, the numbers of genes have been cloned by QTLs analysis. For sink development, some genes for regulating grain numbers and many genes for grain size have been cloned. While for source function, the reports was limited. Recently, Dr. Takai has reported that the amino acid substitutions in *NAL*1 resulted in the increases in photosynthetic rate per leaf area (Takai et al 2013 Sci. Report 3, 2149). To increase rice yield, it is important to search and collect positive alleles to increase both source and sink.

In 2003, Dr. Ishimaru found QTLs for grain weight in chromosome no 6th (Ishimaru 2003 Plant Physiol. 133, 1083-1090). This QTL increases grain weight without decreasing the ratio of filled grain, and resulted in increasing grain yield. We first positional cloned the responsible gene for *qTGW6*. We

carried out high-resolution mapping with homozygous recombinant plants and delimited the *TGW6*-containing region to 4.9 kb between two markers. In this genomic region, there was only one ORF. This gene has only one exon.

The "Kasalath" allele contained six nucleotide substitutions and a 1-bp deletion at nucleotide 313 compared to the "Nipponbare" allele. The 1-bp deletion caused a frameshift and prevented the production of the mature protein. So, this 1-bp deletion might gives functional loss of the Nipponbare-type TGW6 protein. To show the complementation test, we transformed a RNAi construct for *TGW6* into "Nipponbare". Grain length in the transformants was significantly increased. This increase in grain length was negatively correlated with *TGW6* gene expression. Thus, we could confirm that the loss of *TGW6* gives grain length up.

According to BLAST search, TGW6 was similar to strictosidine synthase. It is a Key enzyme alkaloid biocynthesis. However, in rice grain, there would be no accumulation such alkaloids. Thus, TGW6 should have another unknown functions.TGW6 have a similarity with strictosidine synthase (STR1) and DFPase, these are structurally known proteins. These proteins have a large cavity, substrate binding sites. Then, we modeled TGW6 protein structure from these known structures. This is a modeled TGW6 structure, the calcium ion–binding residues of DFPase were conserved in TGW6. The spatial arrangement of His and Tyr on the surface of the large cavity of TGW6 resembled the active site of the hydrolase. These results suggest that TGW6 might have hydrolyzing activity.

Then, what is the substrate for TGW6? This is the structure of strictosidine. TGW6 might hydrolyze the unknown substrate which size is similar to strictosidine molecules.Strictosidine consist of Tryptamine and Secologanin. Tryptamine partly have Indole-rings and Secologanin have glucose. We simulated some substrate docking with modeled TGW6 structure, and tested whether it matches to the cavity or not. Then, one compound had a fine fitting with the cavity in TGW6. Blue compound is IAA-glucose, this is one of several Indole Acetic Acid (IAA) conjugate; it consists of Indole-rings and glucose. To confirm the hydrolyzing activity of IAA-glucose, we tested using synthesized IAA-glucose and recombinant protein of TGW6. "Nipponbare" type TGW6 had hydrolyzing activities of IAA-glucose, while "Kasalath" type TGW6 had no activity. So, we could confirm that TGW6 has a hydrolyzing activity of IAA-glucose. In NIL(*TGW6*), the developing endosperm at 3 days after fartilization had lower contents of free IAA. These

results suggest that “Kasalath” type TGW6 could not produce free IAA from IAA conjugate.

To show when *TGW6* gene expressed, we analyzed expression level of *TGW6* gene. *TGW6* expressed mainly in developing ovary, its level was peaked at 2 days after fertilization.By *in situ* hybridization experiment, this is longitudinal section of ovary, and *TGW6* transcript accumulated around the ovary.This pericarp is the site for cell division. In NIL(*TGW6*), carrying “Kasalath” chromosome region around *TGW6*, showed significant increase in grain length. Compared to “Nipponbare”, NIL(*TGW6*) had longer endosperm and greater dry weight throughout grain development. In the longitudinal section of Rice grain, the endosperm was composed by the layer of cells. So, we determined the numbers of cell layer and the length of individual cells. The number of endosperm cell layers in NIL(*TGW6*) was significantly higher than in “Nipponbare”, whereas endosperm cell lengths were identical.These results suggest that “Kasalath” type TGW6 increases cell numbers in endosperm, and consequently increases in grain length.

Loss of function in the Kasalath allele had desirable effects on grain size. On the other hand, we analyzed the effect of loss of TGW6 to source organ. Compared to “Nipponbare”, NIL(*TGW6*) accumulated more starch in the leaf sheaths just before heading. In grain developing, the growth rate of grain weight peaked at 15 d.a.f.; and the rate was higher in NIL(*TGW6*) than in “Nipponbare”. At the time of the greatest increase in grain weight, the expression of genes related to starch synthesis was stronger in NIL(*TGW6*) than “Nipponbare”. Thus, the accumulated starch in leaf sheath before heading might be a responsible source of developing grains after heading.

Here, we proposed the model of TGW6 in grain developing. Native type TGW6 has hydrolyzing activities of IAA-glucose, and it can release free IAA.

This IAA would limit the cell number in endosperm and grain length. Meanwhile, IAA might limit the starch synthesis and accumulation in source organ. Thus, grain weight is regulated to limited size.It might be a limiter (like a brake) to ensure to fill more numbers of grains. For reproductive strategy for plant, it will be more adaptive to develop more seeds than developing excessively larger seed. On the other hand, “Kasalath” allele can not produce mature TGW6 protein, and can not hydrolyze IAA-glucose. Then, by the loss of limiter, cell numbers in endosperm and grain length increased. Further, starch synthesis and starch accumulation also increased,

and consequently grain weight is increased. This is a schematic model of yield development and known genes.

Numbers of gene had been cloned to regulate grain size, these genes involves in development of spikelet hull size. Then, the endosperm cell sizes were enlarged, and consequently increasing grain size. *TGW6* had a new point of action to grain development. It increases endosperm cell numbers, simultaneously *TGW6* increases starch accumulation and translocations. For further increase in grain weight, it seems to be desirable to collect the genes which have different types of point of action.This is a figure from Dr Zhang's works (Zhang et al. 2012 PNAS 109, 21534-21539).“N411” have an extra large grains.This cultivar have many positive alleles of known genes, *GS3*, *GW2*, *GW5*,*GS5* and *GL3*.This suggest that the pyramiding of known positive alleles for grain size could produce extra-large grains. Thus, to increase rice yield, we should glean superior genes to improving Source and Sink, and collect them.

Rice had been selected by human race and domesticated. In this process, superior and desirable alleles were selected and spread in modern cultivars. However, some desirable alleles might be left behind in domestication. Sometimes, such genes might be phenotypically invisible. To improve modern cultivars further, we should glean superior genes left behind in domestication, and introduce them into modern cultivars. This is a haplotypes of TGW6 genes in world rice. We found 17 haplotypes of the TGW6 from the core collection of cultivated rice and wild rice. We could find “Kasalath” type 1-bp deletion only in 4 rice including “Kasalath” and 1 *O. rufipogon*.These rice localized in indochina peninsula.“Kasalath” type 1-bp deletion was found to be desirable for grain yield, but it had not been spreaded in cultivated rice. To further improve modern cultivar, we made NILs in “Koshihikari” background. “Koshihikari” is a premier japonica cultivar in Japan. NIL in “Koshihikari” background also showed larger grain and weight than “Koshihikari”. By field trial, we confirmed this NIL shows 15% higher grain yield than Koshihikari. Moreover, NIL showed higher content of perfect grain.Immature grain or chalky grain are caused by interruption of grain filling by limited source ability. The accumulated starch in leaf sheath might reduce immature grain and increased perfect grain. Thus, we conclude that TGW6 can be used for further improvement of modern cultivars. Finally, I appreciate these collaborators and grant in aids to proceed this work. And thank you for your attention.

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Recent Research Advances at ERL

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Established in 2007, ERL is an advanced research facility involving a team of multi-disciplinary researchers (i.e. chemists, physicists, engineers, designers, economists and social scientists). It facilitates core research in energy harvesting, generation, conversion, conservation & storage. Research at ERL is funded by UK, EU and International funding agencies, charitable organisations and multi-national and UK industry.

Current research projects at ERL includes but not limited to novel photovoltaics, hydrogen generation (via chemical and solar-assisted routes), studies of CO tolerance levels in reformed H_2 for Fuel cell applications, CO_2 conversion for value added chemicals, N_2 fixation, biogas processing, advanced functional energy materials/coatings, smart windows, novel flexible stretchable and wearable supercapacitors.

In this presentation, we will report the recent advances made in some of these research projects.

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Integration of natural resources in development through research: Biodiversity emphasis

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The world has seen the increasing impacts of human interventions and life styles on the components of the planet and the planet as a whole. We are today in the midst of probably the worst if not the ultimate "environmental issues" that mankind will have to face to avoid a catastrophic situation in the future. All previous "environmental issues" apart from the Nuclear issue, were issues that had limited impacts, often within contained local areas of the planet. Even some so called global issues such as "the brown haze" were primarily concerns of East Asia, while such phenomenons like "El-nino" and "La-nina" had their impacts in defined areas even though the events were the results of global dynamics. Climate Change on the other hand is "global in effect but local in impacts". On the 16th of January 2015, it was announced that 2014 was the year with the highest ever recorded high temperatures, with out an El-nino effect. This is very significant and a clear eye opener to all climate change sceptics. The "Living Planet index" launched in November 2014 reiterated the disastrous state of the planet brought about since 1970. This is during the life time of the present rulers and decision makers. No element in nature is spared, no part of the globe is spared, and no organism is spared either. As such, it has become the concern of all disciplines and all people.

In the midst of these environmental issues and the "development" of Nations, we have seen the growth of information transfer. The world has become "small" and closely "connected". We have come to recognize today as the "knowledge base" era. Actions for tomorrow must be based on "Knowledge" and this is the case for "Nature/ Biodiversity Conservation" too. The last

three decades have seen some major changes in the approach to conservation of nature and natural resources.

The evolution of conservation in general has evolved to become a complex but essentially a knowledge dependent activity. The presentation will attempt to clarify this trend, based on the major conceptual changes that have taken place during this era in

- Biodiversity emphasis, Change from "Game" to "wildlife" to "biodiversity", Protection verses conservation, The Conservation Biology approach, Emergence of Sustainable Use, Adoption of MEAs – Conservation of Biological Diversity,

- Issues arising out of the CBD such as, Bio prospecting, Biopiracy, Technology transfer, Benefit sharing, Genetic resources, Taxonomy Research, PIC/MAT/MTA,

- Ecosystems Approach, Stakeholder Participation, Adaptive Management, Ecosystems Services, Economic Valuation of Nature, Significance of Monitoring and Evaluation, Technological revolutions such as GIS/GPS, Remote Sensing, computers and information transfer, Restoration, Invasives and Landscape Ecological approaches.

All of the aspects have profound impacts on the way we approach to manage the Biological Diversity. It affects the structures and mandates of institutional establishments that have been established to manage the "resource" in the past. Their continuation is largely dependent upon whether they recognize these changes and are willing to be part of the Knowledge Economy Development. The challenge for the future lies in this key element of knowledge, which effectively is a societal element and thus require "integration" at all institutional, social and political levels.

Conservation of the future is a matter of Societal choice, what ever the science may tell us. For it to be effective we need to recognize that it would be possible only on the basis of:

1. A GOOD INFORMATION BASE (note not a COMPLETE information base as in the past)
2. A well QUALIFIED and EXPERIENCED staff
3. A well INFORMED PUBLIC, and
4. A good INSTITUTION

The future challenge is based on achieving this end in each country. The generation of information is primarily based on RESEARCH. The approach to research in order to generate factual, scientific information cannot be compromised in any way to achieve conservation objectives. Thus the main hinge on which the above directions in conservation is dependent is scientific research. How much emphasis do we place on this information generation process and how much of such generated information do we incorporate in the conservation process as needed above. This has remained a major issue in Sri Lanka. The wildlife sector is yet to be able to differentiate clearly the needs of the sources of information for effective conservation. While some research is carried out by the sector itself, it is doubtful as to whether this research is "needs based". The academic institutes and academics are indulging in research driven by their personnel interest and again it is a big question of whether the research is "needs based". In summary the research is often not contributing to make conservation effective.

On the other hand, the finger is pointed at the conservation agencies for not even using the little information that is generated from research in the management to be effective. Attempts to bridge this was tried in 2013, but to this date beyond providing a group of distinguished select researchers with researched global literature on how research in the wildlife sector is "Best Practiced" globally, they have not met once to deliberate. Where is the fault, are the academics waiting to be summoned to formalize the process OR is the sector not interested to receive the directions to be more effective? While we wait to seek answers for this situation the future of biological diversity / wildlife/ natural resources is gently but surely slipping down the abyss – towards disaster.

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Climate change threatens the human nutrition: Challenges and opportunities for increase food and nutrient security

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The world's population is rapidly increasing and to match the global demand, food production needs to increase by 50% by 2050. Food security is largely determined by ten major crop species, of which, rice, wheat and maize contribute more than 70% of the food demand. Since the green revolution, crop productivity has increased significantly due to improved agronomy practices and adopting innovative breeding programs. Today, crop yield increases have plateaued but demand for food has increased substantially. On the other hand, global climate is rapidly changing as a consequence of burning fossil fuels and land clearance. Atmospheric [CO_2] concentration is expected to increase from 390 to 550 µmol-1 CO2 mol-1 by the middle of this century. Consequently, the atmospheric temperature is expected to increase by 1.4 to 4.5°C in 2100 which could lead to more extreme climatic events, such as high temperature, heat waves, and periodic drought, frequent and strong typhoons, prolonged wet and dry seasons, and increased incidence of disease outbreaks which affect the sustainability of agricultural production systems. Thus, understanding of how crops respond to such environmental stresses is essential to maintain food and nutrient security in the world. To address these concerns, (1) greater understanding of agronomic management of crops to avoid stress, (2) mechanistic understanding of stress regulation, (3) identifying new traits that avoid these stresses, (4) genetic engineering and/or breeding of crops to avoid such stresses are essential.

Many C_3 plants will respond positively to increased atmospheric CO_2 concentration under optimum growth conditions, but the beneficial effect of elevated CO_2 could be offset by other climatic stress factors, such as high temperatures and periodic drought. The primary mechanism that promotes plant growth at elevated [CO_2] is the increase in photosynthesis which could increase by up to 50%. Elevated [CO_2] also reduces photorespiration and is directly associated with decrease in O_2/CO_2 ratio at the site of CO_2 fixation. Elevated CO_2 also reduces stomatal conductance by 30-40% at double the CO_2 concentration, which leads to improved efficiency of plant water use. However, the positive effects of [CO_2] response cannot always be capitalized as high temperature and low soil water availability suppress photosynthesis and thus the growth response to elevated [CO_2]. In general, C_3 crops are likely to produce more harvestable products and that both C_3 and C_4 crops are likely to use less water with rising atmospheric [CO_2] under optimum conditions. Higher temperatures can adversely affect crop yield through two principal pathways, namely (i) high maximum temperatures that cause spikelet sterility and thus adversely affect grain quality and (ii) increased nighttime temperatures that may reduce assimilate accumulation that could lower the yield potential.

In the world, almost one billion people are undernourished and lack sufficient protein, fats and carbohydrates. An additional billion peopleare malnourished because their diets lack required micronutrients such as iron, zinc and vitamin A. These dietary deficiencies have an enormous negative impact on global health, resulting in increased susceptibility to infection and diseases, as well as increasing the risk of significant mental impairment. As with climate change scenarios, particularly under elevated [CO_2], the micronutrient such as Zn, Fe and Se concentrations are substantially decreased for many crops species including the C_4biochemical type. In addition, the increased production of phenolics and tannins under elevated CO_2 in some species, as well as many alkaloids, may have potential consequences on the health of primary consumers.The decreased nutritional value in combination with increased tannin and phenolic production has been linked to decreased growth rate and conversion efficiency of some herbivores, as well as an increase in their relative demand and consumption

of plants. Furthermore, many "cyanogenic" species—plants which naturally produce cyanide, and which include 60% of all known plant species have been found to increase their cyanide production under elevated [CO_2]. This is detrimental to both animal and human food sources.Further, Zinc and iron deficiency has been recognized as one of lethal factors affecting human health and is very prominent in South Asia. Currently, breeding efforts are underway to increase the micronutrient density of cereals and legumes. Further, understanding of genotype and environment interaction on nutrient accumulation in grain and identification of new genetic materials are essential to improve global Zn and Fe malnutrition. The identification of genes that are involved in many agricultural traits has been identified by traditional molecular genetic and quantitative trait locus (QTL) mapping for complex traits. Further, these targets can be easily achieved through adopting a quantitative genetics approach together with "omics" technology such as genomics, proteomics, metabolomics and ionomics.

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Structural Biology: A Path to Understand Molecular Machines

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Structural biology is one of the main contributors to understand the biochemical activities of living organisms. Protein structures provide the insights of the function describing the exact details of their activity. The structure determination of proteins is achieved using several techniques mainly protein crystallography. The information obtained from the protein structural studies helps finding ways to control different cellular processes, drug discovery and to enhance several biotechnological processes.

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Response of inbred and traditional rice varieties (*Oryza sativa* L.) to broad spectrum herbicide glyphosate

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Weeds cause serious yield reduction in rice production worldwide and herbicide-based weed management is the most popular method to overcome this problem. Glyphosate, the most effective herbicide in controlling weeds led to decrease the final yield due to off target movements and these adverse effects can supersede by developing herbicide resistant (HR) rice. This study was conducted to determine the most effective glyphosate concentration on cultivated rice varieties and the variability of resistance between them. A preliminary study was conducted with five varieties (Bg300, Bg352, At362, Bg379-2 and H4) to identify the most effective glyphosate concentration. Five different concentrations of glyphosate (0.25, 0.5, 1.0, 2.0 and 3.0 g/l) were applied to plants at three different time periods (2, 3, and 4 weeks after sawing-WAS). Then the most effective concentration was applied to 24 varieties to evaluate their resistance. Complete randomize design was used with three replicates. Plants with ≥50% survival were considered as resistant varieties. Preliminary study revealed 0.5g/l at 3WAS, as the most effective concentration where most of the rice varieties showed resistance. Twelve varieties (Bg352, Bg359, Bg362, Bw364, Ld365, Bg366, Bg369, Bg379-2, "Madel" Pachcha Perumal", "Kalu Heenati" and "Kurulu Thuda") showed a higher resistance (≥50%) compared to others. Agro-morphological characters did not significantly differ among treatments and controls ($p \geq 0.05$) and number of fertile spikelets/panicle and 1000 grain-weight significantly varied ($p \leq 0.05$) indicating a considerable yield penalty. Developing broad-spectrum HR rice varieties offers a novel efficient weed controlling method. Rice varieties with natural HR have a higher potential in rice breeding programs leading to develop new HR rice varieties in future.

Key words: Glyphosate, herbicide resistance, rice

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Soil organic carbon and floristic composition relationships: A simple model using principle factor analysis and regression analysis

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Future carbon storage in tropical forests will be influenced strongly by species composition. Huge knowledge gap has arisen on how floristic richness correlates or contributes to soil carbon storage. This study examines correlations among floristic parameters, soil carbon and relevant environmental variables. We collected soil data (carbon fractions, total C, total N, soil pH, and fine root biomass) from at the Sigiriya forest sanctuary, and Popham Arboretum in the dry zone and Udawattakelle forest sanctuary in the wet zone. The data were pooled and biomass/carbon stocks (e.g. above-ground biomass stock, above-ground C stock, below-ground biomass stock, and below-ground C stocks) were calculated using standard equations. The correlation analysis between biomass/C stock and soil parameters was performed using principle factor analysis (PFA) and multiple regression of SAS version 6.12. PFA resulted in five clusters. One cluster was formed by soil C, soil N, and Mackintosh Distance (U) with high correlation (R^2=0.82). Multiple regression model showed that there is a positive relationship between the biomass stocks and species richness, while Mackintosh evenness has a negative relationship with total carbon of the soils. Basal area of the forests was recognized as a neutral parameter, because it acts as both positively and negatively. These results indicated that the above-ground floristic composition parameters acted as determinants of total soil carbon stock. Thus, changing floristic composition to maximize storage of soil carbon will provide opportunity to enhance soil carbon sequestration.

Key words: Soil organic carbon, Principle Factor Analysis, Dry/wetzone forests

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Egg quality parameters of local chicken genotypes in crop and livestock-based diversifications

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A study was carried out to analyse the egg quality parameters of local chicken genotypes such as village chicken and naked-neck chicken under crop and livestock based diversification systems. The results of the study revealed that all selected egg quality parameters of both chicken population was significantly differed ($P<0.05$) in all diversification systems. Significantly better results found in crop based diversification system for both village and naked neck genotypes in egg weight (49.16±1.07 and 51.43±1.97 respectively), egg shape index (75.23±1.32 and 75.33±1.36 respectively), specific gravity of egg (1.15±0.01 and 1.18±0.001 respectively), egg hatchability (89.24±1.67 and 89.22±2.09 respectively), albumin weight (28.62±1.64 and 30.70±1.87 respectively), yolk weight (17.17±1.05 and 17.64±1.22 respectively) and egg shell weight (17.17±1.05 and 17.64±1.22 respectively). The egg fertility (80.11±2.73 and 75.74±2.13 respectively) and egg shell thickness (0.312±0.003 and 0.317±0.001) were significantly higher in the livestock based diversification system for both village and naked neck genotypes. The calculated yolk: albumen ratio for village chicken was significantly highest (0.62±0.01) ($P>0.05$) under livestock-based diversification system while in naked-neck chicken it was significantly higher (0.57±0.02) in crop-based diversification system. From the results, it was concluded, both the population performed well in crop based diversification systems in terms major egg quality traits.

Key words: Naked-neck chicken, village chicken, diversification and genotypes

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Impact of tillage, nitrogen and stubble management on physico-chemical properties of a soil in Khyber Pakhtunkhwa Pakistan

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Continuous cereal based crop rotation; inappropriate cultivation, burning and removing of crop residues deteriorate soil physico-chemical properties in the Peshawar Valley of Khyber Pakhtunkhwa, Pakistan. The objective of the study was to evaluate the effects of different tillage systems, nitrogen and crop residues management on soil physico-chemical properties of Alfisole type soil. The study was conducted for two years at Cereal Crops Research Institute Pirsabak Nowshera, Khyber Pakhtunkhwa, Pakistan. The treatments of the experiment were three tillage systems i.e. minimum (10 cm); conventional (20 cm) and deep (30 cm) were the main plots, whereas the subplots were maize stubble management such as physical removal, burning and incorporation with and without nitrogen (120 kg ha^{-1}) fertilizer application. The control treatment is considered the plots where stubbles were physically removed and no N was applied. Result of the study showed that minimum tillage system had improved soil moisture retention, soil bulk density, soil mineral nitrogen, soil total nitrogen and soil organic carbon. Similarly, sole stubble incorporation had significantly improved soil physico-chemical properties as compared to sole removed and stubble burnt plots. Stubble incorporation along with application of recommended dose of nitrogen fertilizer (120 kg ha^{-1}) had also improved soil properties as compared to bared and burnt treatments. It is evident from results that minimum tillage and maize stubble incorporation alone or in combination with recommended dose of fertilizer nitrogen in a continuous cereal based cropping system improved soil physico-chemical properties.

Key words: Alfisole type, cereal based cropping system, soil characters

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Antioxidant activity of Sri Lankan black tea measured by ABTS, FRAP and ORAC assays

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Tea (*Camellia sinensis*) is a common beverage possessing lots of health benefit properties such as antimicrobial, antioxidant and anticancer potential etc. Antioxidants have gained great attention because of the importance as a panacea for a large number of diseases. Although a large number of studies have been carried out to determine the antioxidant properties of tea in the world, a few researches have been carried out in Sri Lanka. Therefore, objective of this study was to determine and compare the antioxidant activity of tea infusions from three grades of black tea; Dust(I), OPI and Pekoe which were obtained from Tea Research Institute, Sri Lanka using *in vitro* ABTS, FRAP and ORAC assays. Results are expressed as means of triplicates and mg Trolox equivalant per gram tea sample (mg TE/g). Antioxidant activities of the Dust(I), OPI and Pekoe are; FRAP, 149.17, 55.57, 142.83, ABTS, 162.07, 88.31, 168.69 and ORAC, 68.99, 22.46, 61.90 respectively. Although Dust(I) and OPI are considered as the least and highest quality out of three tea samples used, Dust(I) had the highest antioxidant activities. This may be due to the very small particle size of Dust(I) grade. Small particle size may help to extract higher amount of antioxidant compounds into hot water than the other grades. Results of the different assays for three tea samples also had wide differences, e.g. OPI; 55.57 (FRAP), 88.31 (ABTS), 22.46 (ORAC). This may be due to the different mechanisms involved in each assay. This study suggests that tested Sri Lankan black tea infusions had wide range of antioxidant activities. Further studies are necessary confirm whether the black tea infusions could be used as natural antioxidants in the beverage, food and pharmaceutical industries.

Key words: Antioxidant activity, Black tea, in vitro antioxidant assays.

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Insecticidal activity of selected botanicals on *Sitophillus zeamays* L. in stored maize grains

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Laboratory studies were conducted to study the effect of five leaf powders (10%) of *Lantana camera*, *Azadiracta indica* (Neem), *Annona squamosa* (Annona), *Justicia adhatota* (Adathodai) *and Ocimum tenuiflorum* (Tulsi) against maize weevil, *Sitophilus zeamays* L. (Colepotera: Curculionidae) infesting maize grains in storage. Among them, *O. tenuiflorum* was found to be significantly the best treatment. *O. tenuiflorum* and *A. squamosa* killed 86% of adult weevils by about sixth week. Significant differences were found between the numbers of emerged weevils in different treatments. The new births were not observed in the grains treated with chemical pesticide *Actalic, O. tenuiflorum* and *A. squamosal*. But the appearance of new insects was detected in *L. camera*, *A. indica* and *J. adhatota* from sixth week and it was higher in *L. camera* compared to the *A. indica* and *J. adhatota* from 6th week onwards. The effectiveness of *O. tenuiflorum* and *A. squamosa* in the control of maize storage weevil was apparently as efficient as the chemical pesticide *Actalic.* Use of these botanicals may prevent environmental pollution and replace chemical pesticides currently being used by most farmers and also in agro industries where grains are usually stored in bulk several months to manufacture feeds for human and livestock.

Key words: *Sitophilus zeamays L, Azadiracta indica, Annona squamosa, Justicia adhatota, Ocimum tenuiflorum,* Actalic

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In vitro Lipoxygenase related anti-inflammatory and antioxidant properties of ethanol leaf extract of *Psidium guajava* L.

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Psidium guajava L. (Guava, Myrtaceae) is a fruit tree widely distributed in Sri Lanka and reported to have anti-inflammatory properties. The objective of the present study is to investigate *in vitro* Lipoxygenase related_anti-inflammatory and antioxidant properties of leaf extract of *P. guajava.*The air-dried, powdered leaves of *P. guajava* were extracted with ethanol using cold extraction technique. Anti-inflammatory activity was determined by Lipoxygenase enzyme inhibitory (LOXEI) assay. Antioxidant activity was determined by DPPH free radical scavenging, Ferric Reducing Antioxidant Power (FRAP), Ferrous Iron Chelating (FIC) and Oxygen Radical Absorbance Capacity (ORAC) assays. The Total Phenolic Content (TPC) and Total Flavanoid Content (TFC) were also determined. The total ethanol leaf extract showed a marked LOXEI activity, having IC_{50} value of 42.98 ± 0.45 µg/mL in comparison to quercetin (35.01±0.82 µg/mL). The extract exhibited high DPPH free radical scavenging (IC_{50}=15.00±0.36 µg/mL, Trolox: 5.29±0.09 µg/mL) and low FIC activity (IC_{50}=2684.34±34.30 µg/mL, EDTA-2Na: 13.07±0.64 µg/mL). The FRAP of the extract was found to be 2170.00 ± 89.10mg Trolox Equivalents (TE)/ g and ORAC value was 936.51±63.49 mg TE/g, which is comparable to that of green tea extract (1662.82±0.22 mg TE/g). The TPC and TFC were found to be 125.83±4.60 mg Gallic Acid Equivalents (GAE)/g and 13.73±1.25 mg Quercetin Equivalents (QE)/g, respectively. The LOXEI activity and antioxidant activity of leaf extract were significantly different from their reference standards ($P<0.05$). The present study implies that the leaf of *P. guajava* could be used as a health food and as a source of new drug leads for further research.

Key words: Lipoxygenase, DPPH, FRAP, FIC, ORAC

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Insight into acetylcholinesterase inhibitory and antioxidant activity of *Eryngium foetidium* L. leaves

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Acetylcholinesterase inhibitory (AChEi) and antioxidant activities of natural sources are explored in the treatment of Alzheimer's disease (AD). *Eryngium foetidium* L. (Apiaceae) "Andhu" is used as a traditional culinary and a medicine globally. The objective of this study was to determine the AChEi and antioxidant activities of ethanol extract of *E. foetidium* leaves. Plant material was extracted using ethanol by cold extraction technique. AChEi and antioxidant activities were determined according to Ellman's method and 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, Ferrous Iron Chelating Activity (FICA), Ferric Reducing Antioxidant Potential (FRAP) and Oxygen Radical Absorbance Capacity (ORAC) assays, respectively. Total phenolic and flavonoid contents were determined. Assays were carried out in triplicates using Spectra Max microplate-reader. The leaf extract showed moderate AChEi activity (IC_{50} 243.65 ± 5.24 µg/mL) in comparison to Galanthamine, (IC_{50} 0.14 µg/mL), moderate DPPH radical scavenging activity (IC_{50} 737.94 ± 19.29 µg/mL) in comparison to Trolox (IC_{50} 4.6 ± 0.0 µg/mL), lower FICA (IC_{50} 1395.88 ± 43.77 µg/mL) in comparison to EDTA (12.74 ± 0.21 µg/mL), low reducing power (62.73 ± 1.83 mg TE/gram of extract) and ORAC (53.74 ± 0.15 mg TE/g of extract) in comparison to green tea (IC_{50} 1362.82 ± 0.22 mg TE/g). The total phenolic and flavonoid content was found to be 10.19 ± 0.07 GAE/g of extract and 26.39 ± 0.34 QE/g of extract respectively. This is the first report of *in-vitro* AChEi, FICA and ORAC activity for the ethanolic leaf extract of *E. foetidium.* Results exhibit relatively moderate AChEi and antioxidant properties for the ethanol extract of *Eryngium foetidium* leaves. Further studies are required on biological activity.

Key words: *E. foetidium,* Acetylcholinesterase, Antioxidant

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Evaluation of the antioxidant potential of the extracts of three green leaves in stabilizing Nile Tilapia (*Oreochromis niloticus)* fish nuggets under frozen Storage

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Antioxidants are used to minimize lipid oxidation in the food system to prevent associated negative effects on the quality of foods such as fish and meat products. There has been a growing interest in natural antioxidants over synthetic products as consumers are health conscious. Green leafy vegetables are rich in phenolic compounds that have a wide range of biological functions, including antioxidant and antimicrobial activities. The present study was aimed to evaluate the effect of locally available three culinary leaf extracts (katuru murunga-*Sesbania grandiflora*, murunga-*Moringa oleifera and* curry leaves-*Murraya koenigii*) as antioxidants on the stability of a tilapia fish (*Oreochromis niloticus)* based nuggets. Three different levels (1, 1.5 and 2%) of leaf extracts were mixed with fish nuggets and frozen (-18°C), and were compared with control samples. The pH, total plate count, free fatty acid values (as% oleic) and peroxide value in fish nuggets were analyzed, and the changes in sensory properties at 2 week intervals for 2 months storage period were studied. Total phenolic content, total antioxidant capacities of the leaf extracts and nuggets were also evaluated. The results indicated Karapincha leaf extract showed the highest phenolic content (445.63 mg Gallic Acid Equivalent/100g) and 85.55% of radical scavenging activity whereas Murunga leaf extract showed the highest antioxidant capacity (464.63 mg Ascorbic Acid Equivalent/100g). Incorporation of leaf extracts significantly increased the antioxidant properties of nuggets compared to nuggets without leaf extracts. Free fatty acid values and peroxide values of fish nuggets incorporated with leaf extracts were within the acceptable level of consumption compared to the control. Sensory results revealed that the incorporation of leaf extracts has no effect on the overall acceptability of nuggets, however during the storage, there was a significant reduction in the sensory properties of nuggets without leaf extracts when compared with the leaf extract added nuggets. Overall, the addition of leaf extracts has significant antioxidant and antimicrobial effects on tilapia fish nuggets for minimum of 8 weeks at frozen storage.

Key words: Lipid oxidation, free radicals, green leaf extracts, natural antioxidants, Tilapia nuggets

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Preparation of Ready to Serve (RTS) beverage based on tender coconut (*Cocos nucifera* L.)

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Tender coconut (*Cocos nucifera L.*) is locally available but commercially underutilized tree nut for beverage production. This research was conducted to find out best formulation for Ready to Serve (RTS) tender coconut beverage and evaluate composition and shelf life of final product. Seven months old fresh tender coconut kernel and water was analyzed for its composition and different formulation of beverage were prepared using varying proportion of kernel and coconut water, pectin and sugar. Best kernel:water ratio and sugar level were selected by sensory evaluation. Optimum pectin level was selected by visual observation of sediment height. Microbial stability of the product was evaluated for range of selected pasteurization temperatures and time. Best formula for the tender coconut RTS beverage was 1:7 kernel to coconut water, 10% brix, 0.4% pectin. 13,000 rpm for 3 minutes was the best homogenization level and 5 minutes at 100ºC temperature gives the microbial stability. Proximate analysis and sensory evaluation were carried out for the best sample that was identified by above preliminary trials. Sensory evaluation for the final product was conducted for 50 untrained sensory panel (age 20-45 years) using 7-point hedonic scale. Result was analyzed according to Freidman test at 95% significant level. In proximate analysis of the final product, Total solid (TS), protein, fat, Sugar, crude fiber and total ash contents were found to be 10.35 %, 0.3 %, 0.48 %, 8.20 %, 0.31 % and 0.53 % respectively. Shelf life of the product was analyzed for 1 month according to Brix, pH and acidity. Considering above results, it was concluded that tender coconut beverage could be used to produce RTS with acceptable qualities according to the SLS standards.

Key words: Tender coconut, Proximate analysis, Ready-To-Serve beverage, Sensory evaluation

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Formulation of an antioxidant rich beverage using soursop (*Annona muricata L.*) blended with ginger (*Zingiber Officinale*) extract

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The present study mainly focused on producing an antioxidant rich beverage from soursop (*Annona muricata L.*) blended with Ginger (*Zingiber officinale*) and studying its storage stability at ambient (28°C) temperatures. For the formulation, ginger extract was blended with soursop juice at the ratio of 1%, 3%, 5%, 7%and 10% levels (v/v). Sensory evaluation was carried out by a panel of 25 semi-trained panelists, using 9-point-hedonic-scale to select the best level of ginger. Physico-chemical and antioxidant properties of soursop pulp, ginger extract and final product were evaluated. Changes in physicochemical, microbiological quality and antioxidant activity of the blended beverage were analyzed at weekly intervals. Protein, fat, fiber ADF, ash, carbohydrate, moisture content of sousop pulp were 0.26%, 0.85%, 0.36% 8.9%, 13.83% and 82.8% respectively. Results showed that soursop juice blended with 10% ginger extract was obtained significantly ($p<0.05$) highest sensory scores together with highest level of antioxidants comparatively. The antioxidant capacity in 10% ginger extract blended beverage was found as 6593.1 mg AA/g (FW) while soursop pulp, and ginger extract has got 8132 mg AA/g (FW), 3142.6 mg AA/g (FW) values respectively. Total phenolic content of soursop pulp, ginger extract and final beverage were 144.9 mg GAE/1g, 157.35 mg GAE/1g and 169.71 mg GAE/1 g respectively. The physicochemical properties of the final beverage were found as follows; pH, acidity, and TSS of the final beverage were 3.7, 0.6 g/100ml (citric acid equivalents, and 12° respectively. The formulated beverage was found to be microbiologically safe for consumption. Results showed that the minimum shelf life of the final product was 8 weeks at 28°C.

Key words: Soursop, Ginger, Antioxidant, blended beverage, Total phenolic content

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Development of a user friendly anticorrosive electroplating process

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This abstract introduces a user friendly electroplating method that can be performed without special skills or advanced instruments, which will prevent further corrosion of steel surfaces due to small scale damages. The technique used here is based on electrodeposition of a Zn-Ni alloy coating on the damaged site. In this proposed method, an electroplating paste was developed to coat steel surface using the iron migration concept of gel electrophoresis. Initially, the Zn-Ni plating was performed on steel strips using a solution containing Zn and Ni ions. This mixture was acidified and a simple DC power source was used for the electroplating process. The applied voltage was set at 0.9 V, and the Ni^{2+}/Zn^{2+} concentration ratio was set at 1.0 to improve the efficiency of the electroplating process. Tapes containing polyacrylamide gel (diaper pieces) were soaked in the electrolyte solution to obtain the electroplating paste. Steel strips were electroplated with these anticorrosive electroplating tapes by polarizing the surface with a DC power source. The coated steel strips were tested using weight loss and polarizing methods to determine the rate of corrosion and the corrosion potential. Corrosion rate of uncoated and coated steel strips were compared to determine the effect of Zn-Ni plating. Corrosion rate of the steel strips coated using the described method was significantly lower than that of uncoated strips.

Key words: Zn-Ni electroplating, user friendly anticorrosive process

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Preliminary investigation of wound healing activity of stem bark extract of *Ficus racemosa* Linn.

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Stem bark of *Ficus racemosa* is utilized in the preparation of Ayurvedic and indigenous medicines, which aids in wound healing while ethanolic extract has been reported to be wound healing active on a rat model. The present study was undertaken to investigate the wound healing activity of the extracts and their fractions of *F. racemosa* bark using wound healing assay (WHA). Hexanes, dichloromethane, ethylacetate and methanol extracts of stem bark of *F. racemosa* were obtained by sequentially extracting with respective solvents and removing the solvents. Madin-Darby Canine Kidney cells were distributed on 12-well tissue culture plates with Dulbecco's Modified Eagles Medium (DMEM) to form a monolayer and a wound was made by mechanically scratching the cell layer. Then the extracts were introduced using dimethylsulfoxide (DMSO) at a concentration of 0.1 mg/dm^{-3}. 1% DMSO in DMEM and 100% of DMEM were served as the controls. Initial width of the scratch and the width of the scratch after treatment, at 12 h, 18 h, and 24 h were measured by using a stage micrometer. Of the four extracts, hexanes and dichloromethane extracts showed enhanced, wound closure with respect to controls (84% and 76% respectively at 24 h). Bioactivity guided fractionation of dichloromethane extract showed that fraction 7 is the highest active fraction (100%) while fractions 9-11, 14 and 17 showed >90% activity. Lupeol was found to be the major constituent (m. p., mixed m. p., TLC and Co-TLC) present in the fraction 7 while β-sitosterol was found to be the major constituent (m. p., mixed m. p., TLC Co-TLC and NMR) in fraction 9.

Key words: *Ficus racemosa*, Madin-Darby Canine Kidney cell cultures, wound healing activity, column chromatography

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SnO_2 as a cathode material for rechargeable Mg batteries

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The energy demand is rapidly increasing with increasing global population. Therefore, supply of energy for the society is a major challenge to maintain a comfortable standard of living. Energy storage plays major role in achieving a sustainable energy system and advanced energy storage devices such as ion transfer batteries have become important in research and development work. Majority of current rechargeable battery technologies are directed towards developing Li battery systems due to their high specific energy density. Magnesium is positioned next to Lithium in the electrochemical series and therefore its electrochemical characteristics are comparable with neighbor Lithium. In the view of the natural abundance of Magnesium, their low cost, low molecular weight and safety, Mg rechargeable battery systems are considered to be one of the most suitable replacements for Li systems. In this study, we have explored the possibilities of using SnO_2 as the cathode martial in rechargeable magnesium batteries fabricated with Mg^{2+} ion conducting, quasi solid (gel) polymeric electrolyte based on polyethylene oxide (PEO) as the host matrix. Electrolyte was characterized by AC impedance spectroscopy, cyclic voltammetry (CV) and DC polarization method. The best ionic conductivity of the electrolyte was 2.52×10^{-3} S/cm at room temperature for the composition of PEO (12.20 wt%), $(CF_3SO_3)_2Mg$ (14.6 wt%), EC (36.6 wt%), PC (36.6 wt%). The estimated value of Mg^+ ion transference number and total ionic transference number are found to be 0.20 and 0.98 respectively. Fabricated batteries with cell configuration $Mg/PEO:EC:PC:Mg(CF_3SO_3)_2/SnO_2$ exhibited a discharge capacity of 220 mAh/g and 1.85 V open circuit voltage.

Key words: Mg Battery, Impedance spectroscopy, Polymeric electrolyte

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A preliminary study of a new chromogen derived from phenolphthalein for the trace analysis of fluoride

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This study describes a simple, new, rapid, and sensitive method for the detection and determination of trace amounts of fluoride using a novel chromogen, phenolphthalein diacetate abbreviated as PHPDA. The method is based on the reaction of fluoride with the colorless PHPDA to produce pink colour dianion with a λ_{max} of 571 nm. Previously unknown PHPDA was synthesized from phenolphthalein and characterized by ^{1}H NMR, ^{13}C NMR, ESI-MS and UV-vis spectroscopy. PHPDA is selective for fluoride ions in giving pink color species. The effect of the medium on deacetylation of PHPDA with fluoride was studied in H_2O, dioxane, THF, DMF, DMSO and tBuOH and found that DMSO and tBuOH were the only solvents which could facilitate the removal of the acetate group to generate pink colour. However, in DMSO the pink colour slowly fades and the solution becomes colorless while in tBuOH the colour remains stable. The absorbance of the pink dianion formed at 571 nm increases linearly with the concentration of fluoride in both solvents DMSO and tBuOH. Hence, a spectrophotometric method for the assay of fluoride based on an increase of the colour intensity of the phenolphthalein dianion, in DMSO and tBuOH was designed. The interference study shows that the determination is free from interference of other halides and some cations. Under optimum conditions calibration graphs were linear with the correlation coefficients of (r^2 = 0.979 and 0.992) in DMSO and tBuOH respectively. This approach was successfully applied for determination of fluoride in commercial tea bags and toothpaste. To best of our knowledge, this is the first study of a fluoride trigged colour enhancing reaction which is used in photometric determination of fluoride.

Key words: fluoride, phenolphthaeindiacetate, DMSO, tBuOH, spectrophotometry

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Aryloxy-substituted Tetraphenylethylene derivatives for the preparation of electroactive dendrimers

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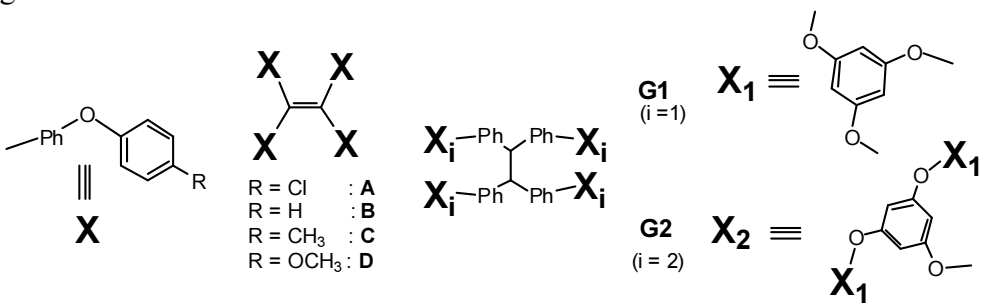
A series of soluble aryloxy-substituted tetraphenylethylenes (A-D) were synthesized by a reaction of *p*-chlorophenol, phenol, *p*-methylphenol or *p*-methoxyphenol with tetrakis(4-bromophenyl)ethylene in excellent overall yields. Preliminary electrochemical studies showed that these molecules undergo reversible oxidation and form stable cation radical salt. Furthermore, a plot of oxidation potentials of A-D against the Hammett constants of aryloxy substituents showed a linear dependence and thus establishing effective electronic coupling of the aryloxy substituents with tetraphenylethylene (TPE) core. A similar strategy was then employed for the preparation of two generations of TPE-core dendrimers (G1 and G2) using phloroglucinol as branching units. The branching units in these dendrimers showed effective electronic coupling with the TPE core in the preliminary electrochemical studies. Efforts are underway to prepare higher generation dendrimers G3 and G4.



Key words: Aryloxy-substituted tetraphenylethylene, electrochemistry, Hammett correlation, dendrimers, cation radicals.

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Degradation of vulcanized natural rubber using locally available natural oils

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Rubber products used in many industrial and domestic applications are discarded after long term usage. Due to crosslinked structure of rubbers and the presence of stabilizers and other additives, very long times are needed for natural degradation causing an environmental problem. Recycling, reusing and making degradable polymers are the solutions to this environmental issue. Rubber molecules are susceptible to degradation in the presence of peroxide radicals. Oxidation of natural oils can produce peroxide radicals and the rate of oxidation increases with the degree of unsaturation. Therefore, highly unsaturated locally available soybean and sesame oil were used for the study. Vulcanized rubber samples were prepared according to the tire tread formulation. Rubber samples were immersed in either sesame oil or soybean oil separately, for various time periods at room temperature and the degradation behavior was monitored by using mechanical properties (tensile and tear strength) and degradation temperature. Simultaneously, degradation behavior of rubber samples in both oil types were studied, in the presence of Cu catalyst and sunlight. Longer the time immersed in oils, lower the tensile strength, tear strength and degradation temperature of vulcanized rubber samples indicating improved degradability. In addition, the presence of sunlight and copper catalyst each has enhanced the reduction of above properties within a short time period. From the two types of oils used, soybean oil was the best. The enhanced degradation will provide a solution for environmental problems caused due to non-degradable rubber waste.

Key words: Natural Rubber, Degradation, Mechanical Properties

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Reinforcement of natural rubber using ahybrid filler derived from mineral silica and In-situ precipitated silica

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This research was conducted to optimize the mechanical properties of Natural Rubber glove material with mineral silica and in-situ precipitated silica fillers. Doubled Centrifuged natural rubber Latex with 60% dry rubber content which was stabilized by ammonia and mineral silica which were ground using "TEMA mill" and sieved to get particle sizes in the range of 40–65 µm were used. In-situ precipitation was done using tetra-ethylorthosilicate and a base catalyst. A standard formulation that is used in industry to produce gloves was used as the glove formulation. Three series of samples were prepared with increasing the mineral percentage by weight. Series A was prepared by adding mineral silica which has random particle sizes less than 65 µm. Series B was prepared by adding mineral silica which has particle sizes in the range from 40-65 µm and the series C was prepared by adding 1:1 ratio of mineral silica (particle sizes in the range from 40–65 µm) and in-situ precipitated silica. Determination of mechanical properties of the samples was based on the tensile and tear strength tests. Series A and B had same pattern of tensile and tear strength results, but optimum filler percentages were different. In series A, the sample containing 2% filler had optimum mechanical properties, while in series B, the sample containing 3% filler had optimum mechanical properties. In series C, the pattern was different and optimum filler composite was the sample with 5% silica. Further characterization was done with Thermogravimetric Analysis.

Key words: Natural rubber, tensile strength, mineral

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Synthesis of Ag-Neem plant extract nanocomposites by microwave irradiation and evaluation of their antibacterial activities

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Antibacterial activity of Ag-aqueous neem leaf/seed extract nanocomposites synthesized using microwave irradiation was studied against the inhibition of *Erwinia carotovora* present in rotten vegitables. Ag nanoparticles are formed due to the electrostatic interaction between the Ag^+ and the functional groups of the biomass. The exact mechanism of the plant mediated synthesis of metal nanoparticles is yet to be fully understood. However, the reduction process was confirmed by the presence of Surface Plasmon Resonance band ~410 nm in the UV-vis spectrum. Neem seed extract, Ag-neem seed/leaf extract nanocomposites and $AgNO_3$ showed a clear inhibition against *Erwinia carotovora* whereas neem leaf extract did not show any inhibition. Comparison of areas of the inhibition zones indicates Ag-neem seed extract nanocomposite showed stronger inhibition than the rest. Identity of the phytochemicals present and their concentration differences in each extract may be possible reasons for this. Stronger inhibition of *Erwinia carotovora* by Ag-neem leaf/seed extract composites than corresponding neem extracts may be due to the enhancement of local concentrations of phytochemicals on Ag nanoparticle due to their adsorption on the surface.

Key words: Silver-neem nanocomposite, antibacterial, phytochemical

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Effects of extraction solvent on the total phenolic and flavonoid content extracted from orange colored Kiwifruit (*Actinidia macrosperma* L.)

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In this study, phenolic compounds from *Actinidia macrosperma* kiwifruit were extracted in to different extraction solvents namely 70% aqueous acetone, 80% aqueous methanol, 80% aqueous ethanol, 100% methanol and water. Total phenolic, total flavonoid contents as well as total flavanol content of the extracts were assessed spectrometrically. Among the solvents employed, 70% aqueous acetone resulted in the highest values of total phenolic (823.1±14.4 mg gallic acid equivalent/ 100 g DW), total flavonoid (170.9±1.9 mg catechin equivalent/ 100 g DW), and total flavanol (82.6±0.6 mg catechin equivalent/ 100 g DW) contents. It is concluded that 70% aqueous acetone extract from *A. macrosperma* kiwifruit contains many flavonoids which can be isolated and identified in the future studies and selected as the best extraction medium for this fruit.

Key words: Antioxidants, Extracts, Flavonoids, Kiwifruit, Polyphenols

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Morphological and mechanical properties of epoxy composites containing banana pseudostem cellulose nanocrystals

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This investigation demonstrated the transformation of valueless banana pseudostem into a high value cellulose nanocrystal (BCN) by chemical methods and the development and characterization of a novel BCN epoxy resin composite. BCN were extracted in a three-step procedure; hydrolysis with 2 wt% NaOH for 4 h at 100^{o}C and dialysis leads to the gradual reduction of lignin and the production of holocellulose. Bleaching at 50^{o}C for 2 h with 7.2 wt% H_2O_2 and 4wt% NaOH and dialysis remove colouring matters; hydrolysis with 64 wt% H_2SO_4 for 2 h at 45^{o}C under vigorous stirring allowed obtaining BCN as an aqueous suspension. Sonication and freeze drying yielded BCN. Whatman filter paper cellulose nanocrystals (FCN) were prepared as a control for the comparison purpose. Chemical analysis of BCN showed 64 wt% cellulose and 0.1 wt% lignin and 6.8 wt% ash contents. BCN were assessed by morphological investigations (optical and scanning electron microscopy) as well as physico-chemical methods (wide angle X-ray scattering for crystallinity index) and by Fourier transform infrared spectroscopy. Absence of peaks in 1509-1609 cm^{-1} region of FTIR spectra indicated lignin has removed and the disappearance of 1734 cm^{-1} peak provided evidence for the removal hemicellulose by the extraction process. XRD results indicate that the crystallinity has increased in the BCN. The reinforcing potential was investigated by incorporating BCN in a thermosetting epoxy resin matrixin different ratios of 10-80 wt%. Shore hardness measurements evidenced that all composites were stiffer, stronger, and less extensible than the corresponding neat polymer. The reinforcing effect increased with increasing BCN content. The SEM images presented secreted indicating the bio-functional properties.The results reported support the repeatability and the effectiveness of the procedure performed.

Key words: Banana pseudostem, cellulose nanocrystals, renewable resource, composites

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Treatment of textile effluents using a combination of chemical/physicochemical processes

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This study was aimed to find low cost efficient treatment technique to treat highly polluted textile dyeing waste-water. Waste-water collected from a local textile dyeing industry was subjected to coagulation, Fenton oxidation, and adsorption methods. Initial characterization of waste water was performed using standard methods. Initial COD and BOD_5 of untreated waste water were 1441 ppm and 223 ppm respectively. The waste water is not suitable for biological aeration treatment due to low BOD/COD ratio. The waste water is not suitable for discharge into inland water bodies due to noncompliance of water quality parameters prescribed by the Central Environmental Authority Sri Lanka. Coagulation was carried out using $Al_2(SO_4)_3$ as the coagulant. Minimum effective dose of Al^{3+} was 300 ppm and 54% COD reduction was achieved at pH 9 for the selected samples. The raw wastewater treated by the Fenton oxidation using 0.33 g/L H_2O_2 and 1.90 g/L $FeSO_4$ resulted 85% COD reduction. Use of Fenton oxidation as a post-treatment after coagulation with $Al_2(SO_4)_3$, the COD reduction was enhanced to 97%. Adsorption studies using commercially available activated charcoal and charcoal prepared by rice husks resulted 43% COD reduction when the adsorbent dose is 1 g/L. UV-Vis spectroscopic data shows that the adsorption on to charcoal and coagulation is quite efficient in waste water decolouration. Based on the COD reduction the combined treatment of coagulation and Fenton oxidation of waste water can be used to achieve the quality standards prescribed by the central environmental authority, Sri Lanka.

Key words: Waste treatment, Coagulation, Fenton oxidation, adsorption

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Preliminary investigation on Selenium levels of some consumable food in Sri Lanka

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Small doses of selenium are essential for human body as it has a major role in metabolism and protection of body via oxidative stress. Selenium also plays an anti-carcinogen or chemo preventive agent role in human body. Selenium concentrations of major consumable food products (fish, meat, eggs and grains) in Sri Lanka were measured using Graphite Furnace Atomic Absorption Spectrophotometer (GF-AAS). Selenium concentrations found were: *Katsuwonus pelamis* (Skipjack Tuna) 0.328 ± 0.024 µg/g, *Sardinella gibbosa* (Salaya) 0.150 ± 0.05 µg/g, chicken $0.3978 \times 10^{-3} \pm 0.20 \times 10^{-3}$ µg/g, Mutton $0.1548 \times 10^{-3} \pm 0.05 \times 10^{-3}$ µg/g, brown rice 1.822 ± 0.15 µg/g, dhal 1.996 ± 0.6 µg/g, egg white 1.436 ± 0.56 µg/g, egg yolk 3.376 ± 1.33 µg/g. Selenium concentrations in beef and pork were below the instrument detection limit ($< 0.125 \times 10^{-3}$µg/g). In the meat samples analyzed, chicken had significantly higher concentration of selenium than mutton. Also, egg yolk had significantly higher concentrations of selenium than egg white. Results of the statistical analysis revealed that measured selenium concentrations between two fish varieties and two grains were not significantly different. The highest selenium concentration was detected in egg yolk and the lowest selenium concentration was detected in mutton. Among the food samples studied, brown rice, dhal and egg have the most favorable selenium levels, therefore, its consumption seems to be preferable as good sources of selenium in Sri Lanka.

Key words: Selenium, Graphite Furnace Atomic Absorption Spectrophotometer, recommended dietary allowances, *Katsuwonus pelamis, Sardinella gibbosa*

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Preparation of chemically activated Carbons using agrowastes and investigation of their surface properties

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Freundlich and Langmuir adsorption isotherms were used to model the equilibrium adsorption data obtained for adsorption of methylene blue (MB) at 27, 60, 80 and 90°C on activated carbons (AC) produced from different agrowastes; teak saw dust (TSAC), rice husk (RHAC) and coconut shells (CAC) by chemical activation using ortho-phosphoric acid at 850, 500 and 450°C respectively. The Langmuir isotherm parameters, X_m and K and the Freundlich isotherm parameters, K_f and n were determined from the adsorption equilibrium data for the above samples. Also other important parameters such as carbonization yield, ash content, volatile matter content, methylene blue number (MBN) and iodine number (IN) were determined for each activated carbon sample. The equilibrium MB adsorption data of all the AC samples fitted well to Freundlich and Langmuir models except for TSAC and RHAC at 27°C. The type of adsorption of MB on all the AC samples is found to be activated chemisorption. Teak saw dust was found to be a viable raw material for the preparation of activated carbon since the maximum adsorption capacity towards both methylene blue and iodine was achieved with it compared to RHAC and CAC. TSAC has the best developed micro pore structure in comparison with the same of RHAC and CAC. The results of FTIR strongly support significant chemical changes occurring due to phosphoric acid treatment in production of all ACs by giving evidence for the presence of OH, carbonyl C=O, -C-O-, R-OH and P=O functional groups.

Key words: Adsorption isotherms, Methylene Blue, Activated carbon, Agrowastes

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Iron nanoparticle based drug delivery system for the effective treatment of pancreatic cancer

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With the advancement of nanotechnology, novel drug delivery systems based on nanomaterials as vehicles have been introduced, having the potential of delivering conventional chemotherapeutic agent selectively to the targeted cancer sites following macromolecular transportation through tumor blood vessels by means of angiogenesis. In this particular research, a Fe/Fe_3O_4 nanoparticle based system is constructed by tethering a chemotherapeutic prodrug of doxorubicin and tumor homing/ uptake peptide sequences to dopamine units that are located at the Fe_3O_4 interface of the Fe(0) nanoparticles. Once the nanoparticles are selectively introduced to the targeted areas, the prodrug is activated due to the acidic environments in the interstitium and (after uptake) the endosome, which causes corrosion of the nanoparticle and release of the drugs and peptide sequences from the nanoparticle's surface. The cytotoxicity of these nanoformulations was tested against murine pancreatic cancer cell lines (Pan02) to assess their therapeutic capabilities for effective treatments of pancreatic cancers. The optimization of the Fe/Fe_3O_4 nanoparticle based drug delivery system and its therapeutic effects was carried out using a statistical analysis method known as response surface methodology.

Key Words: Pancreatic cancer, Nanotechnology, Response Surface Methodology

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Efficacy of physiotherapy management and ayurvedic management of knee joint osteoarthritis

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Osteoarthritis (OA) results in pain and stiffness in joints of affected individuals restricting the performance of daily activities. The main management methods used in Sri Lanka are ayurvedic management and physiotherapy management. The present study was conducted to evaluate the two main methods of management, physiotherapy and ayurveda, of knee joint osteoarthritis and to identify factors influencing the selection of the particular method by the patient. Two groups of patients, who were undergoing ayurvedic (n=55) and physiotherapy (n=55) management for OA in the knee joints were enrolled in the study. Severity of suffering was assessed using a self administered standard Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire, with slight modification. The follow-up assessment of same participants were done after 3 months, using the same questionnaire. The questionnaire comprised of 3 sections, pain, difficulty of performing daily activities (DPDA) and stiffness and a score was given to each response. In the follow-up assessment, there was a significant reduction of pain ($p<0.001$), DPDA ($p<0.001$) and WOMAC total score ($p<0.001$) in both types of management groups and the reductions were comparable between the two groups. Although the stiffness has been significantly reduced ($p=0.001$) in physiotherapy group, this reduction was not statistically significant ($p>0.05$) in ayurvedic group. Socio-economic factors such as age, gender, educational level and employment did not have influence on making the choice between management methods by patients.

Key words: Osteoarthritis, physiotherapy-management, ayurvedic-management

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Risk behaviours for oral cancer among tea industry workers: How do they relate with cancer awareness?

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Oral cancer is a common malignancy worldwide, which ranks first among cancer deaths in Sri Lankan males. Poor health literacy and harmful behaviours increase one's susceptibility for oral cancer. Evaluation of harmful practices and their relationship with knowledge of oral cancer in vulnerable populations is important to identify preventive strategies for this deadly condition. To determine the prevalence and correlates of selected harmful practices related to oral cancer among Tea industry workers in Hiniduma, Galle and their association with oral cancer awareness. A descriptive, cross-sectional study was conducted among 337 tea industry workers in selected tea factories with estates in Hiniduma area. Data were collected using an interviewer-administered questionnaire. Betel quid chewing was the commonest harmful behaviour among the study participants (65.6%), followed by alcohol use (27%) and smoking (18.7%). Prevalence of all harmful behaviours were significantly higher among estate workers ($p<0.001$) and minor ethnic groups ($p<0.05$). Both smoking and alcoholism were significantly associated with male sex ($p<0.001$) but not with age, educational level or income. In contrast, betel quid chewing was significantly associated with older age ($p<0.01$), low educational level ($p<0.001$) and low income ($p<0.05$), but not with gender. A poor knowledge on oral cancer was significantly related with betel quid chewing ($p<0.01$), but not with other harmful practices. Risk behaviours for oral cancer are high among tea industry workers, in some instances due to poor awareness. Oral cancer prevention programmes should focus on improving awareness and preventing harmful behaviours among high risk groups.

Key words: oral cancer, knowledge, practices, tea industry workers, Sri Lanka

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Prevalence of malnutrition in female undergraduates residing in hostels of university of Sri Jayewardenepura

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Obesity and overweight, under-nutrition, micronutrient deficiency and other forms of malnutrition affect millions of people worldwide. The objective of this study was to assess the prevalence of nutritional status using BMI values of undergraduates of the first and fourth years of study residing in hostels of University of Sri Jayewardenepura. The study population of this descriptive cross sectional study consisted of 662 female undergraduates in their first and fourth years of study. A self-administrated questionnaire was administered and weight and height were measured in all subjects. Mean BMI of the sample was 19.35 kgm^{-2}. According to Asian cut-off values, the prevalence of underweight, normal, overweight and obese were 41.1%, 47.6%, 6% and 5.3% respectively. 53.7% of 1st year and 50.9% of 4th year students were malnourished. Majority (53.6%) of the study sample were in the normal BMI category whilst similar prevalence of underweight (41.1%), less prevalence of overweight (4.1%) and obese (1.2%) were observed when WHO cut off values were used. A statistically significant difference was not seen in the academic year with regard to BMI ($p>0.05$). Most of the studies conducted among female university students in other countries revealed that the majority (over 70%) of the students were in the normal and overweight category. In our undergraduate female student population, however, nearly half were in the under-nutrition category probably due to the low quality of meals available in the hostel canteens.

Key words: BMI, nutritional status, malnutrition

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Consumption patterns of animal and high fat food items by patients with Coronary Artery Disease (CAD)

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Coronary Artery Disease (CAD) is a leading cause of premature deaths in Sri Lanka. Blood lipid abnormalities, hypertension, diabetes, and obesity are some of the modifiable risk factors of CAD. Poor dietary habits are recognized as a major contributor in the development of such modifiable risk factors. The objective of this study was to examine animal (chicken, red meat, fish and egg with yolk) and high fat food (full cream milk powder, fast food) consumption patterns of patients with CAD. Patients (n=87) from a selected center who were to undergo CABG participated in the study. Patients' awareness of their dyslipidemic condition, and animal and high fat food consumption frequency (≥3 times per week and < 3 times per week) were recorded by using an interviewer administered questionnaire. Dyslipidemic conditions of the patients were obtained from the bed head tickets. The severity of CAD was evaluated by Genisini score. The sample was divided in to two groups as those who were aware of dyslipidimic condition (group A, n=61) and those who were not aware of dyslipidemic condition, but were under the treatment of lipid lowering drugs (group B, n=26). In group A, the prevalence of consumption (≥ 3 times per week) of red meat, chicken, fish, egg with yolk, fast food and full cream milk were 21%, 20%, 59%, 21%, 52%, and 96% respectively. The corresponding figures for group B were 40%, 24%, 78%, 65%, 57%, and 90%. There was a significant difference (χ^2= 9.9, $p<0.01$) in consumption of egg between the two groups. Even though no significant difference was observed in the Genisini score, it was high in group B (those who were unaware of dyslipidemia). Consumption of ≥ 3 times per week of red meat, chicken, fish, egg with yolk and fast food were higher in group B compared to group A. Therefore, consumption of foods suitable for dyslipidemic condition may contribute to reduce the severity of the CAD condition.

Key words: Coronary Artery Diseases, Dietary habits

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Relationship between pre and post-operative albumin concentrations and development of post-operative infections in Coronary Artery Bypass Graft (CABG) patients

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Low concentration of pre operative albumin increases the risk of development of infection following cardiac surgeries. However, this relationship has not been studied in Sri Lankan patients. The objective of this study was to investigate the association between pre and post operative albumin level and the development of post-operative infection in patients who underwent CABG (n=90) at Cardiothoracic unit of Sri Jayewardenepura General Hospital. The sample consisted of 60 males and 30 females with no pre-operative clinical signs of infection, inflammation, oedema or dilution. The pre-operative and post-operative (after 24 hours) serum albumin levels were analyzed (Konelab 20 analyzer). Infections in the surgical site (sternal and graft leg) and other infections (urinary tract, pneumonia and positive cultures from catheter tips) were recorded.. The pre and post albumin concentrations ranged from 32.6–54.6 g/L and 31.4-52.7 g/L respectively. Twenty eight percent (28 %) of patients developed post operative surgical site and other infections following surgery and had pre and post albumin concentrations of 45.6 (± 5.4) g/L and 41.8 (± 4.6) g/L respectively. The contribution of albumin in the development of infections was studied by the Receiver Operative Characteristic (ROC) curve. The area under the curve of ROC for post-operative albumin and infections was 64.2% ($p = 0.07$). Using a post-operative albumin cut-off value of 40.0g/L, the test had a specificity of 84% and a sensitivity of 87% in detecting post-operative infections. Even within the normal range, a cut-off value of post-operative serum albumin of 41.5g/L can be used as a prognostic cut-off with relatively high specificity and sensitivity for detecting the possibility of developing post-operative infections. Therefore, correction of post-operative serum albumin concentration nearly up to upper limit of normal may be effective in reducing the post-operative infections in such patients.

Key words: Post-operative infection, Albumin

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Socio-cultural implications of living with epilepsy: A qualitative study among children and adolescents with epilepsy living in rural Sri Lanka

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Studies on the implications of living with epilepsy in children and adolescents with epilepsy (CAWE) are limited in the Sri Lankan context. This study aimed to describe the life of CAWE in rural Sri Lanka and to identify their quality of life (QoL) issues. Qualitative study comprising 18 in-depth interviews with CAWE, their parents and siblings, and 3 focus group discussions with key informants (primary caregivers, schoolteachers, health-care workers) were conducted in Ampara, Monaragala and Hambantota districts, representing a multi-ethnic rural community in Sri Lanka. Interviews were conducted in Tamil/Sinhala, audio-recorded, transcribed verbatim and translated into English before content analysis. CAWE reported having received decent care and support from parents and siblings. Poor school performance was related to learning difficulties, lack of teachers' support and behavioural problems. Apparently, teasing and name-calling after seizures in public were more common among children than the adolescents. Discrimination and behavioural problems seemed to prevent socialization process of the CAWE. The term 'epilepsy' was found to be socially undesirable implying stigma. Also, we noted a trend in families opting for gentle terms to indicate epilepsy. Unpredictability of seizures, education, employment, marriage prospects, social support and adverse effects of long-term drug treatment were the QoL issues expressed by the parents of the CAWE. Experiences and issues differ for child, adolescent or caregiver making survival with epilepsy a diverse phenomenon for each individual. Community sensitisation is needed to decrease epilepsy unawareness and stigma to improve the QoL of CAWE in this rural community.

Key words: Caregiver, childhood epilepsy, quality of life, seizure, stigma

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Causality assessment and the severity of the adverse drug reactions (ADR) actively detected in in-ward patients in a tertiary care hospital in Sri Lanka

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Adverse drug reactions (ADR) are leading cause of hospitalization in many Sri Lankan hospitals. We conducted a survey on ADR in all patients admitted to a tertiary care hospital in Galle, Sri Lanka. A prospective observational study was conducted by actively screening for ADR for causation, causality and severity using validated scales. ADR reporting cards were used from the national pharmacovigilance centre in Sri Lanka. 149 patients were analyzed for severity of ADR referring the modified Karch and Lasagna Severity Assessment Scale. Casualty assessment was done using a WHO scale. The mean age of patients was 42 years. We found that 81.8% of patients had moderate ADR, severe, 16.1%, and 2.01% in fatal. Single most common cause of ADR was antibiotics (35.57%) and 64.42% were due to other drugs. Penicillin had the highest incidence of ADR among antibiotic subgroup. Anticonvulsants had caused most of the fatal and severe ADR. WHO causality assessment shows 60% of ADRs were probably drug-related and 18.46% of them were possibly drug related. Skin, nervous and gastrointestinal systems were commonly affected (41%, 18.53% and 14.6% respectively). 16% of patients had previous allergy. We found that females (56%) had higher number of ADR than males (43%). Challenge test had been done only in 3% of the patients and only 40% patients became positive for the test. Our study shows that most ADR detected were probably drug related and hence they are preventable. Prevention of ADR can reduce a big financial burden from the health budget. We suggest seeking contribution from clinical pharmacists and other stakeholders for active pharmacovigilance.

Key words: Adverse drug reactions, hartwigs scale, hospital pharmacovigilance

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Validity of glycaemic tests over Insulin resistance indices in detecting peripheral Insulin resistance in Polycystic Ovary Syndrome–Sri Lankan Study

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Polycystic ovarian syndrome (PCOS) is a heterogeneous disease characterized with abnormal menstruation, and reproductive impairment with impaired metabolism. Insulin resistance (IR) had been identified as a hall mark of many diseases and specially linked to an ovulation. Although the hyperinsulinemic euglycemic clamp method is the gold standard for measuring insulin resistance it is not feasible in hospital set up. Therefore, other standard indirect IR indices such as QUICKI, HOMA and fasting insulin (FI) have been used by many medical scientists to assess IR in hospitals. We planned to investigate the degree of IR, severity of glycaemic control and the validity of using the glycaemic test in diagnosing IR in PCOS patients due to lack of data in our country. Oral glucose tolerance test (OGTT), fasting blood glucose (FBS) and indirect IR indices were calculated in Sri Lankan women suspected with PCOS. Reports of FBS, insulin and OGTT which were done from same laboratory were collected from the patients. Calculation of IR was done using FI, HOMA and QUICKI. Spermann's correlation was used to test the correlation between age at menarche with other dependent parameters tested. Data on 82 patients were analyzed and the majority had IR by all three indices (93% 89% 87% QUICKI, HOMA and FI. In IR group, 7% of patient showed abnormal FBS while 22% of them showed abnormal OGTT. In abnormal FBS, one had type-2 diabetes and the rest of them showed impaired fasting glucose. With abnormal OGTT one was diabetic and 21% of them showed only impaired glucose tolerance. 75% of IR patients showed normal glycaemic control. We could not relate the age at menarche with any other parameter in our study group. According to the khans kappa test, there was no significant agreement between two tests (kappa 0.01, 13.4% CI 0.002-0.022) and the sensitivity is very low with both FBS (6%) and OGTT (22%) but specificity is 100% QUICKI was used as the standard for this analysis. Most of the PCOS patients were insulin resistant by all three indices. Majority of insulin resistant patients were normal in glycaemic control. We conclude that identification of IR in PCOS can be early detected by indirect these IR indices than biochemical tests for glucose imbalance. We further noted that screening for IR in asymptomatic patients with PCOS using these indices would help them in preventing progression of DM and other IR associated diseases and there is potential to use this sensitive test to screen drug targets for reversal of IR in future in PCOS.

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Utilization of Skipjack tuna offal (*Katsuwonus pelamis*) on growth of juvenile koi carp (*Cyprinus carpio)*

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The effects of skipjack tuna (SJT) offal (*Katsuwonus pelamis*) on growth performance of juvenile koi carp (*Cyprinus carpio*) were studied for 42 days. Two isonitrogenous (416.6 kg g-1) and isocaloric (2.02 kcal g-1) diets were prepared by using SJT offal and marketed fish meal with lipid levels (dry matter) of 6.93 ± 0.03% (mean± SD). A total of 900 juvenile fish (*Cyprinus carpio*) averaging 0.58 ± 0.03 g (mean ± SD) were randomly distributed in nine square cement tanks, and each tank was randomly assigned to one of three replicates of three diets containing 36% fish meal (FM) (T1), and 8% FM and 32% SJT offal powder (T2) with commercial diet (T3). After 42 days, weight gain (WG), feed efficiency (FE) and protein efficiency ratio (PER) of fish fed T2 were significantly higher than those of fish fed T3 ($P<0.05$). Even though no significant difference was seen in WG, FE and PER of fish fed T1 and T2, and; T1 and T3. However there were no significant differences in final weight (FW), specific growth rate (SGR), and survival among fish fed three different diets ($P>0.05$). Although significant differences were not recorded in proximate composition fish fed experimental diets. The total cost for T1 and T2 feeds were 210 and 155 (Sri Lankan Rupees (LKR)) respectively while commercial feed was available for 180 (LKR). The results indicate that the SJT offal could be utilized cost effectively as a protein supplement in juvenile koi carp feeds to replace high cost fish meals.

Key words: Fish offal, Juvenile koi carp, Growth and Protein supplement

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A preliminary study on Collembolans associated with three vegetable crops grown at selected locations in Southern Sri Lanka

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Collembolans are one of the invertebrate groups inhabiting in soil. They serve as decomposers and are important as soil quality indicators. To date, Collembolans in vegetable fields are poorly known in Sri Lanka. Collembolans inhabited each of the three, Brinjol, Okra and Tomato fields, in Denipitiya, Labuduwa and Ridiyagama, respectively, were investigated, during July- September 2013. At each location, a 100m2 plot was selected with respect to each vegetable field and ten soil corer samples, each of 500g, were taken at random, fortnightly. The Collembolans in all these soil samples were extracted using floatation method and numbers in the supernatant was counted using a stereo-microscope in a well plate. Identification of Collembolan was done upto the generic level using taxonomic keys. Eight genera, *Cyphoderus*, *Entomobrya*, *Folsomia*, *Guthriella*, *Isotomodes*, *Neaura*, *Podura* and *Tullbergia* in six families, Cyphoderidae, Entomobryidae, Isotomidae, Neuridae, Onychiuridae and Poduridae, were detected.The highest Collembolan diversity (6.33 ± 0.17) and abundance (395.33±0.90) were recorded at Labuduwa followed by Denipitiya. *Cyphoderus, Folsomia, Guthriella, Isotomodes, Neaura and Tullbergia* were common at all the three locations. In contrast, *Entomobrya* was restricted to Labuduwa. *Podura* occurred in Labuduwa and Ridiyagama while *Tullbergia* was prevalent at Labuduwa and Denipitiya. *Cyphoderus*, *Folsomia*, *Guthriella*, *Isotomodes*, *Neaura*, *Podura* and *Tullbergia* were common at three vegetable fields. *Cyphoderus* showed the highest abundance (234 ± 4.09) at Labuduwa (P<0.002) whereas *Folsomia* acquired the second highest (219.1 ± 1.12) at the same location. The abundance of *Isotomode*s (19.33 ± 0.66) *Podura* (51.6±1.21) and *Entomobrya* (9.66 ± 0.06) was the lowest (P<0.0001) at all locations.

Key words: Abundance, diversity, invertebrates, vegetables

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Comparative study on sensory and proximate properties of cage cultured Genetically Improved Farmed Tilapia (GIFT) fed with formulated and commercially available fish feeds

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Effect of two formulated diets and two commercially available diets on taste and chemical composition of fish fillets of GIFT reared in a cage culture unit was evaluated. Protein content (dry weight) in formulated and commercial feeds was 30% and 36% respectively. Each protein diet had two different lipid levels (8% and 12%). Fingerlings stocked in cages were fed with four diets for 120 days and six fish from each treatment (three from each sex) having 175 to 225 g was used for the study. Fifteen member pre trained panel assessed sensory characteristics; colour, juiciness, tenderness, oiliness, flavor and overall acceptability of steam cooked fish fillets. There was no significant difference ($p>0.05$) in all sensory characteristics tested in fish fillets between the fish fed with formulated and commercial diets. Protein, lipid and dry matter percentages were significantly different ($p<0.05$) across four treatments as well as between males and females. In contrast comparison of cumulative data of two commercial diets with cumulative data of formulated diets exhibited significant difference only in fat content. Fish fed with commercial diets having higher percentage of expensive ingredients like fish oil, quality fish meal possibly may have resulted higher fat deposition in the fillets compared to low cost formulated diets made with locally available ingredients like coconut poonac, local fish meal, rice polish and soya bean. Considering no difference in taste, overall acceptance, and three times lesser cost than commercial feeds this formulated feed could recommended for the cage cultured GIFT fish.

Key words: Sensory evaluation, proximate composition, fish feed, GIFT

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Morphometric variation in Sri Lankan populations of *Puntius vittatus* and a comparative analysis with some Indian populations

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Puntius vittatus (Teleosteii: Cyprinidae) is originally described from India, yet it is known to have a wide distribution in inland waters of Asian region. No previous information exists on its intraspecific geographic variation in Sri Lanka, and whether the Sri Lankan species is similar or different from Indian *P. vittatus.* The present study describes morphometric characters of *P. vittatus* in Sri Lanka, and a comparative analysis with some Indian populations is carried out. Fish specimens from selected streams connected to different rivers were used to collect data on 13 morphometrics from digital images of fish (Gin river at Wackwella n=19 and Mapalagama n=20; Kalu river at Rathnapura n=17; Nilwala river at Godapitiya n=30; Mee oya at Puttalam n=10, museum; Kala oya at Sigiriya n=5, museum; and Kelani river at Bellanwila–Attidiya n=5, museum). Museum specimens of three Indian locations (WHT collection: n=10 each from Kerala & Veliyanadu, n=5 from Nedu Mudi-Alleppey) were also included. The size effect was removed from all data prior to analysis. Only Head-pre Dorsal diagonal (HPdD) of *P. vittatus* was significantly different between males and females (t-test, $p=0.04$, n=30, Nilwala River), thus further data analysis was done excluding HPdD to disregard the sex effect. Except Pre-orbital length, dorsal fin base length, anal fin base length, maximum body depth and pre-anal length, all the others were significantly different (ANOVA $p<0.05$) among Sri Lankan populations. Three Indian populations did not show any significant difference ($p>0.05$). Cluster analysis revealed a diverging group represented by Kalu River and Gin river populations, which can be considered as evolutionary significant units (ESU). All the others were clustered into two closely related clades. The study concludes that a group of populations in Sri Lanka (Kalu River & Gin River) is diverging from *P. vittatus*. Although some differentiation exists, the rest of the Sri Lankan populations share the characters more closely with the Indian *P. vittatus*. Until genetic work is done to confirm further, it can be concluded that the Sri Lankan specimens belong to the same species *P. vittatus*, but some populations have diverged.

Keywords: ESU, morphometric characters, phenotypic variation, *Puntius vittatus*

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Nutrient removal efficiency of two plant bed substrates, and changes of selected water quality parameters in aquaponic system

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Aquaponics integrates growing plants without soil technology with aquaculture, having an important role in recovery of nutrients from effluents. Present study was carried out to assess nutrient removal efficiency of two types of plant beds, coir peat & saw dust. Single aquaponic aquatic system consisted of a fiberglass tank with fish, spinach plants grown in three plants beds i.e 50% saw dust + 50% soil (T1) and 50% coir dust + 50% soil (T2) were considered as the two treatments while 100% soil was considered as the untreated control (T3). Physico-chemical parameters such as pH, Conductivity, phosphate and nitrate levels, Biological Oxygen Demand (BOD), Dissolved Oxygen content (DO) and Chemical Oxygen Demand (COD), in water in each fish tank and water drained through the plant beds were measured. Statistical analysis was done using SPSS ver 17 software package. Kruskall Wallis test was used for comparison of water quality parameters in fish tanks, while Mann Whitney test was used to compare water quality parameters in fish tank and water drained through the plant bed. Phosphate level in the water draining through plant bed substrates has exhibited significantly different ($p<0.05$) lower values compared to water in fish tank for all treatments. However, nitrate concentration in water draining through plant bed substrates exhibited higher values compared to water in fish tank except for treatment 1. Present study revealed that coir peat and saw dust used as plant bed material have ability to remove some nutrients in fish pond through aquaponic system.

Key words: aquapoinic system, plant bed, coir peat, saw dust.

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Temporal trends in erythrocyte nuclear abnormalities and leukocyte count of hybrid red tilapia upon prolonged exposure to crude oil

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Acute exposure to sub-lethal doses of crude oil is known to cause erythrocyte nuclear abnormalities (ENA) in fish, yet studies reporting temporal trends in the relevant effects of prolonged crude oil exposure are rare. This study aims to report temporal trends in genotoxic effects (ENA) and relative leukocyte counts of hybrid red tilapia (*Oreochromis niloticus* L. x *Oreochromis mossambicus* Peters) exposed to two concentrations of crude oil, 3ppm (T1) and 15ppm (T2) (V/V ratio in water) using a 40-day controlled laboratory experiment. Blood smears prepared (n=9 fish per tank, two replicates) on the days 5, 10, 20 and 40 were used to count cells of different types of ENA (per 5000 RBC's) and total leukocytes (per 1000 RBC's). Micronuclei were totally absent in all groups, and nuclear buds (NB), bi nucleated cells (BN), fragmented apoptotic cells (FA) were not detected in the control group. A significantly higher frequency ($p<0.05$) of all observed ENA types (i.e. NB, BN, FA, and other types of altered nuclei-AN) were found in both treatment groups compared to the control on all sampling days, except for AN between control and T1 group on day 10. Between-group effect in ENA frequencies showed similar patterns temporally as well. However, temporal trends in ENA types within groups varied. Total leukocytes showed an increase ($p<0.05$) in T2 compared to that of the control on all sampling days. Similarly, T1 group also showed significant increase except on day 40. The count was significantly higher in T2 than in T1 on all respective sampling days indicating some dose-dependent effect, except on day 10. An increasing temporal trend was found in leukocyte count in T1 and T2 groups until day 20, and decreased on day 40. The results show that prolonged crude oil exposure causes induction of some ENA types and increase in total leukocytes in the groups exposed to crude oil indicating genotoxic effects on juvenile red tilapia over 40 day period, and that the among-group differences were temporally consistent.

Key words: crude oil, ENA, genotoxic effects, leukocytes, temporal trend

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Extreme value analysis of wind speed in Puttalam, Sri Lanka

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Geographically there is a possibility of having high wind speeds in Puttalam. This can cause damages to man- made structures such as bridges, wind-turbines, buildings, radio masts, etc. Therefore assessment of wind speed is utmost important to prevent from such disasters to some extent. Daily wind speed (kmh^{-1}) data for Puttalam from January 2007 to April 2014 was used in the analysis. "Extremes" package of R software was used for the data analysis. In this study we present two different methods for extreme value analysis, Peak-Over-Threshold method, which is based on Generalized Pareto Distribution and Block Maxima approach, which is based on Generalized Extreme Value distribution. Parameter estimation was done using Maximum Likelihood estimation and L-moments method. Hypothesis testing on the shape parameter confirmed the type of the distribution to be used. According to Peak-Over–Threshold method, using the Mean residual life plot, threshold stability plot and diagnostic plots the best threshold value was found as 12.25 kmh^{-1}. The shape parameter was negative and the null hypothesis of data fits exponential distribution was rejected (p-value<0.05). Hence the best distribution was identified as the Beta distribution. According to the Block Maxima method the null hypothesis that the data fits Gumbel distribution was rejected (p-value<0.05). Since the shape parameter was negative, data fitted well with the Weibull distribution. Using the identified distributions return levels and their 95% confidence bands were obtained. The 100 year return level using Peak-Over-Threshold method was 18.29 kmh^{-1} whereas according to the Block Maxima method it was 17.99 kmh^{-1}.

Key words: Generalized Extreme Value Distribution, Generalized Pareto Distribution, Peak-Over-Threshold method, Return period, Wind speed

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Factors associated with implementing ERP Systems in Sri Lanka

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Private sector companies in Sri Lanka are currently using Enterprise Resource planning (ERP) systems to increase the productivity. The internationally known factors associated with the implementation of ERP system may not be appropriate in the Sri Lankan context. The main objective of this research is to find the factors associated with the implementation of ERP systems in Sri Lanka. Stratified random sample of 97 is taken from the 128 companies implemented ERP systems (SAP, Microsoft and Oracle ERP) in Sri Lanka after 2005. Correlations analysis and Log-linear models were used to analyse data statistically. Correlations between Project Management (PM) and Project Leader Availability (PL) (r=0.553), User Training (UT) and Software Selection (SW) (r=0.369), UT and Vendor Support (VN) (r=0.402), VN and SW (r=0.342), SW and Hardware Selection (HW) (r=0.555) are found to be correlated at 1% level of significance. Log-linear model indicates that there are associations between PM and UT, and VN and HW at 10% level. So, when implementing an ERP system in Sri Lanka, PM, UT, VN and HW should be considered seriously. And PM, UT, VN and HW were significantly associated at 10% level with the successful implementation of an ERP system Sri Lanka. Furthermore through log linear models it has found that the accuracy of an ERP system is associated VN. And ERP systems will be reliable if the VN and SW is done properly. ERP system will be successful if business process engineering is done properly and the selection of proper hardware, software and vender.

Key words: Enterprise Resource Planning, Implementation, Success, Log-linear

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Modeling tourist arrivals to Sri Lanka

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Research and management of large number of fields, including Hospitality and Tourism rely on mathematical modeling. Statistics plays a vital role in modeling process, capture the uncertainty and make the model more realistic. Accurate forecasts of tourist arrivals facilitates for decisions at all levels, from government to a single tourist. Hence, finding appropriate forecasting techniques is essential. Current study was focused on modeling tourist arrivals to Sri Lanka and identifying the best fitting statistical model for forecasting tourist arrivals. Monthly arrival data from 1968 to 2013 were tested on Moving Average (MA) Smoothing models, Single Exponential Smoothing (SES) models, Double Exponential Smoothing (DES) models and Holt's Winters Three Parameter Models. Model selection criteria were Mean Absolute Percentage Errors (MAPE's). MAPE of the models MA (2), SES of Alpha 0.8 and 0.9, DES of Alpha 0.9, Beta 0.1and Holt's Winters three parameter method of Alpha 0.9, Beta 0.1, Gamma 0.1 were 24%, 20%, 21%, 19% respectively. Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD) also agreed with MAPE's. It was concluded that Holt's Winter's three parameter model is the best fitting model for forecasting international tourist arrivals to Sri Lanka.

Keywords: Smoothing Techniques, MAPE

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Dye sensitized solar cells fabricated with polymer free quasi solid state (gel) electrolyte

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Dye Sensitized solar cells (DSSCs) are cheaper alternatives to the conventional silicon solar cells. In general DSSCs comprises an electrode consisting of a nanocrystalline titanium dioxide (TiO_2) films modified with a dye, a platinum counter electrode and an electrolyte solution in between the electrodes. Replacement of liquid electrolyte by and electrolyte in quasi solid state helps to overcome many problems occurs in dye sensitized solar cells such as lack of long term stability due to liquid leakage, usage of volatile liquids, electrode corrosion and photodecomposition of the dye in the solvent medium. In this study we report results obtained on Quasi solid state electrolyte system composed of ethylene carbonate (EC) and propylene carbonate (PC) as plasticizers, Iodine and Potassium Iodide (KI) as redox species, and fumed silica as the polymer less gelling agent. Short circuit photocurrent density of 7.83 mA cm^{-2}, an open circuit voltage of 665 mV, a fill factor of 63.3%, and an overall efficiency of 3.30% was observed under simulated sunlight of 100mW cm^{-2} on fabricated dye sensitizes solar cell in configuration of FTO/TiO_2 electrode/ Ruthenium dye (N719)/potassium iodide, Iodine polymer less quasi solid state electrolyte/Pt/FTO.

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Forecasting monthly cinnamon prices in Matra district using double exponential smoothing model

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A time series (y_t, $t=1, 2,\ldots,n$) is generally considered as an ordered sequence of measurements at equally spaced time intervals. The time series models are useful in many applications to understand the underlying forces and structure that produced the observed series and to forecast future events. In this study an attempt has been made to build a time series model to forecast monthly cinnamon prices of M-5 cinnamon in Matara district from 1996 to 2014. Plot of data clearly shows a trend which does not indicate any seasonality. The seasonality was tested using Kruskal-Wallis test (p-value = 0.995). Therefore double exponential smoothing method has been applied in this research study. In this study $\alpha= 0.990$ and $\gamma = 0.001$ have been selected as the most suitable smoothing constants. One-step and p-step forecasting methods can be used when double exponential smoothing method is used to forecast. According to the results of this study it has identified that the one-step forecasting method is suitable for predicting the monthly cinnamon prices for Matara district.

Key Words*:* Double exponential, smoothing constants, seasonality, M-5 cinnamon prices

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Designing energy tax rate to optimize energy usage in garment factories using Game Theory

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Energy problem is undoubtedly one of the most serious global problems people all over theworld are facing today. Energy resources, especially fossil fuels, are crucial to everyone on the earth. Unfortunately, these resources are non renewable. Besides, great consumption of fossil fuels is also causing severe environmental problems. Therefore, improving energy efficiency is very important to every country in the world. In this paper, we propose a method of designing energy tax rate based on game theory. Using this method, the effect of energy tax on encouraging manufacturers' improvement in energy efficiency is enhanced. Consequently policy makers can reduce the average burden of manufacturers brought by energy tax. Through utilizing game theory in a numerical example, we explain the effect of energy tax on encouraging manufacturers to improve their energy efficiency. The result shows that, given a fixed average tax rate, energy tax with differential tax rates according to manufacturers' energy efficiency is more effective than that with uniform tax rate. Then, based on differential tax rates, a method to determine a proper average tax rate is presented by utilizing theory of Nash equilibrium in game theory. In addition, practicality of the method is simply discussed in the last section.

Key words: Differential rate, Energy efficiency, Energy tax, Game theory, Nash equilibrium

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Joint probability distribution for drought duration and drought severity based on copula methods for Hambantota District, Sri Lanka

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Hambantota district is known as one of the areas in Sri Lanka which experience severe drought conditions. Therefore, it is vital to study the drought conditions in Hambantota to get a thorough understanding of the drought situation. Monthly rainfall data collected by the Metrological Department for the years from 1951 to 2013 in Hambantota were used for the analysis. In this study, drought characteristics are defined using monthly standard precipitation index (SPI). Drought severity and drought duration were commonly used to describe droughts. Since these variables are dependent, the copula method was used to find the joint distribution. Kendall's rank correlation was calculated between two variables and found that it is significant ($p<0.01$). The best marginal distributions of drought severity and drought duration were found as gamma and exponential distributions respectively. Significant correlation allowed to use, selected four Achemedian (Gumbel-Haugaard, Frank, Joe and Clayton) and one meta-elliptical (Normal) copulas. Parameters of the copulas were estimated by inverting the Kendall's tau. It was found that Gumbel-Haugaard is the best copula for the drought severity and drought duration with lowest AIC and BIC among the selected copulas. The joint probability distribution was fitted using Gumbel-Haugaard copula and univariate marginal distributions. The return periods were calculated using the identified joint probability distribution function and when the drought duration is 2 and drought severity is 2, the return period is about 7 months. That is, we can expect drought duration of two months and drought severity of 2 once in every seven months.

Key words: Copula, Return periods, SPI, Joint distribution

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An application of nonparametric Kernel Density Estimators in Colombo stock market indices

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The Colombo Stock Exchange (CSE) is the major financial trading agency in Sri Lanka. All Share Price Index (ASPI) and Standard & Poor Sri Lanka 20 (S&P SL 20) are main indices of CSE. The estimation of the density distributions of the fluctuation of stock market indices is main and challenging task of the financial market. This paper investigates the density distributions of returns and its variants of Colombo Stock Market Indices ASPI and S&P SL 20. The technique of nonparametric kernel density estimation with appropriately chosen bandwidths are used as a more flexible functional-free approach in fitting the distribution function depicting peaks and fat tails as well for stock market returns and log returns. The results show that the nonparametric kernel density estimators can successfully be applied to estimate the unknown density functions for daily stock market data due to the availability of dense data sets, particularly representing the tail parts of density distributions in contrast to the absence of that in traditional techniques such as single normal density estimators or Lorentzian distributional applications. Finally, concerning on the importance, drawbacks and the inherent nature of nonparametric methods used, some concluding remarks are given about the analysis on the returns and log returns of stock market indices.

Key words: Nonparametric Kernel Smoothing, Stock Market Indices, Density Distribution

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A Context-Free grammar for IUPAC names of hydrocarbons for developing a Syntactic Parser using Swi-Prolog

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Information retrieval is a necessary task in many applications in any field and retrieval of chemical information is one of them. In addition, predicting chemical structures from their name is also a useful application for students and teachers. For processing the chemical names, there needs to be a systematic or algorithmic way of representing the name. The International Union of Pure and Applied Chemistry has set rules to name a structure for a chemical, starting with hydrocarbons. The rules are not in a suitable form for computer processing. There is only a limited amount of literature on such work, but even in them, the grammar definitions are not made explicit or are implicitly embedded within the source code. The aim of this paper is to present a context-free grammar for organic chemicals so as to process their names for information retrieval or for the provision of structural information for 2-dimensional drawing, and to demonstrate how the names can syntactically parsed by implementing the grammar in an free and open source language *Swi-Prolog* making use of its automatic backtracking feature and declarative nature. The Backus-Naur notation is used to define the grammar. The definitions are set as Prolog rules correspondingly so as to identify the components of the names with the proper tagging, so that one can make use of the tagged information for other processing as necessary.

Keywords: context-free-grammar, hydrocarbon, Swi-Prolog, information-retrieval, structure-drawing

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Improving the performance of an algorithm by using multiple single dimensional memory structures for index mapping

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Execution time of an algorithm is a critical factor in process optimization. Index mapping is a technique that is used to improve the efficiency of an algorithm by improving the arithmetic efficiency of the algorithm. Usually, multi-dimensional or single dimensional memory structures are used for implementing index mapping. We found that the usage of multi-dimensional or single dimensional memory structures for implementing the index mapping did not always improve the resultant efficiency of an algorithm. Furthermore, we observed that the usage of multi-dimensional or single dimensional memory structures lead to cause reduction of the performance of an algorithm. As a solution for this problem, we used multiple single dimensional memory structures with equal length for implementing the index mapping. We evaluated the proposed technique with an algorithm that is used to create bit reversal permutation, which is considered as a critical sub process of Fast Fourier Transformation process. Two, four, eight, and sixteen multiple array and vector implementations of the algorithm reported 44% - 21% and 28% - 16% less clocks per element (CPE) in relation to the relevant multi-dimensional version, respectively. Also, two, four, eight, and sixteen multiple array and vector implementations of the algorithm reported 4% - 48% and 3% - 61% less CPE in relation to the relevant single dimensional version, respectively.

Keywords: Index mapping, Fast algorithm, Memory management, Multidimensional memory structures, Multiple memory structures

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Properties of CdS thin films prepared using the electro-deposition technique for applications in CdS/CdTe solar cells.

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Cadmium Sulphide (CdS) thin films were electrodeposited successfully onto Indium Tin Oxide (ITO) coated glass substrates from an aqueous solution of pH 1.4 containing 0.3M $CdCl_2$ and 0.03M $Na_2S_2O_3$ or 0.03M thiourea at 46^oC temperature. Properties of CdS thin films prepared at different deposition voltages, deposition time periods, bath temperatures and annealing temperatures were investigated using the current-voltage (I-V) plots. It was found that the best quality CdS layers were formed under the deposition conditions of -1.13V for a period of 45 minutes in a solution of pH 1.4 at 46^o C. The performance was improved significantly after annealing the sample at 400^o C for a period of 20 min. The properties of CdS thin films prepared by using two and three electrode systems and using two different electrolytes were compared using the current-voltage plots. It was found that there is a significant improvement of current of the samples prepared with two electrodes when using thiourea as the S source compare to the samples prepared with $Na_2S_2O_3$. The analysis of XRD spectra showed the hexagonal crystal structure of electrodeposited CdS. In addition, absorption spectra gives a bandgap value of 2.42 eV which is similar to the characteristic bandgap of CdS. Atomic Force Microscopy (AFM) analysis shows that the roughness of CdS samples are in the range of 10-15 nm. The film thickness of the samples were in the range of 175-225 nm according to the optical profilometric data.

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Comparison of ARIMA and Neural Network Models for S&P SL(20) Index

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In the current financial world, prediction of stock prices has become a vital task. Predicting the future is important for the organizations to plan or adopt the necessary policies. Forecasting can assist them to make a better development and decision making for the country in the academic literature. The main aim of this study is to compare the forecasting performance for future values of Standard and Poor Sri Lanka 20 (S&P SL 20) between Auto Regressive Integrated Moving Average (ARIMA) models and Artificial Neural Networks (ANN) which are based on statistical and artificial intelligence based techniques by fitting the data and calculating computational errors. We used daily S&P SL 20 index value of Colombo Stock Exchange from the period 27th July 2012 to 28th December 2013 to forecast the future values of S&P SL 20. The best architectures for forecasting nth future day of S&P SL 20 were 30-10-1 feed-forward ANN model and ARIMA (1, 1, 1) model. The suitable parameters of each model are selected by using training data set together with trial and error technique. The forecasting performance of each model was compared by using Absolute error, Absolute fraction of variance (R2), Mean Absolute Deviation (MAD), Mean Square Error (MSE) and Root Mean Square Error (RMSE). The results show that ANN forecasting is more accurate in forecasting for an increased number of days than ARIMA model.

Key words: Forecasting, S&P SL 20 index, ARIMA model, ANN model

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A stochastic model for T-cell-APC system based on Random Energy Model

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A simple stochastic model for the interactions between T-cell and Antigen Presenting Cell (APC) system is proposed with a major concern on the effect of T-cell receptor cluster formation on T-cell activation. We consider a 'sample space' {-1, 1} of interaction events, where '-1' (respectively'1') corresponds to an unfavorable (respectively favorable) interaction between the T-cell and APC and propose the Hamiltonian model for the binary sequences of interactions between T-cell and APC system. The specific free energy of the model with respect to a control parameter called 'generation time' is calculated via numerical Monte-Carlo simulations. We report the effects on the specific free energy of the strength of the interactions between clusters, that of the number of clusters, of the standard deviation of the distribution of energies associated with the interactions between the T-cell and APC, and also that of the generation time. We cannot see any discontinuity in the free energy with respect to the parameter, $\widetilde{T}$ - generation time. However, at $\widetilde{T}$ (= 0.163) we can notice a change in the derivative which shows that the free energy remains constant for $T \geq \widetilde{T}$. The sustained interaction between the T-cell and the APC leads to intracellular signaling mechanisms that would ultimately cause the activation of the T-cell. The activated T-cell is no longer the same as the non-activated or a naive T-cell; it would undergo substantial conformational/ geometrical changes as well as internal changes that occur in the nucleus of the T-cell to activate the gene regulation as transcriptional factors leading to launch various activation functions. Hence, the system of interactions between T-cell and the APC evolves into a new state, which we propose here to explain via phase transitions in the Random Energy Model.

Key words: Random energy model (REM), T cell receptor (TCR), Antigen presenting cell (APC), Peptide Major histocompatibility complex (pMHC), Specific Free energy (SFE), Monte-Carlo Simulations.

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Study the effect of ZnO and TiO_2 to develop photo-degradable LDPE based composite materials

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Low Density Polyethylene (LDPE) is widely used for packaging applications due to their exceptional properties. However, it does not readily decompose in an environmental friendly manner after the usage due to high chemical stability. LDPE based photo-degradable polymers are especially designed by controlling their degradability by adding photocatalysts. The degradation occurred when exposed to sunlight. Photo-degradable polymers are produced with the help of photocatalysts. TiO_2 and ZnO can be used as photocatalysts. Titanium dioxide is mainly available as Rutile (TiO_2) and Ilmenite ($FeTiO_3$) deposits in Sri Lanka. These minerals containing sand deposits are available in Pulmoddai in the North East of Sri Lanka. In this research, 0 -150 μm particles of TiO_2 (3.06 eV), ZnO (3.0 eV) and LDPE were used to develop photo-degradable composite material. 1-5 % wt. of ZnO and constant 4% wt. TiO_2 were blended with LDPE and test pieces were prepared. Photo-degradation behavior was tested by using variation of tensile strength and percentage elongation, water absorption, weight loss measurements and FTIR spectroscopy for initial samples and after exposure to UV for 50 hours, 100 hours, 150 hours, 200 hours and 250 hours. Melt Flow Index (MFI) was measured to analyze the processability of the product. According to experimental results, developed LDPE + 4% wt. TiO_2 + 5% wt. ZnO system showed the required tensile strength, percentage elongation, minimum water absorption and good processability. This composite material can be used as an alternative material to replace non-degradable LDPE product to create green environment.

Key words: LDPE, ZnO, TiO_2, Photo-degradable

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Effect of natural enzymes on the biodegradability of cellulose containing polymer composites

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Low Density Polyethylene (LDPE) is the most common thermoplastic material use in the world today. It is an organic polymer which has the chemical formula of $(C_2H_4)_n$. It does not have any active regions; therefore, natural tendency to degrade in normal environment of polyethylene is very low and creates serious environmental problems after the usage. Disposal of plastic waste is a serious concern in world today. New technologies have been developed to minimize their adverse effect on the environment. Currently, worldwide accepted technologies used for the plastic disposal are incineration and mechanical recycling. However, these methods have several limitations and create several environmental issues. Biodegradable polymers are solution to waste disposal problem. Most of the natural polymers are biodegradable. Cellulose and hemi cellulose are two types of natural polymers and they were extracted from rice straw which is highly available in Sri Lanka. Biodegradability imparted by cellulose and hemi cellulose further increased by radish peroxidase natural enzyme. It was extracted from radish roots. Cellulose – hemicellulose, radish peroxidase and LDPE were mixed by using laboratory scale internal mixer by varying radish peroxidase concentration form 0.5% wt. to 2.5% wt. and measured the degree of degradation and variation of mechanical properties. Degradability of the product increased with the increase of radish peroxidase concentration. Tensile strength and percentage elongation decreased during the soil burial test. Optimum results were obtained with 4% wt. cellulose -hemicellulose and 2.5% wt. radish peroxidase with LDPE. This product can be used as a packaging material to protect the environment.

Key words: LDPE, cellulose, radish peroxidase, biodegradable

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Modeling Outcome Reporting Bias and Parameter Estimation Using Markov Chain Monte Carlo Method for Meta-analysis on 3 × 2 Tables

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A Meta-analysis, also known as systematic overview, is a statistical procedure in which the results of several independent studies are integrated, with the aim of being able to resolve issues that cannot be concluded from a single study alone. If a comparative binary outcome is being considered, generally it will be possible to construct, a 2 × 2 table, for each study. Methods for analyzing these types of data are well developed. Our interest is to investigate the study results involving two treatments, which can be summarized into 3×2 table. If all outcomes for all 3×2 tables are available, then already available methods of meta-analysis for 2×2 tables can be used to obtain results. However there are some statistical problems in reporting outcomes of 3×2 tables. It has long been accepted that research with statistically significant results is more likely to be published or submitted than non-significant results. This process of publication of outcomes based on their results is called as Outcome Reporting Bias (ORB). This can impact the results of a meta-analysis due to the biasing of the pooled treatment effect estimate. A parametric selection model is proposed to correct the reporting bias in the reporting of outcomes within a study. A Markov Chain Monte Carlo (MCMC) method is proposed to calculate maximum likelihood estimates. Proposed model is applied to an illustrative data set assuming missing data follows missing at random (MAR)[1] mechanism. The computation is done by using WinBUGS, Bayesian software based on Gibbs sampling.

Key words: Meta-analysis, Outcome reporting bias, MCMC, MAR.

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[1] Missingness mechanism does not depend on the unobserved data.

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A study on parameter estimation in modelling using a model independent program – PEST

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The parameter estimation in mathematical models according to the observations requires a considerable effort as those parameters are used for the verification of the suitability of the models in many fields. Some of such problems are considered as inverse problems which are hardly treatable. In some models, parameters are directly estimated using the available observations. PEST (named using an acronym of Parameter ESTimation) is a program that can be used to estimate parameters for the models that are used to describe real scenario. This work presents the details on estimating spring constants using PEST for a simple mathematical model that simulate the oscillation of objects that are connected by three springs which is known as coupled harmonic oscillator. This study with the test example illustrates the validity and versatility of the PEST program which has the ability to find one or more parameter sets, if available, for the same scenario. It is important for researchers in any filed to identify possible availability of such sets of parameters, when available, for the models that are being investigated. By this work, it is communicated to the interested research community the details of the ability and suitability of PEST for parameter estimation as PEST is independent from the model investigated but it can use the model (that is being considered for estimating the parameters), the observations and initial guesses for those parameters for the estimation process.

Key words: Model, Unknown Parameter Estimation, PEST

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Development of water management system to bg 358 rice variety using a computer model

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Sri Lanka is a tropical country with two major cultivation seasons, called *Yala* and *Maha.* Rice is the major staple food grows under different climate and environmental conditions. Crop models have been found to be very good methods for testing different decision making process and management option in crop cultivation. Agricultural Production Systems Simulator (APSIM) is a best crop model used in present day in several cropping systems. Study was done in Kadaweramulla area of the Kurunegala district and APSIM crop model was used to evaluate paddy yield under different water management methods (irrigation only, rainfall only and irrigation+rainfall conditions) to identify water stress condition for paddy cultivation. The crop model used for simulate rice yield under number of dates irrigation supply for each farmer and graphical show yield variation and simulated water content in the root zone under different water management methods. According to the results of different water management options, the simulated yield was higher under the irrigation+rainfall option compared to other two options because of less water stress conditions. According to simulate data after increasing number of irrigation days supply for paddy field, soil moisture less fields paddy yields continuously increase and after some point yield try to decrease. Soil moisture condition high paddy fields can see opposite results. Those two phenomena mainly happened due to water stress condition in the paddy fields. Soil water content in the root zone is varied in whole life cycle of the rice plant according to the simulation results.

Key words: APSIM, water stress, water management, irrigation days, soil moisture

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Organic acid production and phosphate solubilization by phosphate solubilizing bacteria isolated from green house soils in South Korea

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The present study was aimed at assessing organic acid production and inorganic phosphate solubilization by phosphate solubilizing bacteria (PSB). Fifteen inorganic PSB strains were isolated from green house soils at Daejeon, South Korea and their organic acid production and inorganic phosphate solubilizing efficiency were assessed under laboratory conditions. All the tested isolates demonstrated diverse phosphate solubilizing capacity in liquid culture medium. They increased available phosphorus concentration in the medium and the increments were pronounced (> 600 µg/ml) during the 2-3 days of incubation. Simultaneously, the pH of the medium lowered (3.63-3.85), and the relative time course coincided with the increase in the phosphate solubilization. Analysis of the culture medium by High Pressure Liquid Chromatography (HPLC) revealed that strains produced gluconic acid as the main organic acid followed by oxalic and citric acids. Results further indicated that organic acid production in the culture medium increased with the incubation period, reaching the maximum at 2-3 days as in the case of soluble phosphorus concentration in culture medium, thus it can be concluded that the production of organic acid may enhance the phosphate solubilization.

Key words: Organic acids, phosphate solubilizing bacteria, gluconic acids, oxalic acids, citric acids

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Survey on the success of mangrove restoration in Sri Lanka

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Mangrove ecosystems in Sri Lanka are decreasing at an alarming rate, regardless of the awareness on their economic uses and ecological services. Mangrove restoration received a lot of attention in Sri Lanka, particularly after the tsunami in 2004 due to their role in buffering action against tsunami. The main objective of the study was to investigate mangrove restoration success along with major prevailing stress factors and disturbances in Sri Lanka. All the lagoons and estuaries along the coastline of Sri Lanka were examined and information was gathered from visual observations and interviews with relevant parties in each site visited. *Rhizophora* sp. has mainly been used for replanting (72%) and in this study, twenty one (21) restored sites encountered. However, only two sites *i.e.* Kalpitiya and Pambala showed success rates higher than 70% and Mannar showed the third highest success rate of 33%. Post planting care was the major reason for their success. Cattle trampling (100%), browsing (100%), algal accumulation (77%), insect attacks (95%), prolonged inundations or floods (27%), infestation by barnacles (14%) were observed as common reasons for the poor success in the unsuccessful and less successful sites. Starting restoration projects with sound scientific knowledge on the autecology of the planted species and on the factors responsible for failures in previous efforts and regular maintenance of the site being restored at least during the first few years are recommended as solutions to avoid poor success rates.

Key words: Mangroves, restoration success, Sri Lanka

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Effect of Nisin on post-processing acidification of curd produced by controlled fermentation of *Streptococcus lactis*, *Streptococcus cremoris* and *Lactobacillus bulgaricus*

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Nisin is a polycyclic antibacterial peptide which used as a preservative in cheese. It is a bacteriocin effective against many Gram-positive organisms including lactic acid bacteria. Hence, the present work was undertaken to assess the effect of Nisin on post-processing acidification and the lactic acid bacteria population of curd. Curd was prepared using freeze dried curd starter cultures and was divided in to three groups. 0.015% (w/v) of Nisin and 1000 mg/Kg of Potassium Sorbate (E 202) were added to two parts separately while the remaining part was kept without adding any preservatives (control). Curd samples were analyzed for lactic acid bacteria population, titratable acidity and pH for 10 days period while storing at 4^{o}C. Incorporation of Nisin in to curd reduced ($P<0.05$) the lactic acid bacteria population than the control (curd without any preservative) by 1.27 log CFU/mL at day 01 of refrigerated storage. Nisin incorporated curd samples showed slightly higher ($P>0.05$) pH and lower Titratable acidity than the curd without any preservatives (control) at day 1 of refrigerated storage. Therefore, this study revealed that Nisin can reduce the post-processing acidification of curd than Potassium Sorbate upon refrigerated storage up to 10 days.

Key words: Curd, Nisin, Potassium Sorbate the post-processing acidification

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Isolation and screening of potential bacterial antagonists from forest floor soils against *Colletotrichum truncatum* causing anthracnose disease in chilli (*Capsicum annuum*)

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Possible utilization of bacterial antagonism as a reliable alternative in controlling anthracnose disease in chilli was assessed in this study. Rhizosphere soil taken from a forest floor was used as the source of antagonists against the chilli anthracnose pathogen, *Colletotrichum truncatum*. Bacteria were isolated through serial dilution procedure and the contrasting bacterial colonies were initially screened for their antagonistic property by spotting them on a spore lawn of the *C. truncatum* on potato dextrose agar medium (PDA). Bacteria which gave a clear zone on spore lawn were then subjected to co-cultivation and dual culture assay in triplicates on PDA under *in vitro* conditions. The mean radial mycelial growth of the fungus was measured against each bacterial isolate seven and fourteen days after culturing and the percent inhibition of radial growth was calculated compared with the control. Out of 104 contrasting bacterial colonies isolated from forest floor soils, 18 exhibited antagonism among which 13 isolates significantly ($p<0.05$) inhibited the growth of *C. truncatum* in co-cultivation ($p<0.05$). Dual culture assay with selected 13 bacterial isolates, revealed that in four isolates, the radial growth inhibition of *C. truncatum* was greater than 90% at $p<0.05$ level. The selected antagonists were coded as F2, F65, F79 and F80 and were used for further analysis. The selected promising antagonists almost totally inhibited an average of 96.90% of the mycelial growth of *C. truncatum in vitro.* Microscopic studies of fungal hyphae subjected to the antagonism showed many deformations such as thickening, swelling and malformation. These results suggest that above mentioned bacterial isolates can be further studied as potential biocontrol agents in controlling anthracnose disease in chilli.

Key words: Antagonists, bacteria, Chilli anthracnose, *Colletotrichum truncatum*, forest floor soil

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Effect of different storage media: sand, paddy husk and coir dust on the shelf-life of fresh lime (*Citrus aurantifolia*) fruits

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The present study was conducted to evaluate the effects of different storage media; river sand paddy husk and coir dust which can be used to extend the shelf-life of fresh lime (*Citrus aurantifolia*) fruits. Lime fruits harvested at fully grown light green stage were used for this study. Three different storage media such as sand, paddy husk and coir dust were used for the extension of shelf-life of lime fruits in fresh form. Plastic crates filled with media were used to store lime fruits. Titratable acidity and weight loss of samples were measured at weekly intervals. Temperature of the environmental, storage room and media were recorded daily. The environment temperature during the test period ranged from 33°C to 35°C while it ranged from 27°C to 29°C at the storage room. The temperature in sand and paddy husk was significantly higher ($P<0.05$) than that in coir dust. Lime fruits stored in sand showed a significantly higher ($P<0.05$) weight loss during the experimental period and all the fruits were discarded due to un-usability for human consumption after four weeks of storage period. The significantly lowest ($P<0.05$) weight loss were recorded at each sampling stage of fruits which were stored in coir dust medium and remained up to six weeks. The titratable acidity of lime fruits stored in all the media decreased from 11% to 7% with the time. The rate of decrease was 3% after four weeks in fruits stored in sand while other fruits did not show any significant difference. The shelf-life of fresh lime fruits can be extended up to six weeks using coir dust as a storage medium under ambient conditions.

Key words: Lime fruit, shelf-life, storage media and weight loss

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Diversity of true mangroves in Mandativu Island of Jaffna, Sri Lanka

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Mandativu is one of islands connected with the mainland of Jaffna and located in close proximity of Jaffna town. The extensive studies of mangroves of Jaffna Peninsula are very scanty and the literature pertaining to mangroves of Jaffna are decades old. In order to document the present day mangrove species associated with Jaffna lagoon, a study was carried out with the following objectives namely to documents the mangrove species found in Mandativu coastal line and to find out the plant cover and distribution of mangroves in the study area. The study was started from October 2013 to April, 2014. Mangrove species were identified with the help of standard keys. To document the abundance, a 30 Km^2 area was selected by walking and marked points through GPS meter. Then ARCGIS software aided 5m x5m square grids were developed covering the sampling area and the random selections of grid were done via the Ms excel. The grids have marked through the GIS and the exact locations were sampled in the Mandaitivu Island. The plant species and their abundance were noted in 30 randomly selected grids. From these recordings frequency, relative frequency, density, abundance and dominance were calculated. Altogether five true mangrove species were identified namely *Avicennia marina, Rhizophora mucronata, Ceriops tagal, Bruguiera cylindrica and Pemphis acidula. A. marina* was the dominant species as it has the highest relative density value (0.62%). *P. acidula* and *B. cylindrica* species are rarely found in the study area. *A. marina* showed uniform distribution (35.8% relative frequency) while rest of the mangrove species showed clumped distribution pattern. In this study region, mangroves were cut for firewood. In conclusion, Mandaitivu Island is dominated by *A. marina* and *B. cylindrica* showed the lowest abundance. Among these *A. marina* is uniformly distributed and other species showed clump aggregation pattern.

Key words: Mangrove species, distribution, relative density, relative frequency, Mandaitivu

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Isolation and preliminary characterization of hydrocarbon degrading bacteria from petroleum contaminated soils

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Petroleum hydrocarbons (PHs) are being accumulated in the environment due to a variety of anthropogenic activities and are considered as pollutants. These compounds badly affected on flora, fauna and micro-organisms. Removal of these compounds from the environment is very difficult and a costly process. It is known that certain micro-organisms are capable of degrading PHs as a natural process. Therefore, the key aim of this study was to isolate PHs degrading bacteria for potential candidates to be used in future bioremediation process. By using enrichment culture technique, eight bacterial strains were isolated from sub surface soil samples that have been exposed to petroleum hydrocarbons during long period of time. These isolates were subjected to screen their ability to degradation of diesel in petri plate assay. Out of them five bacterial strains that produced varying degrees of clear zones on diesel amended mineral salt medium were also capable to grow on diesel and kerosene amended mineral salt broth as a sole carbon source. This indicates the ability of these strains to biodegrade petroleum hydrocarbons. Increase of turbidity in mineral salt broth amended with 1% (v/v) diesel and 1% (v/v) kerosene was used as an indication for the ability of those bacterial strains to grow on diesel and kerosene. Bio chemical characterizations were done for certain PHs degrading isolates. Further studies are needed to determine whether they can degrade other petroleum hydrocarbons and their growing ability in different concentrations of various PHs, such as benzene, toluene, ethyl benzene, xylene and producing ability of bio-surfactant and bio-polymer by these bacterial strains to be employed them successful bioremediation of petroleum hydrocarbons in practice.

Key words: Petroleum hydrocarbons, biodegradation, soil bacteria, oil spills

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Construction of a fusion cassette for the introduction of a lysine rich gene into rice (*Oryza sativa* L.) genome

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Lysine is the least available amino acid among the eight essential amino acids needed for human growth and function. Protein deficiency disorders in human are particularly severe, especially in Asia where rice is the major staple food. One way to address this problem is enhancing both lysine and total protein content in rice by genetic engineering. The present study was carried out to increase total protein content including lysine in rice (*Oryza sativa* ssp *indica*) by introducing a pollen specific lysine-rich gene, *SBgLR*, from potato (*Solanum tuberosum*) under the control of a rice seed-specific globulin promoter. Genomic DNA was extracted from rice leaves (*Oryza sativa* ssp *indica*) and promoter region of globulin was amplified by PCR using globulin promoter-specific primers. The amplified product of 1024 bp was sub cloned into pGEM®-T Easy vector. Recombinants were screened by rapid screening method, colony PCR and restriction digestion. Sequencing was performed for further confirmation of 1024 bp fragment. Recombinant clone was cleaved with *Pst*1 and *Bam*H1 restriction enzymes and the resulting fragment was cloned into pCAMBIA1391Z for the construction of pCAMBIA1391Z-*Glb* recombinant vector. The lysine rich gene cloned previously (pCR®2.1-TOPO-*SBgLR*) was cleaved and cloned into pCAMBIA1391Z-*Glb* recombinant vector for the construction of pCAMBIA1391Z-*Glb*-*SBgLR* fusion cassette. Recombinants were identified and isolated. Current study is in progress to transform *Glb*-*SBgLR* fusion cassette to rice calli by *Agrobacterium* mediated gene transfer.

Key words: Globulin (Glb) promoter, *SBgLR* gene, *pCAMBIA1391Z* vector

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Size frequency distributions of *Pocillopora damicornis* in coral reefs: responses to anthropogenic impacts

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Size-frequency distributions of coral colonies reveal important characteristics of composition of coral populations by providing insight into past events and have some predictive power with respect to population development on the reef. The aims of this study were to evaluate the size frequency distribution of *Pocillopora damicornis* between impacted reef (Polhena, Matara–subjected to anthropogenic activities and influence from Nilwala river discharges) and relatively non-impacted reef (Paraviwella, Tangalle), and to find the size dependent patterns of the partial mortality and bleaching. Data were collected during May and June 2014 using 25 m long line intercept transect. The colony size was determined as its volume using the maximum height, length, width and a "k value" (0.0658) which was estimated from a volumetric method. There was no significant difference in the size frequency distribution of *P. damicornis* for impacted versus relatively non-impacted reefs (Pearson χ^2= 21.55, df= 14, p= 0.088). There were large number of colonies in the lowest size class (<100 cm^3) at both sites and the number of colonies in that size class were higher in relatively non impacted reef than in impacted reef indicating that the condition of the reef locality affects to the distribution patterns of corals. There was a significant positive relationship of the size of *P. damicornis* with the estimated volume of the partial mortality (R^2= 0.63, F= 150.82, p= 0.01) and with the estimated volume of bleaching (R^2= 0.34, F= 5.23, p= 0.045) revealing that the larger size colonies may not spent much of their energy for repair and maintenance. As *P. damicornis* is a key reef building species on reefs in Sri Lanka, it is very important to study its population dynamics and this study provide base line data need for coral reef management.

Key words: Coral population dynamics, *Pocillopora damicornis*, Partial coral mortality, Coral bleaching

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Understanding the seasonality of butterflies in maragamuwa regenerating forest

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Butterflies are important faunal group in eco-tourism, because of their attractiveness and occurrence throughout the country. A study was carried out to identify the seasonal variation in abundance of butterflies and correlation between climatic factors and temporal variation, therefore, selecting a suitable period to observe butterflies with regards to ecotourism. Research was carried out in a regenerating forest at Maragamuwa in Naula in Matale district, which is in intermediate zone and has a long dry period and a short wet period per year. Dry season spans from May to November, and wet period from December to April. The study was conducted for one year from June 2013. Butterfly abundance and climatic data were collected once in every week. Line transects were used to sample butterflies. Five, 100m long transects were established. All the visible butterfly species, their abundance, and climatic factors were recorded. Total of 58 butterfly species belonging to six families were recorded. Their abundance per visit was calculated. April had the highest abundance of individuals (103±19.0) with three families having the highest abundance (Family Nymphalidae, Piridae, Lycaenidae). April and June had the lowest abundance (26.5±5.3) with four families (Family Papilionidae, Piridae, Hesperiidae, Riodinidae) having the lowest abundance in July. Two periods namely March to April, at end of wet season, and from November to December, beginning of the wet season high butterfly abundance was recorded. Comparatively wet season had the highest abundance and number of species. The highest day time mean temperature of 33.6°C was recorded in May and the lowest was recorded in December (26.8°C). Findings infer that butterfly abundance in Maragamuwa forest increases during wet season, and most suitable period for butterfly observation is beginning of wet season and end of wet season from December to April.

Key words: Temporal variation, Butterfly Abundance, Species composition, Maraamuwa forest

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Spatial variability of mixed layer, isothermal layer and barrier layer of northern Bay of Bengal area

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Barrier Layer Depth (BLD) is the distance between the bottom of the mixed Layer (ML) and the isothermal layer (IL). Data of Underway Conductivity Temperature and Depth profiler (UCTD) of US research vessel "R/V Roger Revelle" collected during a cruise in the northern Bay of Bengal (BoB) (5.193^0N, 84.897^0E and 7.073^0N, 85.399^0E) from 29th November to 11th December 2013 were used to understand the spatial variability of mixed Layer, isothermal layer and Barrier layer (BL). Satellite altimetry data were collected from the AVISO database to visualize the Sea Surface Height anomalies. Recorded MLD ranged between 10-60m and the minimum MLD value was recorded in the observed freshwater plume, added by the Indian major rivers. ILD varied between 21-93m. BL and IL were deepest in the fresh water plume recording a range of 60-79m and 50-75m respectively. Satellite altimetry data has showed that there was a positive sea surface height in this plume, depicting a divergence in the area making ILD deep. The ship passed the cyclonic storm 'Madi' during 06th and 07th December. Calculated wind Stress (τ) was maximum (11.7 Nm^{-2}) during this period. Wind stress had significantly impacted on ILD, MLD and BLD ($r = -0.218$, 0.212 and -0.299 respectively, $p<0.01$) along the cruise track, even in the storm period. This study reveals that fresh water in BoB, forces for deepening of BLD by shoaling MLD. Surface heat fluxes, Ekman drift and surface geostrophic currents should be studied further to understand the spatial variability of MLD, ILD and BLD.

Key words: Mixed Layer Depth, Isothermal Layer Depth, Barrier Layer Depth, Ekman Drift, Geostrophic currents.

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Influence of climatic factors on the butterfly abundance in Kumaragala natural forest of Sri Lanka

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Butterflies are common inhabitants in every terrestrial habitat in the country. However, the species are not evenly distributed. This study was conducted to identify impact of climatic factors, mainly temperature, humidity and wind on butterfly abundance and diversity in Kumaragala forest reserve located in the intermediate zone of Sri Lanka. Systematic random line transects were used to collect abundance data. Five, 100m long transects were placed through the forest which are separated by 25m gaps. Abundance of all butterfly species and climatic factors (temperature, humidity, light intensity, wind speed, and cloud cover) were recorded in each transect. Field sampling was conducted once a week for a seven month period from January 2014. A total of 69 species were recorded during the study. Species diversity of butterflies in study area was calculated using Margalef's index (D_{mg}= 9.43). Canonical Correspondence Analysis (CCA) was performed to see whether butterfly abundance is determined by climatic factors. CCA showed that abundance of butterflies of family Hesperiidae increases towards high temperature and low humidity (Dryer conditions), butterflies of family Papilionidae increases with both cloud cover and humidity (wetter conditions), and the abundance of all butterfly families except Lycaenids decreased in high wind conditions. According to results, other butterfly families (Nymphelidae, Piriidae, and Riodinidae) do not showed a clear relationship with climatic variables. Also CCA results showed that June had high winds and July had comparatively high temperature. Results highlights that butterfly abundance in a natural forest mainly depend on local climatic conditions. Most of families of butterflies showed increased abundance under dry conditions.

Key words: Natural forest, Abundance, Temperature, Humidity

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Minimizing of delayed bitterness of lime juice

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Lime *(Citrus aurantifolia)* is widely used as a flavor enhancer in Sri Lanka. As extracted lime juice cannot be preserved for long time due to the development of delayed bitterness, industry has introduced artificial alternatives for lime. The aim of this research was to evaluate effect of sedimentation and filtration on bitterness of natural lime juice. Extractions were kept in PET bottles for one month at ambient conditions to facilitate sedimentation and the development of bitterness and then the juices were filtered through activated carbon columns with and without removing the sediments. Columns of three heights (5 cm, 10 cm and 15 cm) were used. Filtered juices were analyzed for physiochemical (pH, titrable acidity (TA) and total soluble solid (TSS), antioxidant (total phenolic content (TPC), antioxidant scavenging activity (DPPH), sensory quality (simple ranking test, 5 point hedonic scale) and for microbiological properties. Based on these results, the juice obtained after de-sedimentation and filtered through 10 cm activated carbon column was selected for further studies. The pH, TSS, and TA values for selected juice were 2.2, 4.8°, 5g citric acid equivalent /100mL respectively, and those values were significantly different compared to the natural lime juice (pH 2.01, TSS 7° and TA 6.29g citric acid equivalent /100mL). Total phenolic content of selected lime juice was 0.029 mg galic acid equivalent/g, which is significantly lower than natural lime juice (0.611mg galic acid equivalent/g). Sensory results revealed that the sour taste and the overall acceptability of the filtered lime juice were similar to that of natural lime juice. On the other hand, natural lime juice showed higher "bitterness" compared to filtered juice. Results revealed that the layer separation and filtration through activated carbon is an effective treatment to reduce the development of delayed bitterness, though the phenol content was reduced significantly than the natural lime juice.

Key words: delayed bitterness, limonin, sedimentation, activated carbon, phenolic compounds

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Eco-friendly synthesis of Silver nanoparticles functionalized with *Flueggea leucopyrus* (Willd) bark extract

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Currently nanoparticles get much attention due to their wide range of applications in various fields such as electronics, catalysis, energy and medicine. This work presents a simple and eco-friendly synthesis of silver nanoparticles (AgNps) using Silver nitrate and plant extract, *Flueggea leucopyrus* (Willd.) as the reducing agent. The aqueous solution of 1 mM silver nitrate was shaken with aqueous extracts of bark of *F. leucopyrus* and silver nanoparticles were obtained in average diameter of 109.4 nm. They were characterized using UV–Visible absorption spectroscopy, Fourier Transfer Infra Red (FTIR) and Particle size analysis. As there are no drastic conditions and toxic chemicals used in this synthesis, the method can be explained as eco-friendly synthesis. These nanoparticles will be investigated to see the possibility of use as the career for transferring *F. leucopyrus* (willd.) to cancer cells.

Key words: Silver nanoparticle, *Flueggea leucopyrus* (Willd.), Eco-friendly synthesis

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Possible effects of tidal currents on the water chemistry at RekawaLagoon, Tangalle, Sri Lanka

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The possible effects of tidal waves on the physico-chemical properties of the Rekawa Lagoon were assessed based on the preliminary experimental data collected on April and July 2014. The April data showed a strong positive linear relationship ($r^2 > 0.9$) between pH and dissolved oxygen (DO) and a negative linear relationship between turbidity and DO ($r^2 > 0.8$). These two linear relationships were explained by hypothesizing that the pH and the DO of the lagoon are highly influenced by the photosynthesis of aquatic plants. Moreover, negative linear relationships between conductivity and DO ($r^2 \approx 0.7$), and TDS and DO ($r^2 \approx 0.7$) were also observed. The concentrations of sodium, calcium, iron, chloride and sulfate were also positively increased with the conductivity and turbidity. These observations were explained by hypothesizing that the seawater delivers to the lagoon during tidal currents is responsible for the changes in the lagoon water chemistry during tidal events. The changes in the concentrations of certain chemical constituents such as sodium and chloride are a direct result of mixing seawater with the lagoon brackish water. However, the changes in the DO and pH were explained based on the possible effects of sediments brought to the lagoon by the tidal waves on the photosynthetic processes of aquatic plants. The fine and coarse sediments increase the water turbidity and as a result, the penetration of sunlight through the water column is greatly reduced. This phenomenon negatively affects the photosynthesis and hence, the production of O_2 and the consumption of CO_2 (aq) is greatly reduced. The pH and DO of aquatic systems has a significant impact of its water chemistry. The rate of certain chemical reactions in aquatic systems including redox reactions, solubility of metal oxides, complexation and de-complexation reactions, photochemical reactions are highly dependent on the pH and DO. For an example, the rate oxidation of Fe^{2+} (aq) is first order with respect to DO and second order with respect to pH. Therefore, it is proposed that tidal currents have a relatively high impact on the overall water chemistry at the Rekawa Lagoon based on April experimental data.

Key Words: Rekawa Lagoon, water chemistry, tidal currents, photosynthesis

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Novel indirect spectrophotometric method for the determination of trace copper using methylene blue as a chromogenic agent

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Copper plays an important role in plants and animals as an essential trace element. However, high concentrations of Cu(II) is toxic, which causes health problems for human and has large influence on the growth of plants. In addition, copper is a potent environmental pollutant as it is a heavy metal. Therefore, it is a necessity to develop a rapid, sensitive, and cost-effective method for the determination of trace levels of copper. This abstract presents a novel, inexpensive, and suitable method for the determination of trace copper in industrial and environmental samples. UV-visible spectrophotometry is a convenient and reliable method, which has been used for the determination of many elements in trace quantities using several chromogenic agents. In this research, we develop a simple, rapid, and relatively-sensitive spectrophotometric method for the quantitative determination of trace levels of copper using methylene blue as a chromogenic agent. This method involves a reaction of Cu(II) with potassium iodide in acidic medium. It liberates iodine and consequently the liberated iodine bleaches the blue colour of methylene blue. Then the absorbance of remaining colour was measured using a UV-visible spectrophotometer at the wavelength of 665.6 nm. The decrease in absorbance of methylene blue is directly proportional to the concentration of Cu(II). The measurable range was found as 2.0-10.0 μg ml^{-1} of the concentration of Cu(II). The results obtained using the noval method were verified with the standard flame atomic absorption spectroscopic method. In addition, the reaction conditions such as pH, buffer concentration were optimized and effects of diverse ions were tested.

Key words: Trace copper, chromogenic agents, Methylene blue, UV-visible method

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Production of biodiesel from rubber seed oil and effect of Hydroquinone on its storage stability

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Biodiesel is a possible alternative for petrodiesel and normally produced by transesterification of vegetable oils. It is a mixture of alkyl esters of fatty acids and the production cost is high. Objective of this work was to develop a method to reduce the production cost of biodiesel by using rubber seed oil which is having no commercial value and by using a cheap catalyst. Acid esterification was used to convert free fatty acids in the oil to their methyl esters by treating the oil (45°C) with methanol (6:1 methanol:oil molar ratio) and conc. Sulphuric acid (0.5 wt% of oil) and then by heterogeneous transesterification using methanol (12:1 methanol:oil molar ratio) in the presence of calcium glyceroxide (0.5 wt% of oil), and Na_2CO_3 (5 wt% of oil). During storage, gel/flakes were formed in biodiesel. It was inhibited by using quinhydrone as the antioxidant. Density, freezing point, iodine value, calorific value, sodium level and calcium level of biodiesel were 874 kg m^{-3}, 16.8^{o}C, 51.9 g I_2/100g, 39.95 MJ kg^{-1}, 2.93 ppm and 3.39 ppm respectively and agree with the recommended values by ASTM. Density of biodiesel after storing for four months was 880 kg m^{-3}. Major fatty acid methyl esters present were palmitic (13.12 %), stearic (13.67 %), oleic (10.92 %) and linoleic (54.92 %) acids. The method developed is a promising low-cost way to produce biodiesel and, hydroquinone can be used to increase the storage stability.

Key words: Antioxidants, biodiesel, rubber seed oil, transesterification

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Antibacterial properties of chitosan silver nano composites (CAgNCs) against *Vibrio salmonicida*

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The aim of this study is to characterize and investigate the antibacterial properties of chitosan-silver (Ag) nano composite (CAgNCs). The synthesized CAgNCs was characterized by field emission scanning electronic microscope (FESEM) and Fourier transform infrared (FTIR) spectrometer techniques. Results show that CAgNCs could inhibit the growth of *V. salmonicida*. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined as 50µg/mL and 100µg/mL respectively. The field emission scanning electronic microscope (FE-SEM) revealed that the exposure of *V. salmonicida* to CAgNCs led the disruption of cell membranes and the leakage of cytoplasmic materials. The existence of elementary Ag in the membranes of treated bacteria, detected by FE-SEM equipped with an energy dispersive X-ray spectrum (EDS). The effect of CAgNCs on bacterial protein synthesis was determined by SDS PAGE and results showed inhibition of protein level in concentration and time dependent manner. Treatment of CAgNCs induced the level of reactive oxygen species (ROS) in concentration and time dependent manner suggesting that it may generate oxidative stress leading to bacterial cell death. Propidium iodide (PI) uptake results suggest change in the permeability of the inner cell membrane of *V. salmonicida* with CAgNCs. Overall results from this study suggest that CAgNCs is potential antibacterial agent to control fish pathogenic bacteria.

Key words: Chitosan silver nanocomposite, antibacterial agents, *Vibrio salmonici*da, ROS, membrane permeability

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Study on food consumption pattern of pregnant women at Kattankudy area of Batticaloa district

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This study was conducted in antenatal health care clinics at Kattankudy Divisional Secretariat area of Batticaloa District, Sri Lanka during March 2014 to June 2014 to assess the consumption pattern of pregnant women. A total of 56 pregnant women at second trimester period were randomly selected for the study. Pre tested questionnaire was used to collect data and frequency of food consumption were estimated using food frequency questionnaire. Weight and height were measured using standard techniques. Body fat percentage was measured using Warrior digital Body Mass Caliper. Processed data was analyzed using Descriptive statistics and Statistical Package for Social Sciences (SPSS) version16. Results indicated that about 87.5% of the pregnant women were between the age ranges of 20-35. Among them 92.5% had secondary education, 44.6% and 37.5% earn income through labour and business respectively. Majority of the pregnant women (87.5%) obtained their energy from rice on a daily basis while 62.5% and 57.1% got their protein from chicken and beef curry respectively, on a weekly basis. Further orange (30.4%) accounted for the mostly consumed fruit and okra (55.4%) was the mostly consumed vegetable on a weekly basis. In terms of milk, 48.2% consumed daily, while curd and yogurt were consumed once in a week by 26.8% and 21.4%, respectively. Further, the study revealed that, fruit and vegetable consumption by the pregnant women was low in the study area. Therefore, dietary interventions like awareness campaign to sensitize the pregnant women to improve their healthy eating behavior especially fruits, vegetables and dairy products to prevent adverse health consequences.

Key words: Antenatal health care, food consumption, body fat percentage, pregnant women

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A study of selected risk factors in Sri Lankan breast cancers

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Breast cancer (BC) is the most common cancer among Sri Lankan females. Being null parous, use of oral contraceptives, lack of breast feeding and a family history of BC are some of the risk factors believed to be associated with increasing BC incidence. The present study attempted to observe the effects of above risk factors in the development of BC. Data on civil status, parity, duration of breast feeding, usage of oral contraceptives, family history and knowledge on self assessment of BC was gathered from newly diagnosed consented BC patients (n=100) using an interviewer administered questionnaire (Ethical approval-651/32). Among the BC patients majority (63%) were postmenopausal and 37% were premenopausal. Majority of the participants were married (99% of premenopausal and 96% of postmenopausal) and have given birth to at least one child (99% and 97% of pre and postmenopausal) and 38% have given birth to more than 3 children. Among all, majority (82%) has breast fed for more than one year. Twenty of premenopausal (54%) and fourteen of postmenopausal (22%) have used oral contraceptives and among all who have had oral contraceptives, 14 of pre (38%) and 6 of postmenopausal BC patients (10%) have relied on oral contraceptives for more than 5 years. Considering the family history 29 (29%) had first order relatives with breast cancer and 32(32%) had blood relatives with other cancers. 10% had both family history of BC and have had oral contraceptives more than one year and 12% had a history of any cancer and have had oral contraceptives more than one year. However, only 2% of the patients had family history, used oral contraceptives and had breast fed for less than one year. Among the total 60% were unaware of self assessment of breast lumps and have initially identified the breast lump randomly. Nearly 30% in the study group had a family history of BC and one third has relied on oral contraceptives more than one year. Being nullparous and lack of breast feeding was not common among the study population. However, the knowledge on self assessment of BC was not satisfactory.

Key words: Breast cancer, family history, oral contraceptives

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An evaluation of microbiological tests used in the diagnosis of bacterial meningitis

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Bacterial meningitis is a rapidly progressing, common infection that requires immediate medical attention. To assess the efficacy of different diagnostic tests done at the Microbiology Laboratory, Teaching Hospital Karapitiya (THK) for bacterial meningitis. Bacterial Antigen Test (BAT) and Enrichment Culture were routinely performed for 5 weeks of duration using 50 specimens from clinically suspected meningitis patients. Gram stain and CSF culture were also performed on these 50 specimens concurrently. CSF full reports of the 50 cases were obtained from the biochemistry laboratory of THK. Using BAT, an etiological diagnosis could be made in 4 (8%) of cases of clinically suspected meningitis patients in all age groups. One bacterial meningitis patient was diagnosed using BAT but all the other investigations gave negative results for that specimen. Both CSF routine culture and CSF enriched culture results showed 100% negativity. CSF full report indicated evidence of bacterial meningitis in 7(14%) specimens. Four (8%) specimens were positive for Gram stain and all identified organisms were Gram negative bacilli and those were not compatible with other investigations. In this study 47 (94%) patients had antimicrobial therapy before lumbar puncture (LP). CSF full report seems to be a superior diagnostic tool than Gram stain, enriched culture, routine culture and bacterial antigen test in clinically suspected bacterial meningitis patients. BAT also an important guide to diagnose bacterial meningitis. Cerebrospinal fluid routine and enriched cultures failed to diagnose bacterial meningitis. There is no use of performing routine and enriched cultures for patients who had antimicrobial therapy before LP.

Key words: Cerebrospinal fluid, Bacterial meningitis, Antigen test, Routine test.

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Quality of life and social support of patients with knee osteoarthritis in two selected hospitals in Sri Lanka

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Osteoarthritis (OA) is a degenerative joint disease. Knee OA limits a person's ability to participate activities in physical, occupational and social. This study aimed to measure the Quality of Life (QoL) and social support of patients with knee osteoarthritis (OA) in two selected hospitals in Sri Lanka. A descriptive cross sectional study was conducted among knee OA patients (n=77) at the National Hospital of Sri Lanka and Rehabilitation Hospital Ragama using self-administrated Short Form-36 (SF-36) and Medical Outcomes Study–Social Support Survey (MOS-SSS). These tools were widely used in literatures to asses QoL and social support of knee OA patients. A recommended scoring method was used (0-100) and average is taken with SD. Higher scores indicate higher social support and QoL. Mean age of the participants was 53.8 years (*SD*=±10.1) with male: female ratio 1:4.5. Mean scores of QOL and social support were 50.5 (*SD*=±16.3) and 59.0 (*SD*=±18.3) respectively. Mean score of the mental health components of the QoL (55.0±20.1) was higher than that of physical health components (45.1±17.8). QoL and physical health scores were significantly lower when OA is bilateral (p=0.022 and p=0.004 respectively).QoL and mental health component scores were significantly and inversely associated with numbers of family members (p=0.027 and p=0.009 respectively). Also mental health components were significantly positively associated with age (p=0.004). No significant co-relation was found between QOL and social support (r=0.15, p=0.19). QOL was significantly negatively associated with number of family members and bilateral OA increases the chances of having poor QoL in the patients.

Key words: Quality of life, Social support, Knee osteoarthritis

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Utility of three mitochondrial gene regions to infer genetic variation of brood stock populations of *Catla catla* (Hamilton, 1822) in three Aquaculture Development Centers in Sri Lanka

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Catla catla is an economically important freshwater fish species in the carp family Cyprinidae and introduced species to Sri Lanka as a food fish. Their brood stock cultures are maintained at three Aquaculture Development Centers in Sri Lanka and fingerlings are produced for culturing purposes. This study was designed to investigate the utility of three mitochondrial gene regions to infer genetic variations of brood stock populations of *Catla catla* in three Centers. Samples were collected from brood stock populations of *Catla catla* of three Aquaculture Development Centers in Dambulla, Iginiyagala and Udawalawa. From each brood stock, 15 individuals were randomly selected and DNA was extracted using a sample from the caudal fin of each individual. Partial DNA sequences of three mitochondrial gene regions; Cytochrome Oxidase II (COII) (920bp), Cytochrome *b* (Cyb) (354bp) and 12S rRNA (286bp), were recovered. Resulted sequences for each gene region were homogenous for all three centers indicating lack of genetic variation within and among populations. The percentage of A+T values were similar for COII and Cyb gene regions (58%) while it was 49% for 12S rRNA gene region. These results suggested that amplified section of the three mitochondrial gene regions in this study are highly conserved in nature and are not appropriate for population level study of *Catla catla.* It could be suggested that genetic information are needed to gather from more variable regions of mitochondrial and nuclear genome to analyze the population diversity levels of the above species.

Key words: *Catla catla*, brood stock, genetic variation, mitochondrial genes

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Fourier analysis on modeling stock returns of individual companies in bank finance and insurance sector of Sri Lankan share market

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Sri Lankan share market returns have wave like patterns. A wave can be viewed either in time domain or in the frequency domain. The frequency domain analysis is known as Spectral Analysis or Fourier analysis. Spectral analysis was initially established in physics and engineering. Later it has been applied in explaining the behavior of economic variables exhibiting cyclical or seasonal patterns. However applications of Fourier analysis in economic time series were limited and were unable to find in Sri Lankan context. Current study was focused on applying the Fourier transformation on modeling stock returns of Sri Lankan share market. Random sample of three companies from Bank Finance and Insurance (BFI) sector of Colombo Stock Exchange (CSE) was selected. Monthly average returns from year 2000 to 2011 were used for data analysis. Auto Correlation Functions and Partial Autocorrelation Functions were used to test the stationary of returns. Fourier transformation is used to transform the data into series of trigonometric functions. Multiple Regression analysis was used for estimating amplitudes of the Fourier series and forecasting returns. Normality of residuals and Mean Square Errors (MSE) were used for model validation. Study revealed the ability of applying Fourier transformation on modeling returns of individual companies in BFI sector of CSE. But MSE's of the models were high. It was recommended to test Fourier transformation on more company returns, representing all the business sectors of CSE. Also it is necessary to find techniques for reducing MSE's.

Key words: Spectral Analysis, Fourier transformation

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An appropriate representation of the Genetic Algorithm for the travelling salesmen problem

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In artificial intelligence, a Genetic Algorithm (GA) is a search that mimics the process of natural selection. It is routinely used to generate useful solutions to optimization problems. In a GA, we simulate the survival of the fittest among individuals over consecutive generation for solving problems. Choosing a representation in the design of a GA is the major problem. The Travelling Salesmen Problem (TSP) is an NP-Hard problem in Computational Optimization. Computation of the exact solution of the TSP requires an amount of computation time which is exponential in the size of the problem. In this research, TSP is solved by a new representation of GA. An encoding mechanism is developed and selection, crossover and mutation operators are defined. We have presented a GA variant for solving the TSP that uses the novel cross over method. In the crossover it uses one of the parent's position of the gene structure to mate with other parent's chromosomes. Our GA representation is tested with 17, 26 and 42 cities and found that our algorithm performs accordingly and generates expected near optimal results within acceptable levels. Using Brute force search for 17 cities problem, TSP would have needed checking 2.092279 x 10^{13} possibilities, however GA within 1000 iterations gives the optimal solution. The actual answer for 17 cities TSP is 2085. We also ran GA for 26 cities and 42 cities TSP's with average results of 1034 (actual 937) and 944 (actual 699) respectively for 5 runs when the population size, number of generations, *max_crossover_gene* parameter are increased to 500, 2000 and to 8 respectively, we got average of 994 and 837 for 26 cities and 42 cities TSP's respectively. So, we could see that tuning of the GA parameters optimizes the result.

Key words: Genetic Algorithm, Travelling Salesmen Problem, Optimization

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Recognition of Sinhala handwritten characters using Artificial Neural Networks

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In the Government of Sri Lanka, most of the information based activities are still carried out manually. This research attempt proposes a new way to automate an important public service which is fundamental by nature, issuing the National Identity Card (NIC). This presents an approach to recognize Sinhala handwritten characters in application forms. Initially, set of handwritings of 30 individuals were collected and then two third of those samples was used for the training process and the remaining one third was used for the testing process. The scanned images of the characters were gone through preprocessing for further processing. Finding boundaries and the normalization of the characters was handled by the preprocessor. After preprocessing, segmentation was done in order to get the individual characters from the list of characters. Standard image processing techniques were employed to accomplish these tasks. Then they were trained by an Artificial Neural Network (ANN). The recognition of Sinhala characters is done by an ANN which is widely used in applications involving uncertainty. Rules are imposed on the results of the neural networks (NN) to make the recognition process more accurate. Then the details of the applicant are appended to the database. The outcome of this research will be beneficial to the general public at large.

Key words: Artificial Neural Network, Document Management System, Sinhala Character Recognition, e-government, Sri Lanka

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A study on clustering algorithms in data mining using Weka tool

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This study is based on clustering data mining algorithms by using WEKA machine learning software. This paper discusses about four clustering algorithms: *k*-means, Expectation Maximization(EM) ,Density Based and Hierarchical clustering algorithm, and study the performance of these clustering algorithms based on the cluster building time of each algorithm and the quality of built clusters. The experiment is done on five datasets using WEKA interface. In this experiment, the selected four clustering algorithms are used for five datasets to create clusters. From the results obtained in the experiment, it was concluded that there are both advantages and disadvantages among these clustering algorithms. The *k*-mean significantly reflected that it is the best performing algorithm for large datasets and cluster building time taken was significantly low. Density based clustering algorithm was not suitable for data with high variance in density. Hierarchical Clustering algorithm did not support for large datasets. However Hierarchical clustering algorithm was more sensitive for noisy or outlier data. EM clustering algorithm gave log likelihood values of the clusters to ensure more reliable clusters. EM algorithm is an extension of *k*-mean which satisfies more iterations. Although this is a complex algorithm, it can be applied to parallelization to obtain best performances using cross validation. According to this study, it was identified that to choose the best clustering algorithm it is necessary to study size of the dataset, density of the dataset and its distribution. This study is continued for several clustering algorithms to increase the performance by using parallel programming methodologies.

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Design and implementing a microcontroller based smart ECG adapter for healthcare

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Electrocardiography (ECG) has a significant place in diagnosis for giving medical treatment especially for patients who are suffering from heart ailments. In Sri Lanka, the government has provided facilities to obtain ECG reports for free of charge. But this facility is not enough due to the enormous number of patients in government hospitals and takes considerable time per patient. Most of the time patients seek assistance of private medical centres. Also the hospitals in remote areas have lack of facilities, and then the patients have to get reports from private Medical centres with paying exorbitant fees. To minimize this problem, we have designed and implemented a low cost smart microcontroller based ECG adaptor. This has been implemented using a Peripheral Interface Controller (PIC) microcontroller as the main controller to acquire the ECG signals and display them on a Personal computer (PC) or Laptop. An ECG monitoring software was implemented as a part of this research in order to monitor ECG signal via a RS-232 interface. In addition this ECG monitoring software is capable of saving the previous records and comparing them with the current record. This will help Cardiologists to study any changes to the heart conditions of the patient. Also, printed paper is not required to keep ECG records. It helps Cardiologists to determine the patient's condition even in rural areas and it is possible to transmit them via a mobile network to consultants. The resultant ECG reports were verified using a standard ECG machine (Cardiofax ECG6501/6511.01 machine) and also verified by the Principal of school of Cardiography, in the Cardiology Unit National hospital, Colombo.

Key words: Electrocardiography (ECG), Cardiology, Microcontroller, Peripheral Interface Controller (PIC).

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Investigation of the efficiency of ram pumps with the volume of the pressure chamber

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The hydraulic ram pump transfers the energy of a falling water flow to a fraction of the original water flow and there by taking it to a higher elevation without the use of an external energy input such as fossil fuel and electricity. Some percentage (>50%) of input water has to be wasted and that percentage value depends on several parameters such as the input head, output head, diameter of input and output pipes, diameter of the waste valve and the delivery valve and the volume of the pressure chamber. Today energy consumption is increased and hence, the energy crisis is a burning problem for almost all of the people living in the world. Therefore, this energy free pump is a timely needed solution for the energy crisis. The aim of this project is to investigate the efficiency of hydraulic ram pumps with the volume of the pressure chamber. We analyzed the volume of the pressure chamber which, directly effect to the pumping rate, keeping other parameters constant. We designed a volume variable pressure chamber and pumping rate was measured with different volume of the pressure chamber. The experimental results showed that the efficiency of the designed ram pump is 27.6 % when the volume of the pressure chamber gets its critical volume. The experimental results showed that the physical dimensions of the pressure chamber does not effect to the efficiency of the ram pump. Around the critical volume of the pressure chamber, the shape of the graph of time (t) for pumping a desired volume Vs the volume(v) of the pressure chamber is well fitted to a quadratic polynomial ($t = av^2 + bv + c$) with a minimum.

Key words: water hammer, higher elevation, pressure chamber, pumping rate and delivery rate

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Developing a Tourist Arrivals Forecasting System for Sri Lanka

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This study attempts to identify suitable forecasting models for accurate forecasting of tourist arrivals in Sri Lanka. Monthly arrival data, obtained from Sri Lanka Tourism Development Authority, for January 2010 to October 2014 period have been used to build models and evaluate the degree of accuracy of their forecasts in respect to the total arrivals as well as arrivals from six origin countries. The reason for selection and confinement to the said duration was the unique growth trend observed in tourist arrivals after conclusion of civil war in 2009. Altogether four forecasting models were evaluated using four accuracy measures namely MPE, MAPE, RMSE and Theil's U. From the analysis it appears that forecasts from Holt Winters multiplicative seasonal model for Total tourist arrivals and for three of the selected origin countries (India, United Kingdom and Maldives) outperform those from other models in terms of most of the accuracy measures. For France, SARIMA model generated the most accurate forecasts while for China and Germany, Holt Winters additive seasonal model showed more accurate forecasts. Vector Autoregression model was the other model that was considered. Although the selected statistical forecasting models are good examples of modern methodology, neural network approach can be more successful with a much larger data set. As the final outcome a web-based system is being developed to make these forecasts publicly available. This system will also work as a platform for sharing experts' opinions about future flow of tourist arrivals to further support the decision making process of users.

Key words: tourist arrivals, forecasting support system

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Traffic noise contour mapping in Tangalle city - Sri Lanka

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Noise pollution is one of the major environmental problems in many cities in Sri Lanka and therefore, systematic studies in city noise pollution are essential to control the situation. Noise from different sources or activities in a certain area can be mapped quantitatively on to a single map called "Noise Contour Map (NCM)". These maps have been used in Environment Impact Assessments (EIA) and they provide great environmental information of the relevant area. The main objective of this study was to map the noise distribution in Tangalle city (6.0167° N, 80.7833° E) which is a popular destination among tourists. Noise measurements were carried out using B&K Type-2250 hand held analyzer (IEC 61672-1; 2002 Class1) in November, 2013. A-weighted equivalent continuous sound pressure level ($L_{Aeq,}$) was logged to five minutes period ($L_{Aeq,\ 300s}$) continuously at a single location and for more than 15 minutes continuously on both sides of the road. Total of 25 locations were covered at suburb of A2, B141, B410 and B628 roads in Tangalle city during one week period. Measurements were carried out from 6.00 am to 10.00 pm in each day and therefore busy and calm hours were investigated. Average L_{Aeq} values were used to produce NCM with internationally recommended IMMI mapping software. According to the results, 37.7±7.1 % out of 14.21 km^2 total area has exceeded the maximum allowed level (63 dB) given by Sri Lanka National Environment Act. No. 47, 1980 for mixed residential area. The densely populated area in the city lies within the noise contours of 65-70 dB. Mapped L_{Aeq} besides A2 road was more than 80 dB at some locations. The results suggest that necessary regulations to reduce the noise production and noise reduction techniques have to be imposed to control the noise pollution and to protect the economic value of the city.

Key words: Traffic noise, Noise contour map, Tangalle city, L_{Aeq}, B&K Type-2250

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Using a Linear Data Structure to maintain Dynamic Convex Hull in two Dimensions

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Finding convex hull of a set of data points is an interesting problem in Computer Science and Mathematics. This paper concentrates on the use of linear data structure to solve dynamic convex hull problem. In this study, we propose a convex hull algorithm that dynamically computes convex hull of a data set where new data points are inserted randomly without deleting existing ones. Given the initial convex hull, the algorithm dynamically maintains the relevant convex hull according to the random appearance of data points. The proposed algorithm is useful in situations where dynamic construction of a new convex hull is required as a result of randomly inserting new set of data points to a large number of exiting data points with an already computed convex hull. The use of static algorithms, in such situations, requires constructing the convex hull from scratch every time a new data point is inserted and involves unnecessary computational cost. The proposed algorithm is tested against data sets having large number of randomly generated data points and gave satisfactory results.

Key words: Computational Geometry, Convex Analysis, Computer Graphics, Coordinate Geometry, Data Mining

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