RISTCON 2021

"Advancing Science & Technology towards an Eco-Sustainable Future"

Proceedings
of
8th Ruhuna International
Science & Technology Conference
February 17, 2021

Abstracts and Plenary Lectures

**Faculty of Science
University of Ruhuna
Matara, Sri Lanka**

RISTCON 2021

Proceedings of
8th Ruhuna International Science and Technology Conference

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Conference Advisory Board

Editorial Note

Thanks to all the contributors, we received high number of abstracts in diverse disciplines for RISTCON-2021. All of them were initially screened by the editorial board for novelty and plagiarism. Then each abstract was sent to two experts in the relevant field, serving in different universities/research institutes, for a double blind review. In cases where the decisions by the two reviewers were remarkably different, the abstract was sent to a third reviewer. Final decision was taken by the Editorial board by considering the decisions as well as comments made by all reviewers. We believe that, this process has ensured a high standard of the publication through a quality and unbiased review.

However, the responsibility for the content and the message of each publication remains with the respective authors. No part of this serial publication will be reproduced by any form. When citing the abstracts published, this serial publication can be referred as 'Proceedings of the 8th Ruhuna International Science and Technology conference, Faculty of Science, University of Ruhuna, Matara, Sri Lanka'.

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RISTCON-2021

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Message from the Vice Chancellor, University of Ruhuna

As the Vice Chancellor of University of Ruhuna, it gives me immense pleasure to send this message to the 8ᵗʰ Ruhuna International Science and Technology Conference (RISTCON-2021). This is one of the prominent scientific conferences of the University of Ruhuna. The theme of the RISTCON-2021 is "*Advancing Science and Technology towards an Eco Sustainable Future*".

The world has begun to witness numerous negative impacts of environmental degradation. The natural ecosystems are severely threatened by irresponsible human activities and behaviors. As a result, the equilibrium of the ecosystems and inherent natural phenomena has broken down. Overexploitation of natural resources, climate changes and biodiversity degradation are a few serious global issues emerged with human activities. Unfortunately, humankind has become the major driving force of accelerating ecosystem depletion. In that context, this is an extremely important theme to address within the global academia.

After thousands year of evolution, the world has reached a milestone. Nature will no longer be able to tolerate the pressure of this destruction or imbalance. Hence, this change might be irreversible beyond the maximum point of bearing. However, the reality is that we are unable turn back to the past by throwing away the modern lifestyles. Hence, the only gateway to a sustainable future is science and technology. This is the best time to rethink the role of science and to shape the direction of technological changes. The 2015 UNESCO World Science Report emphasizes that "*science will be critical to meeting the challenge of sustainable development, as it lays the foundations for new approaches, solutions and technologies that enable us to identify, clarify and tackle local and global problems*." On the other hand, the 2030 Agenda and the Sustainable Development Goals (SDGs) directs the world towards a more sustainable future through synchronizing the social, economic and environmental concerns. In that context, eco-sustainable future should be the most ambitious vision of all the countries in the world.

We should commit to meet the needs of the present without compromising the ability of future generations to meet their own needs. The eco-sustainable initiatives should be suitably integrated with the development approaches. In that sense, the advancement of science and technology is vital. Green movements such as energy-efficient appliances, green buildings, recycling and reusable approaches would address the global challenges and help to restore the structure and function of the pre-disturbance ecosystems.

RISTCON provides an excellent scholarly forum for academics, researchers, students and industry personnel to discuss the contemporary trends and innovative research findings in relation to the above framework. RISTCON would encourage an interactive discussion and create a multidisciplinary platform to share insights on ecological sustainability.

I profoundly appreciate the enormous effort of the Dean, Faculty of Science, Chairperson of the RISTCON-2021 and the organizing committee in organizing such a premier scientific conference in 8th consecutive year while overcoming the challenges of the COVID 19 crisis.

I wholeheartedly wish the 8th Ruhuna University Science and Technology Conference (RITSCON) 2021 a great success.

I look forward to witnessing a fruitful conference.

Senior Professor Sujeewa Amarasena
Vice Chancellor
University of Ruhuna

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

It is a great pleasure to provide a message as the Dean of the Faculty of Science of the University of Ruhuna for the 8th Ruhuna International Science and Technology Conference (RISTCON-2021). RISTCON has been providing the platform for discussing findings of researchers, practitioners and educators from various scientific fields for several years. I am glad to know that RISTCON-2021 has received around 206 submissions and at least 140 of them will be presented as poster or oral presentations online. I would like to appreciate all the authors who submitted their findings to RISTCON-2021, for their efforts in research work and willingness to share their findings among the contributors and the participants of the conference.

Everyone around the world currently has concerns about the Covid-19 pandemic. Therefore, the scientists have to pay special attention to carryout research on how to cope with such pandemic situations, in addition to the requirement of collaborative efforts of researchers, policy makers, governing bodies and citizens for enhancing and developing the socio-economic status of the societies around the world. The current pandemic situation which negatively affected the education system of our country, will lead to lowering the socio-economic status of our people in the long run, unless we come up with alternative methods for reinstating our education system at least to the status which was in existence before this global pandemic situation.

Therefore, the academics in our country also have to make an effort to introduce and develop methods for teaching and learning activities and assessment techniques, specifically suitable for our culture, ensuring that the standard of our education system is not downgraded. A country without a considerable proportion of its population attending and graduating from schools and universities other educational and training institutions will not gain a significant socio-economic growth, because of the growing number of less educated people in the society. Therefore, the governing authorities in the education system and the government must make decisions to wisely invest on the education system for its improvement in every aspect to overcome the prevailing situation. In this context, these types of conferences organized with the aims to provide the premier multidisciplinary forum for leading academics, researchers and research students to present and discuss their innovations, concerns, practical challenges encountered and the solutions adopted in the fields of Science & Technology should also be forums to discuss above mentioned facts, in addition to the traditional research activities many of our researchers usually concentrate on.

I wish that the conferences like RISTCON will be a platform for our researchers to share their scientific knowledge and new findings with a special focus towards the development of the country in every aspect to overcome the current struggling situation of the world. Organizing a conference is a difficult and very

responsible task due to current conditions. Therefore, I would like to convey the gratitude of the Faculty of Science of the University of Ruhuna to Dr. K. A. Sunanda Kodikara, the Chairperson of the Organizing Committee of RISTCON-2021 and his team for their creative, effective and untiring efforts for making this hybrid mode conference a reality.

I hope that all the presenters and participants would have productive discussions during the conference and enjoy the humanity and the kindness of the community of the Faculty of Science, University of Ruhuna.

Professor P. A. Jayantha
Dean and Professor of Mathematics
Faculty of Science, University of Ruhuna

Message from the Chairperson – RISTCON-2021

On behalf of the organizing committee, I am delighted and honoured to convey this message to the 8th Ruhuna International Science and Technology Conference (RISTCON) 2021. We all know that the fields of science and technology serve a systematic venture that shapes and establishes knowledge in the form of verifiable predictions and explanation on global developments while giving sustainable solutions for dynamic challenges. The theme of "Advancing Science and Technology towards an Eco-sustainable Future" is therefore created to leverage this remarkable gathering of researchers and professionals to identify the gaps in science and technology and bridge them in novel and innovative ways. I wish the conference would be able to deliberate on current issues of national and international relevance, particularly in the field of science and technology, allowing the participants to seed new ideas and initiate collaborations towards excellence in research. Further, I believe the knowledge that surfaces at the conference will lead to technological initiatives and advances.

The RISTCON-2021 is enriched by the keynote speech of a renowned scientist, Dr. Daniel Gorman, CSIRO, The University of Western Australia, Crawley, Australia while the plenary lecture by an eminent scientist, Professor Ragupathy Kannan, University of Arkansas Fort-Smith, Arkansas, USA. This would be a great opportunity for all conference attendees to hear the latest findings from their respective fields of research and also to learn from their vast experiences.

On behalf of the organizing committee, I greatly appreciate the support and guidance given by the Vice Chancellor, Senior Professor Sujeewa Amarasena who has a real enthusiasm and genuine desire to upgrade research in the University. We express our sincere gratitude to the Dean/Faculty of Science, Professor P.A. Jayantha, for his support, corporation and encouragement throughout the planning of RISTCON-2021. Also, we thank all Heads of the Departments, academic and non-academic staff members of the Faculty of Science and the media team of the University for their kind-cooperation shown in this event. I express my heartfelt gratitude to the keynote speaker and the plenary speaker for accepting our invitation with much enthusiasm. The two joint secretaries and the other members of the organizing committee, the advisory board and the editorial board are greatly acknowledged for their hard work, sense of responsibility and brilliant suggestions on organizing the conference, especially, under the COVID-19 pandemic situation. We convey our sincere gratitude to the main sponsors, the Bank of Ceylon (BOC) and Nippon Paint, for their generous financial assistance. In addition, a special note of appreciation is extended to the reviewers for their thorough and timely appraisal of the submissions. Most of all, I am grateful to all the authors for

enriching the conference by sharing the contemporary knowledge of their research findings at RISTCON-2021.

I convey my best wishes for a successful and productive conference.

Dr. K.A. Sunanda Kodikara
Chairperson- RISTCON-2021
Faculty of Science
University of Ruhuna

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Keynote Speech

The rise of blue carbon science in Sri Lanka: conservation, restoration and resilience

Dr. Daniel Gorman

CSIRO, Western Australia

Blue carbon ecosystems (mangroves, seagrass and saltmarsh) are charismatic and highly important features of Sri Lanka's 1,340-kilometre-long coastline. The island nation relies on these coastal habitats for livelihoods, fisheries productivity and coastal protection. While the importance of these systems was not fully understood at the beginning of the past century (leading to substantial losses), their ecological and economic value is now more fully appreciated due to a focus on conservation and quality scientific research. Research in the fields of science and technology have mirrored Sri Lanka's exceptional economic performance over the last few decades (i.e., GDP growing to be worth $84 billion in 2019), with the number of scientific articles peaking at 1,348 in 2018. The number of papers on coastal wetlands and blue carbon ecosystems has also ridden this wave, with nearly 200 peer reviewed articles published since 1979.

'Blue carbon' refers to the carbon stored by mangrove forests, seagrass meadows and tidal marshes (Figure 1). The term was coined in the mid 2000's to distinguish these important sinks of carbon from those stored in terrestrial systems (e.g., native forests and plantations). The term is derived from the fact that they are intrinsically associated with the marine environment (i.e., the 'blue' part) and because they sequester and store large amounts of organic carbon (i.e., the 'carbon' part). Indeed, the need to distinguish these habitats came from a realisation that although they cover a small fraction of the earth's surface, they sequester and store more carbon on average than boral and tropical forests (Fourqurean et al., 2012).

When occurring simultaneously (as they often do in Sri Lanka), these ecosystems form a distinct subtidal-intertidal gradient. Seagrasses occur in soft or muddy sediments from shallow subtidal waters, through to the lower intertidal. Mangrove forests occupy the middle zones of this estuarine gradient (often showing a distinct transition in species composition) between mean sea level and mean high water of spring. In Sri Lanka, this zone is usually quite narrow, given the relatively small tidal variation across the country. Tidal marshes (sometimes called saltmarshes) are found above this elevation and typically constitute the boundary between the marine and terrestrial domains (i.e., the landward margin).

The global distribution of blue carbon ecosystems shows distinct latitudinal and climatic trends. Mangrove forests are abundant within tropical, sub-tropical and some temperate regions between 32ºN & 38ºS, with the greatest

extents and diversity occurring within the Indo-Pacific as well as Latin American regions. Recent estimates suggest that mangroves cover an area of 181,000 km^2 globally (Spalding et al., 1997). Seagrass meadows span a much wider latitudinal range, being found in tropical through to Artic seas (i.e., largest species tend to dominate in temperate regions) and are thought to cover as much as 266,562 km^2 (McKenzie et al., 2020). There is, however, considerable uncertainty in estimates driven by difficulties in sampling turbid (muddy) waters and deeper areas where surveys are problematic, and satellite remote sensing approaches are not possible. Tidal marshes are typically found in higher latitudes (e.g., Europe, USA and parts of Australia) and have the smallest distribution of the 3 blue carbon ecosystems; recently estimated to be 54,951 km^2 (Mcowen et al., 2017).

Figure 1. Photographs showing the three primary 'blue carbon' ecosystems; mangrove forests, seagrass meadows and tidal marshes, that have been given this term to distinguish them from terrestrial systems (forests) and to emphasise the tremendous amount of carbon that they sequester and store in the form of biomass and soil carbon.

Sri Lanka is fortunate, in that it has a good representation of all three blue carbon ecosystems. While the total extent is less than neighbouring countries in the Indian Ocean (i.e., it ranks 15th in terms of mangrove distribution and 9th for seagrass; Vanderklift et al., 2019) they are vital resources for the 34% of the nation's population that live along the coasts. Mangroves are found all around the island and across the various climatic zones, having an estimated

total area of 157 km^2 (Edirisinghe et al., 2012). The distribution is well known, thanks to satellite remote sensing approaches and the diversity and forest structure has been well studied (including by researchers at the University of Ruhuna). Seagrass meadows are similarly extremely important, but their distribution and ecology are poorly understood when compared to mangroves, because they tend to occur in inaccessible areas (particularly so during the years of conflict) and because they are challenging to study. Recent estimates have suggested a major underestimate of the area of seagrass in Sri Lanka which could be as much as 2900 km^2 (Vanderklift et al., 2019). Saltmarshes occupy a large, but somewhat overlooked fraction of coastline in Sri Lanka but are mostly restricted to the north of the country around Jaffna where they may even rival mangroves in terms of total area.

The vital importance of blue carbon ecosystems is related to their ability to generate a multitude of Ecosystem Goods and Services (EGS). One of the most important EGS to the island nation of Sri Lanka is the profound support they provide for coastal fisheries (as a habitat, nursery and source of nutrition). Fisheries production in Sri Lanka supports the livelihoods of more than 2.7 million people (560,000 people are directly or indirect employed), contributes 70% of animal protein and subsidizes 1.3% of the country's GDP. Unfortunately, inappropriate and unregulated development (urbanisation, industrial infrastructure, aquaculture and agriculture) have accelerated the loss of all three of Sri Lanka's blue carbon ecosystems. Mirroring losses around the world, Sri Lanka is thought to have lost 76% of its mangroves, 50% of its saltmarsh and a large but unknowable area of seagrass (estimates in some areas of more than 29%). Together, this has led to a reduction in fish breeding and feeding habitat, a decline in fish stocks (and catches) and has created numerous socio-economic and livelihood challenges.

Another important service provided by blue carbon ecosystems is that of coastline protection. This role is very pertinent to Sri Lanka, which suffered tremendously from the 2004 tsunami, and often faces storm surges, flooding and severe tropical cyclones (having been struck by eleven since 2000). Indeed, the 3-dimensional structure of coastal forests and to a lesser degree seagrass meadows can dampen the action of waves. Mangrove roots and canopies absorb the wave energy, leading to reduced height and velocity of waves reaching the landward side of the forests. Studies done in Indonesia following the 2004 tsunami showed that in areas having a fringing mangrove forest, the damage to infrastructure and loss of life was significantly less.

Another important function provided by blue carbon ecosystems is that of climate regulation. Although they cover a relatively small area on a global scale (less than 2%), mangroves, seagrass and tidal marsh vegetation sequester and store an enormous amount of carbon in their biomass and in the soils upon which they grow. On a global scale, these habitats show tremendous rates of sequestration at 226, 218 and 138 g C m$^2 \cdot$ y^{-1}, for

mangroves, tidal marshes and seagrass respectively, greater per unit area than boral and tropical forests (McLeod et al., 2011). When left undisturbed, this can lead to the creation of large carbon pools (than remain stable for millennia), with a recent Sri Lankan study showing that depending on climate zone and environmental setting mangrove forests can store up to 1455 Mg C ha^{-1} (Cooray et al., 2021).

Despite the huge array of benefits provided by blue carbon ecosystems, they have and continue to be under major pressure globally. The huge amount of carbon stored by these ecosystems, means that if they are degraded or damaged, this capacity is lost or adversely affected, and the carbon released to the atmosphere as emissions of carbon dioxide (CO_2).This is where Sri Lanka, as a nation has stepped up in terms of protection and conservation. In conjunction with several NGOs, the government announced a joint program that makes Sri Lanka the first country in the world to grant full protection to all its mangrove forests.

One of the most exciting aspects of blue carbon research in Sri Lanka is the intensive activity relating to marine coastal restoration. The country has cemented itself as a regional leader in mangrove forest restoration with many projects initiated following the 2004 tsunami. Although many early projects had low levels of success (because they were often done in the wrong areas or using inappropriate methods; Kodikara et al., 2017), scientists and practitioners are now fine-tuning 'best practice' approaches to significantly improve outcomes and upscale restoration efforts. This is answering calls by the United Nations for an upscaling of efforts during the 2021-2030 Decade of Ecological Restoration.

While Sri Lanka is certainly leading efforts in mangrove conservation and restoration across the Indian Ocean, significant challenges remain. Growing pressure from an increasing population and the need for economic development (more pressing in the wake of the SARS-CoV-2 pandemic and flow on effects of reduced international tourism) are likely to create conflict and land-use change resulting in loss of mangrove and seagrass habitats. However, new partnerships such as those established through the Sri Lanka Mangrove Conservation Project will give many impoverished Sri Lankans alternative ways to earn a living that do not necessitate cutting down mangroves or degrading other blue carbon ecosystems. Positive outcomes can be achieved by encouraging community efforts in mangrove conservation and restoration and by ensuring appropriate control over community projects by the government. Continued assessment of ecosystem status will help in conserving threatened ecosystems and informing governmental policy makers as to what level and how political interventions are necessary. Doing this will require the provision of capacity building, education and support to develop alternative livelihood options and the sharing of best practise approaches to conservation and restoration.

In conclusion, the blue carbon ecosystems of Sri Lanka are vital to ensure a healthy coastal environment and the prosperity of the nation's people. Despite significant challenges, research into the biology, ecology and social aspects of mangroves, seagrass and tidal marshes are increasing the current state of knowledge, informing policy and ensuring best practice methods when it comes to fields such as marine ecosystem restoration and building resilience. This information is vital to allow decision makers to weigh up the relative costs and benefits of various socioeconomic and policy decisions. This type of robust, accessible and defensible knowledge will be vital to ensure that Sri Lanka continues to punch above its weight when it comes to the protection, conservation and restoration of these vital ecosystems that guard the frontier between the marine and terrestrial realms.

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Abstract of the Pleanary Speech

The reality of anthropogenic climate crisis: convincing a skeptical public

Prof. Ragupathy Kannan

University of Arkansas Fort-Smith, Arkansas, USA

The current human-caused climate change clearly poses an existential threat to humanity and biodiversity. The time has come for scientists to make a concerted effort to reach out to the skeptical public to convince them on the reality of anthropogenic climate change, to mobilize public opinion, and to suggest possible ways to curtail it. Denial of the science behind global warming is rampant around the world. Developing economies need to balance their need for growth with mitigating the environmental catastrophes that climate change brings. Attention is also needed on the plight of wildlife in the face of a warming planet. In this plenary talk, I will address five key questions: 1) Is carbon dioxide increasing? 2) If so, is it warming the planet? 3) What is the evidence that humans are causing it? 4) What lessons can we learn from prior episodes of global warming? and, 5) What are the ways we can solve the problem? It will also cover the possible impact of future warming on island nations like Sri Lanka. The presentation will be freely made available to everyone so they can in turn spread the word and do their part to save the planet from this looming catastrophe. The talk is intended for the general public and students, while the focus is on science outreach and environmental education. Although not an expert on the intricacies and nuances of climate change, I emphasize on the role that good science communicators from any discipline can play in educating the masses and helping create an informed citizenry, so that sound, fact-based policy decisions can be made by governments around the world.

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Effect of Cow Urine Based Plant Extracts Against Maize Weevil (*Sitophilus zeamais*) on Different Pulse Grains

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Productive handling of storage grains following harvest is greatly contributed to socio-economic endorsement in every country. As the cow urine infusion has been expressed as remedial enhancer and availability of anti-infectant agent, this experiment was conducted to evaluate the effects of 10% cow urine-based extract of four selected botanicals; nochi (*Vitex nugendo*), eucalyptus (*Eucalyptus globulus*), neem (*Azadirachta indica*) and annona (*Annona squamosa*) against the infection of *Sitophilus zeamais* on pulse grains namely red cowpea, cowpea with black eye, green gram and chick pea. Treated and untreated grains were significantly varied ($p \leq 0.0001$) in weevil mortality and grain damage. The results indicated that neem and annona provided significantly ($p \leq 0.0001$) highest protection among these botanicals and eucalyptus was followed by nochi was effectively killed the weevils. Similarly, numbers of damaged grains were relatively less in neem and annona treated treatments. Furthermore, nochi had no significant influence on the grain damage except green gram among the tested host seeds. Moreover, significantly ($p \leq .00001$) very low adult mortality and huge grain damage was observed in untreated control. The results of the present study confirmed the efficacy of cow urine-based neem owing to the antifeedant, deterrent, and anti-ovipositional effects.

Key words: *Anti-infectance agent, botanicals, grain damage mortality*

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Characterization of Drought Resistance of Some Selected Traditional Rice Varieties of Sri Lanka

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Rice (*Oryza sativa*) of family Poaceae, is an important food crop and considered a drought susceptible crop. This experiment was aimed to screen some selected Sri Lankan traditional rice varieties; three cultivars of Niyan wee and Podi niyan wee (PN) with reference to Dular, Black Gora (BG) and IR64 as positive controls and BG 370, BG 374 as negative controls for drought resistance using morphological and molecular methods. The study was designed as a pot and block experiment in green house conditions. Panicle initiation dates and shoot height were recorded once a week under field conditions. The varieties were grown in complete random blocks for 30 days and imposed with an artificial drought of 15 days and were re-watered for ten days. Then drought scores and drought recovery scores were recorded according to Standard Evaluation System of International Rice Research Institute. Shoot height, fresh weight, dry weight and root length, fresh weight, dry weight of uprooted plants were measured after drought and drought recovery periods. DNA extractions of all varieties were tested with two drought resistance related SSR primers; RM234 and RM252. Dular and IR64 recorded highest shoot height. Dular showed the lowest increment of drought scores. In molecular characterization, Niyan Wee II, PN, Dular, BG and IR64 gave bands with both primers. The present study collectively suggests, tested rice varieties showed resistance to drought conditions. The molecular assay supported these results. Therefore, these varieties can be propagated in drought prone areas to avoid crop losses due to drought.

Key words: *Rice, drought, drought resistance*

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Identification of selected vegetable seed-associated fungi and their susceptibility to fungicides

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Seed-associated fungi have the potential to cause diseases in seeds or
developing plants. They may reduce seed germination, vigor, and yield
performance in crops. The present study aimed to identify fungi from the
seeds of ten vegetable crops and evaluate their susceptibility to fungicides.
The fungal strains were isolated from surface sterilized and non-surface
sterilized seeds of cucumber (*Kalpitiya white*), tomato (*Rajitha)*, capsicum
(*CA-8*), brinjal (*SM-164*), okra (*Haritha*), snake gourd (*TA-2*), bitter gourd
(*MC-43*), radish (*Beeralu*), pumpkin (*Meemini*) and spinach (*Yoda*) using agar
plate method. The fungal strains were morphologically identified using CMI
descriptions followed by DNA sequencing-confirmation using the ITS1 and
ITS2 regions with single spore cultures. Antifungal activity of Thiram (80%
w/w wettable powder), Captan (50% w/w wettable powder) and Mancozeb
(80% w/w wettable powder), (0, 2, 4, 6 and 8 gL^{-1}) on the isolated fungi was
evaluated using well diffusion inhibition assay on PDA. From the nine fungal
species identified, *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *Mucor indicus*,
Gilbertella persicaria and *Rhizopus oryzae* are known to be plant pathogens
while *A. terreus*, *Talaromyces pinophilus* and *Penicillium citrinum* are
reported as potential biocontrol species. In general, 6 gL^{-1} of Thiram was
required to inhibit the growth of *M. indicus*, *G. persicaria* and *R. oryzae* (6-11
mm inhibition) and 2 gL^{-1} of all three fungicides was adequate to inhibit the
growth of other six fungal species (4-26 mm inhibition). The results of the
present study can be applied to manage the seed-associated fungi of studied
vegetable crops in Sri Lanka.

Key words: *Fungi, fungicides, seedborne, vegetable crops*

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Physicochemical and functional properties of flours obtained from *Dioscorea alata* L. and *Dioscorea esculenta* (Lour.) Burkill yams available in Sri Lanka

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Yams are considered as starchy based staple food crops. The objective of this study was to evaluate physicochemical and functional properties of *Dioscorea alata* (Kahata-ala) and *Dioscorea esculenta* (Java-ala) flours which are important to be known in food processing. Functional properties of flours may depend on the availability of starch, dietary fiber, resistant starch and amylose and amylopectin contents. Water holding capacity, oil holding capacity, swelling power and water solubility were analyzed under physicochemical properties. Starch granular shapes were observed by scanning electron microscope. Significantly highest starch content ($p<0.05$) was observed in *D. alata* flour as 74.11±0.27 % among two varieties. The total dietary fiber contents of *D. alata* and *D. esculenta* showed as 11.75±0.26 % and 36.06±0.37% and resistant starch contents were as 7.52±0.19% and 20.68±0.38%. Amylose contents were observed as 35.50±0.27% and 16.00±0.19% for *D. alata* and *D. esculenta* respectively. Significantly ($p<0.05$) highest water holding capacity was shown in *D. esculenta* flour and there was no significant different in oil holding capacity in two types. *D. esculenta* flour showed significantly higher values for swelling power (13.98±0.19 g/g) and water solubility (3.72±0.03 %). Starch granules of *D. alata* presented as large individual spherical shape granules while starch granules of *D. esculenta* was observed as polygonal shape individual starch granules and agglomerated granules preparing large globular structures. Both tested varieties were having considerable amount of dietary fiber and resistant starch along with preferable physicochemical properties that could lead to several health benefits and are favorable for food processing.

Keywords: *Dioscorea alata*, *Dioscorea esculenta*, *functional properties, physicochemical properties, yams*

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Potassium solubilizing *Serratia* species for growth promotion in tomato

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As the third essential plant macronutrient, potassium plays crucial roles in plant growth, metabolism and development. The most common soil components of potassium, 90–98%, are feldspar and mica which are plant unavailable forms. Therefore, potassium fertilizers are generally used for the soil supplementation. However, the demand and the cost of fertilizers has been increasing over the years. Soil microorganisms are also involved in sustaining soil as well as crop productivity. Some of them are capable of decomposing aluminosilicate minerals and releasing a portion of the potassium contained therein. This study isolated four potassium solubilizing microorganisms as CRa (bacterial), FU2 (fungal), FU10 (fungal), and FU20 (fungal) from four selected sites around Kandy and Kurunegala. According to the potassium dissolving ability and availability in soil, CRa bacterial isolate was selected as the best isolate over the other three. Plant growth promoting and disease controlling ability of CRa isolate was tested using seeds of T-245 tomato variety. CRa inoculated garden soil effectively improved the seed germination rate and seedling shoot length when compared to the natural soil. CRa inoculated soil effectively suppressed the seedling root pathogens by reducing the number of diseased seedlings compared to the natural soil treatment. CRa bacterial isolate and FU10 fungal isolate was identified as in Genus *Serratia* and in Genus *Aspergillus* respectively according to the morphological and bio chemical characteristics. Since CRa isolate is effective in solubilizing potassium and also as a plant growth-promoting rhizo-bacterium, it can be potentially developed as a plant growth promoting inoculants.

Key words: *Soil microorganisms, potassium solubility, mica powder, growth promotion, disease control*

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Screening of rice varieties for Bacterial Leaf Blight under different inoculum concentrations

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Bacterial Leaf Blight (BLB) is one of the most devastating diseases in rice caused by *Xanthomonas oryzae* pv. *oryzae*. This is a growing and challenging concern in South Asian countries including Sri Lanka. BLB reduces grain production to a greater extent, by affecting panicle formation and grain filling thus resulting in a huge yield loss. The present study was carried out to screen 14 rice varieties for Bacterial Leaf Blight. Thirteen varieties received from International Rice Research Institute and one local variety; Bg94/1 were sown in 3m x 3m plots in a Randomized Complete Block Design with two replicates at Rice Research Station, Labuduwa, Galle. Rice plants at maximum tillering stage were inoculated using clipping method of artificial inoculation using 3 concentrations [undiluted and diluted; (1:1 and 1:2)] of inoculums and distilled water as a control. After 21 days, disease length of cut leaves and full length of respective healthy leaves were recorded and infection percentage was calculated. A two way ANOVA test was used to observe whether there is a significant effect of the concentration of the inoculum and the type of rice variety on the infection percentage. Out of the 14 varieties tested IR018, was graded as resistant; IR308, IR310, IR318, IR322, IR324 were found moderately resistant, while, IR043, IR050, IR306, IR316, IR319, IR321 were graded as susceptible. Further, IR301 and Bg94/1 were graded as highly susceptible at the highest inoculum concentration. Importantly, the results showed that the concentration of inoculum has significant effect ($p \leq 0.05$) on diseases development. Therefore the results of the study provide useful information for breeders to develop BLB resistant varieties.

Key words: *Bacterial Leaf Blight, inoculation, lesion length, resistance, Xanthomonas*

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Chemical, physicochemical, rheological characterization and antioxidant properties of Malabar Spinach (*Basella alba L.*) seed mucilage

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Spinach (*Basella alba*) is a green leafy vegetable widely grown in Sri Lanka and the spinach seed has a non-exudate gum. Plant gums are used as gelling agents, thickeners, stabilizers and emulsifiers in the food industry. The current study evaluates the physiochemical and rheological characterizations of the extract of the spinach seeds. A water-based extraction procedure was adopted to extract mucilage from spinach seeds. Extracted gummy mucilage was analyzed for its proximate composition and physicochemical, rheological and functional properties. Extractable plant mucilage content was 5.0 % from the dried basis. The presence of the mucilage was observed using Ruthenium red reagent. Mucilage comprised of reducing sugars and starch. Water holding capacity, Oil holding capacity and Solubility of the gum were 100.0%, 6.8% and 20.51%, respectively. It was shown that the solubility of the extracted gum increased with elevated temperatures. Isolated spinach seed gum exhibit DPPH radical scavenging capacity, similar to commercially available Xanthan gum, suggesting it can enhance antioxidant capacity in the food matrix. The swelling index of mucilage is also determined. In conclusion, the study suggests that spinach seed gum can be used potentially in the food industry as a cheap and environmental friendly hydrocolloid.

Keywords: *Spinach, seed mucilage, physico-chemical properties, functional properties*

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Functional properties of *Averrhoa bilimbi* L. aerial parts and silver nanoparticles synthesized using its fruit extract

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Averrhoa bilimbi has been demonstrating various health benefits such as anti-inflammatory, anti-diabetic, and antibacterial properties. However, this food crop remains under-utilized. In this study, ethanolic extracts of leaves, fruits, and flowers were evaluated for antioxidant and anti-diabetic properties. Further, a rapid and simple approach was applied for the synthesis of silver nanoparticles using *A. bilimbi* fruit extract. Formulated silver nanoparticles were evaluated for their antimicrobial, α-amylase inhibition and antioxidant properties. Antioxidant capacity of the ethanolic extracts of flesh, leaf and flower of *A. bilimbi* have shown higher antioxidant and α-amylase inhibition percentages in fruit extract than the extracts of leaves and flowers. Antioxidant activities of silver nanoparticles show in DPPH assay inhibition percentages within the range of 6%-22% at the concentrations of 4-20 mg/L. Morphological characteristics of the synthesized silver nanoparticles were observed using scanned electron microscopy. Results revealed that *A. bilimbi* possesses antioxidant and anti-diabetic properties. Synthesized silver nanoparticles also possessing antimicrobial properties and this may be due to the new nanomaterials with photochemicals of *A. bilimbi* adsorbed to them.

Keywords: *Averrhoa bilimbi*, *antioxidant, anti-diabetic properties, silver nanoparticles, DPPH radicals*

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Bioactive potential of phlorotannins from *Sargassum turbinatifolium* Tseng et. Lu and the effect of encapsulation on its bioactivity

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Phlorotannins in brown algae have proven to be a group of excellent bioactive agents for functional foods and nutraceuticals. Less effectiveness and stability of phenolics in their free form have led to their microencapsulation. Phlorotannins are metabolized and absorbed predominantly in the large intestine of human while chitosan is a vehicle for the colon targeted delivery of active compounds. The study was carried out to evaluate the brown algae *Sargassum turbinatifolium* from Thalpe beach, Sri Lanka for the presence of phlorotannins, their bioactivities and the potential to be microencapsulated in chitosan. Phlorotannin fraction was extracted, semi- purified, quantified and analyzed for the DPPH scavenging ability, reducing power, α-amylase inhibitory activity and antibacterial activity. Phlorotannins were encapsulated with chitosan extracted from crab shells. The results showed that the phlorotannin content was highest in the ethyl acetate extract of semi purification, $854.4+_68.5$mg PGEs/g of extract. The IC_{50} value was $989.27+_12.45$ g/mL in the DPPH assay. Ferric reducing power and α-amylase inhibition values were $680.2+_24.4$mg of AAE/g and $76.3+_3.5$% respectively. The inhibition zone diameter of 7mm against *E.coli* was observed. The yield of encapsulated phlorotannin was $30.6+_3.1$ %. These results highlighted higher bioactive properties of phlorotannin extract from *S. turbinatifolium* and its encapsulation efficacy.

Keywords: *Phlorotannins, Sargassum turbinatifolium, encapsulation, α-amylase inhibition, antioxidation properties*

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Effects of volatile organic compounds of *Morinda citrifolia* L. ("Ahu") leaves on second- stage juveniles of *Meloidogyne javanica*

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Several plant species are known to reduce plant nematode diseases in soil via nematotoxic volatiles. In the present study, the effect of Volatile Organic Compounds (VOCs) emitted by leaves of *Morinda citrifolia* L. ('Ahu") on second-stage juveniles (J_2s) of *Meloidogyne javanica* was determined as an *in vitro* assay. In separate experiments, 30-one-day-old-J_2s in 1 ml of Sterile Distilled Water (SDW) were exposed directly to the VOCs emitted by dry and aqueous filtered leaf macerate (AFLM), and VOCs trapped for 72 h, in a closed glass vial at 30ºC. The juveniles which did not expose to volatiles represented the untreated controls. The effects of the VOCs were assessed 48 h after exposure to the volatiles based on the mobility, immobility and mortality shown by J_2s. The experiment was replicated five times and repeated once. One-way ANOVA was performed for the data analysis using SAS statistical package.

In untreated controls, J_2s showed 100% mobility. VOCs emitted from DLM caused 49% reduction in J_2s mobility, while VOCs from non-accumulated and accumulated AFLM caused 89% and 95% reduction in J_2 mobility, respectively. When J_2s were exposed to the DLM, a significantly higher (*P*<0.0001) mobility in J_2s (51% ±1.23) was detected compared to immobility (9% ±1.13) and mortality (40±0.99). In contrast, VOCs emitted from AFLM caused a significantly higher (*P*<0.0001) mortality and immobility in J_2s than mobility. The maximum mortality of 83% (±1.05) was recorded with the accumulated AFLM while maximum immobility (31% ±1.58) was recorded with non-accumulated AFLM. The findings indicated that the VOCs emitted from leaves of *M. citrifolia* had a potential to affect survival and mobility of J_2s of *M. javanica* indicating nematicidal and nemato-static activity. The effect of VOCs varied with the nature of macerate and mode of exposure.

Key words: *Exposure, juveniles, mobility, mortality*

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Effect of polyamines on seed germination of tomato under water stress

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Seed germination is one of the critical and sensitive stages of plant development, and the process is inhibited or even prevented depending on the intensity of water stress. Polyamines (PAs) are aliphatic amine growth regulators that play key roles in seed germination and plant resistance to drought stress. The diamine putrescine (Put), the triamine spermidine (Spd), and the tetramine spermine (Spm) are the most common free PAs in plants. The study was conducted to explore the benefits of seed priming with PAs on germination of tomato (*Solanum lycopersicum* L) variety "Thilina" seeds under water stress. Surface sterilized seeds were primed with 50 µM of Put, Spd and Spm or with distilled water (control) for 24 hours. Primed seeds were then sown on filter papers soaked with water (control PEG-free), 0.5 and 1% polyethylene glycol-6000 (PEG-6000) solution to enforce water stress. Germination percentage, mean germination time and α-amylase activity of germinating seeds were assessed. After 04 days of sowing, percent of germination was reduced in 0.5% and 1% PEG in comparison to control (PEG-free). Percent germinations of control, Put, Spd and Spm-primed seeds were 43%, 53%, 62% and 63% respectively in 0.5% PEG and in 1% PEG the percent germinations were 37%, 52%, 60% and 62% respectively. Higher α-amylase activities in Spd and Spm-primed seeds were observed than that in control at 04 days of germination in 1% PEG. These results indicated that PA priming favoured tomato seed germination under water stress.

Key words: *Amylase, germination, polyamines, tomato, water stress*

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Effect of Nano-CuO and Nano-ZnO Micronutrient Fertilizers on Physiological Parameters of selected Rice (*Oryza sativa* L.) Varieties

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Rice (*Oryza sativa* L.) is the second most important staple food in the world. The expected rice yield should be increased to feed the increasing population under changing climate. Nanotechnology can play a potential role in the food security by strengthening agricultural sustainability and provide an alternative for conventional fertilizers. The proposed research was carried out to examine selected physiological parameters (plant height, number of tillers, number of leaves and chlorophyll content) of rice varieties Bg360, BW364, *Kaluheenati* and *Kuruluthuda* under Nano-CuO, Nano-ZnO and composite of Nano ZnO-CuO micronutrient fertilizers. Nano-micronutrient fertilizers were synthesized by the Sol-gel method and thermal decomposition method and applied as a foliar spray at concentrations of 30mg L^{-1} (T1), 60mg L^{-1} (T2), and 120mg L^{-1} (T3) and double deionized water served as control (T0). These nano-fertilizers were applied during the bearing stage [at 48-58 days after sowing (DAS)] and filling stage of grains [100-105DAS]. Physiological parameters were recorded at 30DAS, 60DAS and 90DAS. The experimental design was a complete randomized block design (CRDB) with three blocks and five replicates in each block. Data were subjected to descriptive analysis-mean, standard deviation and a MANOVA to assess the significance between the treatments. Data analysis was performed using SPSS v.20. The physiological parameters of the selected rice varieties significantly ($p \leq 0.05$) increased with application of nano-fertilizers. The most effective concentrations for all four parameters were Nano-ZnO 60 mg L^{-1}, Nano CuO120 mg L^{-1} and Nano Composite (ZnO-CuO) 60 mg L^{-1}. However, depending on each rice variety, the most effective concentration of Nano-ZnO Nano-CuO and Nano-ZnO-CuO differ. The interactions between the nano-fertilizer treatments and the rice varieties clearly showed a significant ($p \leq 0.05$) effect on number of tillers and chlorophyll content. Yield parameters are also important to evaluate the complete effect of Nano-CuO and Nano-ZnO micronutrient fertilizers on growth and yield of rice varieties.

Key words: *Rice*, *SMART- Nano micronutrient-fertilizers, Oryza sativa*

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Isolation and characterization of bacteriophages infecting *Pectobacterium* spp. causing soft rot in carrots

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Soft rot in carrots caused by *Pectobacterium* spp., is one of the most widespread and economically important diseases in carrots. As available methods to control bacterial phytopathogens are unsatisfactory, phage-mediated biocontrol is considered as an attractive, environmental friendly, relatively cheap and safe alternative for the control of bacterial plant diseases. Hence, the objective of this study was to isolate and characterize bacteriophages that could effectively be used against the bacteria that causes soft rot disease in carrots. Bacteriophages were isolated from infected carrots with trapping hosts followed by the single plaque isolation using agar double-layer technique. Several locally isolated *Pectobacterium* strains, as well as *P. caratovorum* type strain, were used as trapping bacterial hosts for phage isolation. Fourteen bacteriophages were isolated and evaluated for their host range by spotting each phage on a lawn of bacterial host. Phages P9-PC2B7, P10-Pcc and P11-Pcc showed the broadest host range against all tested bacterial pathogens including *P. carotovorum* subsp. *caratovorum*[T]. Phage isolates P12-PC2B6, P13-PC2B7 and P14-PC2B8 showed clear lysis with previously isolated *Pectobacterium* strains C2B6, C2B7 and C2B8, but not with *P. carotovorum* subsp. *caratovorum*[T]. However, none of the isolated bacteriophages showed lysis against *P. caratovorum* subsp. *odoriferum*[T]*, P. atrosepticum*[T] and *P. betavasculorum*[T] indicating the host specificity of these phages. Further characterization of these phage isolates together with field trials will enable the development of a promising solution for the bacterial soft rot disease in carrots.

Key words: *Carrot, bacterial soft rot, bacteriophages, biocontrol*

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Positional variation of oils extracted from the stem of Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume): Qualitative and Quantitative Comparison

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Differences in the content and the chemical constituents of the bark oil extracted from different parts of the stem from the bottom to the top of Ceylon Cinnamon (*Cinnamomumzeylanicum*Blume) were studied. Cinnamon plants from introduced accession Sri Gamunu and common accession were used and the bark samples obtained from the apex, middle, and bottom of the stems were analyzed separately. In Sri Gamunu, both genetic and ecological factors remain constant as the plants were vegetatively cultivated at the same field located in the agro-ecological zone, IL1a ($6^0$1.7820N'; $80^0$33.4990'E; 22.3 amsl.). But in the common accession, only the ecological factor remains constant as the result of cross-pollination through the seed cultivation. Two maturity stages of the plants, more than 5 years and less than 2 years, were used. Both Sri Gamunu and the common accessions did not show any significant difference in the oil content with maturity. Sri Gamunu showed a significant increase in the oil content from the bottom to the top of the stem. Apex samples had a significantly higher ($p < 0.05$) bark oil content (3.62%) than the middle (3.17%), and the bottom (2.67%) parts of the stem while common accession showed no such difference from the bottom to the top of the stem. In Sri Gamunu, only cinnamyl acetate among all the chemical constituents showed a significant differencefrom the bottom to the top of the stem while in common accession, none of the chemical constituents significantly differed relevant to the position of the stem.

Keywords: *Cinnamon, common accession, introduced accession, part of stem,
chemical constituents*

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Cobalt codoped silver-zinc oxide micro-particles for photocatalytic degradation of textiles dyes under sunlight

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Co co-doped Ag-ZnO, ZnO, and Ag-ZnO micro-particles with different Co percentage (Co wt%) using a solvothermal method were synthesized and their photocatalytic power towards the degradation of textile dyes was investigated. Fe-SEM images confirmed that 3 wt % Co-Ag-ZnO particles adopted the cauliflower shape crystals in the micro-scale while EDS spectrum confirmed its purity. The lowest bandgap energy, 3.26 eV, was also obtained for the 3 wt % Co-Ag-ZnO compound promising its use as a potential photocatalyst for dye degradation. Photocatalytic degradation of the textile dye Reactive Black 5(RB5) under sunlight in the presence of synthesized particles was investigated with a different set of conditions to understand the effect of catalytic dosage and the pH of the medium using the bare dye solution as the controller. The photodegradation was carried on sunny days between 9.00 am-2.00 pm with the average solar intensity around 3500±100 lux. As expected based on the bandgap energy, 0.003 g of the 3 wt % Co co-doped Ag-ZnO in 60 ppm of RGB5 dye concentration showed the highest dye degradation reaching the 100 % within 2.5 hours at pH = 4. The reusability/stability was more than 50% dye degradation after three consecutive cycles at pH 4. Therefore this study reveals that the Co co-doped Ag-ZnO with the optimum Co percentage of wt 3% is a potential candidate for the degradation of RB5 textile dye, and hence it is an effective and safer method for the treatment of wastewater contaminated with RB5 textile dye.

Key words: *ZnO micro particles, photocatalysts, photodegradation, Co co-doped Ag-ZnO, ZnO bandgap*

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Agroecologicaldependence of the quantity of phytochemicals in barks of Ceylon Cinnamon, (*Cinnamomumzeylanicum* Blume)

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Ceylon cinnamon, *Cinnamomumzeylanicum* Blume, cultivars are located in five districts covering seventeen agroecological zones in Sri Lanka. Nowadays, most of cinnamon products in Sri Lanka are exported as raw bark materials. The quantities of major classes of phytochemicals in barks of Ceylon Cinnamon have been analyzed to determine their agroecological dependence using two asexually propagated genotypes, Sri Gamunu and Sri Vijaya. The samples, cinnamon plants of about 2-2.5 years of maturity from both Sri Gamunu and Sri Vijaya varieties, were collected at three regional research centers of the department of export agriculture: Palolpitiya, Narammala, in the IL1a agroecological zone, and Nillamba, in the WU2b agroecological zone. In general, it is observed that the bark of the Sri Gamunu genotype is superior in phytochemicals over the Sri Vijaya in spite of the agroecological variation. Quantities of phytochemicals in the barks of Sri Gemunu from three different agroecological zones are analyzed: alkaloids (Palolpitiya: 7.94, Narammala: 3.56, Nillamba: 3.10 g/100g), Saponins (Palolpitiya: 9.55, Narammala: 8.22, Nillamba: 7.68 g/100g), flavonoids (Palolpitiya: 1.63, Narammala: 1.57, Nillamba: 0.96 g/100g) and polyphenols (Palolpitiya: 6.23, Narammala: 5.41, Nillamba: 4.11 mg TAE/gFW). All contents in the barks of Sri Gamunu variety are higher in the IL1a agroecological zone compared to those in the WU2b agroecological zone providing an indication that the barks of Sri Gamunu genotype growing in the low country intermediate zone (IL1a) contains a considerably higher amount of phytochemicals than up country WU2b zone.

Keywords: *Cinnamon varieties, Sri Gamunu, Sri Vijaya, cinnamon bark, genotype*

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Phosphate solubilizing and PAH-degrading bacterial isolates associated with Kadol Kele mangrove

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Microorganisms that inhabit mangrove ecosystems have very characteristic functions as mangrove ecosystems bear harsh environmental settings. Thus, they can perform important functions, such as solubilization of phosphate and biodegradation of polycyclic aromatic hydrocarbons (PAHs), under extreme environmental conditions. Phosphate solubilizing bacteria are beneficial for soil fertility, because soil phosphorous often becomes unavailable for plants due to the immobilization with Ca^{2+}. PAHs are organic aromatic hydrocarbons that cause severe environmental and health damages. Therefore, the aim of this study was to isolate and identify PO_4^{3-} solubilizing and PAH-degrading bacteria from Kadol kele mangrove ecosystem. Sediment flora was enriched with phosphate and naphthalene separately. Cycloheximide was added to Pikovskaya medium to suppress fungal growth and selectively isolate phosphate solubilizing bacteria. Naphthalene degrading bacteria were isolated on seawater aga and naphthalene was introduced as the sole carbon source during incubation by adding crystals to the lid. Purified bacterial cultures were identified using their morphological and biochemical characteristics. Three bacterial isolates belonging to genera *Bacillus* and *Pseudomonas* were capable of solubilizing insoluble phosphates, while two bacterial isolates belonging to genera *Pseudomonas* and *Vibrio* were capable of degrading the naphthalene. Further characterization of these bacterial strains may help in expanding their potential agricultural and environmental applications. Phosphate solubilizing microorganisms can play an important role in improving crop production in salt-rich fields as biofertilizers, and PAH-degrading bacterial isolates can use for the bioremediation of polluted mangrove sediments.

Keywords: *Mangrove sediment, Phosphate solubilizing bacteria, Naphthalene degrading bacteria*

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Preliminary investigation of culture filtrates of*Mucuna pruriens* endophytic fungi for the presence of L-dopa

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Mucuna pruriens (Fabaceae), is a major source of the natural drug L-3,4-dihydroxyphenylalanine (L-Dopa). This plant has become scarce due to urbanization and overexploitation thus seeking alternative sources for natural L-Dopa is important. Therefore, this study was aimed to investigate the production of L-Dopa by the endophytic fungi present in this plant. The plant samples were collected from a home garden in Gampola, Central Province, Sri Lanka. Endophytic fungi present in leaves, seeds, and pods of *M. pruriens* plant were isolated in potato dextrose agar. Solvent evaporated methanolic extracts of dried leaves, seeds, and pods of *M. pruriens* plant and extracts of endophytic fungal culture filtrates were evaluated for the presence of L-Dopa using thin-layer chromatography (TLC). Ninhydrin was used as the revelator reagent. Methanolic extract of dried plant samples, as well as aqueous and ethyl acetate fractions of endophytic fungal culture filtrates were compared separately on the TLC plate with respect to the standard L-Dopa. A total of nine morphologically distinct endophytic fungal cultures were isolated from the leaves, seeds, and pods of *M. pruriens* plant. The solvent evaporated methanolic extracts of dried seeds and pods as well as culture filtrates of four of the endophytic fungi isolated from seeds and pods were most likely to L-Dopa as they were similar Rf to standard L-Dopa. These findings suggest that the endophytic fungi isolated from *M. pruriens* plant could be excellent source for natural L-Dopa. Further investigations are necessary to validate the conclusions that can be drawn from this study.

DFT/TD-DFT investigation of linear and nonlinear optical properties of porphyrin-bridged push-pull ruthenium complexes

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There is considerable interest in nonlinear optical (NLO) materials based on transition metal complexes due to their potential in a broad range of technological applications such as photonics, optical computing, and signal processing. For the past two decades, various metal complexes have been studied for their large NLO response, amongst which metal alkynyl complexes and push-pull metalloporphyrins have received special attention. The present study proposes a new class of NLO-active metal complexes which features a highly polarizable metalloporphyrin component, a ruthenium alkynyl complex that serves as an electron donor and a tricyanofuran (TCF) electron acceptor. Computational studies employing density functional theory (DFT) and time-dependent (TD) DFT were undertaken to explore the linear optical and second-order nonlinear optical properties of these hybrid species. The calculated first hyperpolarizabilities of proposed chromophores are considerably larger than those of their phenylene counterpart with the porphyrin-bridged Ru complex containing the thiophene-TCF acceptor displaying the largest first hyperpolarizability value. The calculations also showed that the calculated NLO coefficients of ruthenium complexes are reasonably larger than those of their organic counterparts and that the composition of the porphyrin unit has a reasonable effect on the NLO properties. The calculated electronic spectra of these species feature a significantly red-shifted charge transfer band in the visible region compared to corresponding spectra of their phenylene analogues. This band arises mainly due to the transition from HOMO to LUMO and may be responsible for the large NLO response predicted for the porphyrin-bridged Ru complexes studied herein.

Keywords: *Nonlinear Optics, computational chemistry, Porphyrin, organometallics*

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Solvent-free microwave assisted synthesis of oxindole derivatives as effective antifungal agents

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Recent emergence of microwave-assisted green synthesis as a tool of novel drug discovery is gaining much interest in the pharmaceutical field. The dielectric heating procedure found in microwave radiation has improved the atom- economy and product purity. In terms of green chemistry, reactions under solvent free condition have gained considerable attention as they reduce usage of environmentally hazardous solvents. Compounds containing oxindole pharmacophore such as 3-benzylidene-indolin-2-ones have been credited to have extensive range of biological applications. The aim of the current study was to develop novel green synthetic method in the synthesis of 3-benzylidene-indolin-2-ones from oxindole and naturally occurring aldehydes under microwave radiation. APTES ((3-Aminopropyl) triethoxysilane) modified silica was used as a solid catalyst to yield the targeted compounds within 12 minutes. Synthesized compounds (A, B, and C) were characterized by Nuclear Magnetic Resonance spectroscopy (^{1}HNMR), Fourier-Transform Infrared spectroscopy (FTIR), and melting point analysis. Antifungal activity of the compounds was tested against *Candida albicans* (ATCC 10231) using well diffusion assay. Compounds A, B, and C had mean zones of inhibition (ZOI) against *Candida albicans* as 20.0 mm, 20.0 mm, and 19.3 mm, respectively. Mean ZOI of miconazole positive control against *Candida albicans* was 11.3 mm. Both Minimum Inhibitory Concentration (MIC) and Minimum Fungicidal Concentration (MFC) of compounds A, B, and C against *Candida albicans* were 31.2 μg/mL, 125 μg/mL and 62.5 μg/mL, respectively. These findings revealed that 3-benzylidene-indolin-2-ones retains a significant antifungal activity against *Candida albicans*. Microwave assisted, solvent free, green synthetic method was efficiently advanced to synthesize biological active oxindole derivatives.

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Evaluation of kaolin clay and palm oil boiler fly ash as an adsorbent for removing methylene blue dye in wastewater

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Color removal in wastewater using adsorbents prepared from waste materials is a major treatment option. In this study, we attempted to develop adsorbents for color removal using residues from the palm oil industry. The objectives of this study were to prepare adsorbents using Kaolin clay (KC) with palm oil boiler fly ash (POBA), evaluate them for adsorption using methylene blue (MB), and modeling for dye removal. Four different adsorbents were prepared by mixing two types of Kaolin clay (KC_1 and KC_2) in two different ratios with POBA (1:1 and 1:2). After mixing, they were heated up 1200 ºC for 1 h in a muffle furnace. Batch adsorption studies were conducted using four dye concentrations (15, 30, 50, and 100 ppm) with adsorbents (5 g of each) at room temperature. Adsorption studies under different pH (4, 7, and 10) were also conducted. The results showed that dye adsorption increases with increasing initial dye concentration, contact time, and initial pH. The equilibrium data were best fitted to the Langmuir isotherm model showing the monolayer coverage of MB onto the prepared adsorbents. Maximum adsorption capacity of KC_2: POBA (1:1), KC_2: POBA (1:2), KC_1: POBA (1:1) and KC_1: POBA (1:2) were found 0.51 mg/g, 0.33 mg/g, 0.47 mg/g, and 0.28 mg/g, respectively and they were significantly different (Probability =0.0001). Maximum color removal was observed in absorbents prepared using KC_2 with POBA (1:1). However, further adsorption studies are suggested to evaluate the adsorbents using real dyeing wastewater before the large scale applications.

Key words: *Adsorption, isotherms, kaolin clay, methylene blue*

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Effect of agro-ecological variation on growth and cinnamon oil yield of Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume)

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Comparison of the growth parameters and oil content of Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume) at different locations were studied chemically and physiologically. The genetic factor has been kept constant throughout using asexually grown two accessions of Ceylon Cinnamon, Sri Gamunu, and Sri Vijaya. Samples were collected from three different locations in two different agro-ecological zones: National Cinnamon Research and Training Center, Palolpitiya (IL1a), Intercropping and Betel Research Station, Narammala (IL1a), and Mix Cropping and Up-country Research Center, Nillamba (WU2b). The physiological evaluation was based on the measurements of stick length, stick girth at breast height, stick weight, and fresh weight of leaves per stick in the same field. At the processing center, fresh and dry weights of bark were measured. The physiological parameters were significantly different at different locations. Length, girth, and weight of a stick and dry leaf yield per stem was significantly higher ($p<0.05$) in Narammala than the other two locations while dry bark yield per stem has no considerable difference at three locations. When compared two accessions separately from three locations, both Sri Gamunu and Sri Vijaya at Narammala showed significantly higher growth performances. The leaf and bark oil contents showed significant differences at different locations even in the same agro-ecological zone. Significantly higher bark oil content was shown in Sri Gamunu at Palolpitiya than Nillamba and Narammala. In contrast, Sri Gamunu accession at Palolpitiya and Nillamba showed significantly higher leaf oil content than Narammala.

Keywords: *Cinnamon, growth parameters, oil content, different locations, accessions*

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Scientific investigation of ayurvedic formulation, "nishadi churnaya" for its antioxidant capacity and activity towards anti glycation pathways

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The ayurvedic formulation "Nishadi churnaya'' is a mixture of four plant constituents that are *Curcuma longa*, *Strychnos potatorum*, *Coscinium fenestratum* and *Salaciareticulate*, and has been used in ayurvedic medicine of Sri Lanka to treat diabetes mellitus. This study attempted to investigate the phytochemical profile, antioxidant and antiglycation activities of "churnaya" in order to validate its usage in ayurvedic system for the treatment of diabetes. Aqueous and methanolic extracts of individual plant materials were prepared by Soxhlet method and maceration respectively while aqueous extract of churnaya was prepared by a method similar to traditional "Kasaya" which is a refluxing followed by concentration. Total flavonoids and total phenols contents in aqueous extract of "Nishadi churnaya'' were determined using colorimetric methods described in the literature and found as 195.00 mg Quercetin Equivalent /g and 96.21 mg Gallic Acid Equivalent /g respectively. Proximate analysis of raw powder of churnaya showed 32.35% of crude fiber, 44.89% of carbohydrate, 12.23% of moisture, 5.21% of ash and 1.97%. of crude fat. The antioxidant capacities of aqueous extracts of churnaya was evaluated using FRAP and DPPH assays using $FeSO_4.7 H_2O$ and ascorbic acid as the standards, respectively. "Nishadi churnaya'' showed the lowest IC_{50} value (182.71 ppm) for DPPH assay and the highest value for FRAP assay which is 992.82 μ mol Fe^{2+}/g FRAP equivalents. Antiglycation activity of aqueous extract of plant materials and churnaya was determined using browning measurements. The relative percentage intensity of browning of Glucose/Lysine system, with aqueous extracts of *S. reticulate*, *C.longa, C. fenestratum, S. potatorum* and churnaya has shown 67.33%, 66.90%, 55.78%, 57.20%, 45.93%, and for fructose system 76.32 %, 59.71%, 60.72%, 73.18 %, 47.68%, respectively. Quantification of carbonyl content of glycated samples was conducted and churnaya showed the lowest relative percentage value of 5.84%. This study reveals that churnaya possesses the highest antioxidant and significant antiglycation activities. Thus it can be concluded that the combination of individual plant constituents, churnaya' produce their effect in synergistic manner to exert great therapeutic efficiency.

Key words: *Nishadi churnaya, antiglycation, antioxidant, phytochemical, proximate*

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Phytochemical screening, Proximate composition and antioxidant properties of *Rhinacanthus nasutus* (Heen Aniththa)

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Rhinacanthus nasutus (Heen Aniththa) is a native plant to Sri Lanka found in the dry zone. *R. nasutus* has been used in Sri Lankan traditional medicine, especially for treating skin diseases. Almost all the parts of the plant are used in treatment of various illnesses internally and externally. As there is no adequate literature on *R. nasutus* for its composition and antioxidant properties, this study was aimed on investigation of phytochemical profile, proximate composition and antioxidant properties of *R. nasutus* grown in Sri Lanka. Phytochemical screening of methanolic extract of leaves using the standard methods showed the presence of flavonoids, saponins, steroids, alkaloids, tannins, glycosides, quinones, terpenoids, diterpenes, anthracene and phytosterols. Alkaloids and saponins were quantified using gravimetric procedures recorded in the literature. Further, flavonoids, total phenols, and tannins were quantified by following colorimetric methods and using quercetin(Q), gallic acid(GA) and tannic acid (TA) as the standards respectively. Phytochemical quantification of leaves showed the presence of 4.48 (w/w)% of alkaloids, 7.74 (w/w)% of saponins, 57.17 ± 2.78 mg GAE/g of total phenolics, 11.64 ± 0.61 mg QE/g of flavonoids and 7.02 ± 0.24 mg TAE/g of tannins. Proximate analysis was carried out for using the standard AOAC (Association of Official Analytical Chemists) methods and the proximate composition of fresh leaves of *R. nasutus* showed the presence 14.46% of moisture, 15.04% of ash, 2.38% of crude fat, 14.25% of crude fiber, 12.19% of crude protein and 41.68% of carbohydrate in a w/w basis. The antioxidant capacity was studied using DPPH(2,2-diphenyl-1-pycrylhydrazyl) free radical scavenging and FRAP (Ferric Reducing Antioxidant Power) assays with ascorbic acid and $FeSO_4.7H_2O$ as the standards, respectively. Accordingly, IC_{50} value of DPPH assay was found to be 514.3 μgmL^{-1} whereas FRAP value was recorded as 594.30 ± 2.93 μmol Fe^{2+}/g. In conclusion the leaves of *R. nasutus* are rich with important phytochemicals, it contains higher amount of minerals and appreciable amount of proteins, and possess significant antioxidant properties. This study signifies the multifunctional therapeutic potential of *R. nasutus*.

Keywords: *Rhinacanthus nasutus, phytochemicals, proximate composition, DPPH assay, FRAP assay*

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Determination of antioxidant, anti-bacterial, and moisturizing efficacy of *Aloe barbadensis miller*

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Aloe vera is a medicinal plant grown in households vastly due to home-remedial and cosmeceutical applications. The plant is used in several industries such as the food, pharmaceutical, and cosmetic industry. In this study, the antioxidant anti-bacterial and moisturizing effect of the aloe leaf was investigated. The antioxidant property of three different aloe species found in Sri Lanka was determined using the DPPH method. The anti-bacterial effect was determined by antibacterial susceptibility test for selected bacterial strains. Selected volunteers were involved in the evaluation of moisturizing efficacy-measured with the help of resistance of skin for different concentrations of leaf juice extracts. The latex of all the three species contains highest concentration of antioxidants (relative activity = 87.30%) followed by leaf skin 65.84% and leaf gel 11.72%. The species 2 has the highest antioxidant effect among all (relative activity = 68.47%) followed by the species 3 (40.94%) and species 1 (44.51%) respectively. The leaf skin extract has better antibacterial properties compared to the leaf gel extracts upon several skin pathogens. Leaf skin extract and leaf gel extract of species 3 showed 35mm and 25 mm inhibition zones against *Staphylococcus aureus* and both extracts showed similar activity against *E.coli*. The moisturizing efficacy results indicated that the 50% of Aloe in a formulation is capable of retaining moisture on the skin equally as 99% Aloe containing formulations as well. Thus, the humectant potential of Aloe vera in on human skin was well recognized from this study.

Keywords: *Aloe vera, moisturizing, cosmetics, antioxidant, anti-bacterial*

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Preliminary study of antioxidant action of Sri Lankan curry powder

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Adequate levels of antioxidants are needed for optimal body functions and its dietary supplementation is recommended. The ingredients of Sri Lankan curry powder have shown to possess antioxidant activity. However, studies on the mixture have not been conducted. This research focusses on analysing the antioxidant action of unroasted curry powder and its ingredients, Coriander (*Coriandrum sativum*), Cumin (*Cuminum cyminum*), Fennel (*Foeniculum vulgare*), Cinnamon (*Cinnamomum zeylanicum*) and Curry leaves (*Murraya koenigii*). Total Phenolic content (TPC), determined using Folin-Ciocalteu assay, was expressed as Gallic Acid Equivalents (GAE). Highest and lowest TPC was observed in cinnamon (2688.85±22.91 µg GAE/mL) and coriander (704.77±6.06 µg GAE/mL) respectively. Other TPC values were Cumin (1190.51±19.08 µg GAE/mL), Curry leaves (1145.55±88.70 µg GAE/mL) Curry Powder (1096.69±29.14 µg GAE/mL) and Fennel (936.36±23.33 µg GAE/mL). The Highest and lowest Total Flavonoid Content (TFC), in catechin equivalents, was observed in Cinnamon (1003.99±25.27 µg/mL) and Curry Leaves (109.52±16.17 µg/mL) respectively. Other values varied as, Fennel (351.82±30.24 µg/mL), Cumin (204.73±28.45 µg/mL), Curry Powder (149.81±6.44 µg/mL) and Coriander (120.29±5.20 µg/mL). DPPH scavenging activity in descending order was Cinnamon (IC_{50}= 32.52±1.31 µg/mL), Curry Powder (IC_{50}= 448.47±235.21 µg/mL), Cumin (IC_{50}= 474.29±314.50 µg/mL), Fennel (IC_{50}= 520.56±282.17µg/mL), Coriander (IC_{50}= 1533.89±66.17 µg/mL) and Curry Leaves (IC_{50}= 3805.21±2524.27 µg/mL). Ferric reducing power in descending order was Cinnamon (EC_{50}= 1859.75±382.18 µg/mL), Fennel (EC_{50}= 10081.24±521.31 µg/mL), Coriander (EC_{50}= 37670.70±4152.80 µg/mL), Cumin (EC_{50}= 58130.51±4324.66 µg/mL), Curry Powder (EC_{50}= 69565.72±4202.72 µg/mL) and Curry Leaves (EC_{50}= 144604.00±7176.39 µg/mL). In summary current results state that curry powder possesses antioxidant activity to a considerable extent.

Key words: *Curry powder, antioxidants, phenolics, flavonoids, DPPH*

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Antioxidant properties of some selected medicinal plants

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Eventhough the natural plant therapy has been used for ages in Sri Lanka, most of those plants have not been scientifically validated. This study is focused on antioxidant properties of selected four medicinal plant crude extracts which include *Pterocarpus marsupium* (Gammalu) letax, *Katharanthus roseus* (Mini Mal) root, *Citrus aurantifolia* (Dehi) fruit, *Terminalia arjuna* (Kumbuk) bark Plant aqueous extracts were prepared as specified by the ayuvedic practitioners. Then the plants' antioxidant properties were checked using DPPH antioxidant assay on these extracts using spectrophotometric methods. Further, a preliminary phytochemical assay was conducted on the extracts of selected plants. The selected plants showed IC50 values *Pterocarpus marsupium* 0.083±0.001, *Katharanthus roseus* 0.087±0.001, *Citrus aurantifolia* 0.094±0.005, *Terminalia arjuna* 0.086±0.000 and they were compaired with the standard Ascorbic acid solution 0.080±0.001. The selected plants showed a significant correlation in percentage scavenging activity tests with standard ascorbic acid.It was found that tannins, alkaloids and flavonoids were present in all the plants by phytochemical screening. *T. arjuna* showed very high correlation thorugh out the selected concentrations. The highest potency was seen in *Pterocarpus marsupium* letax extract and lowest potency was seen in *Citrus aurantifolia* fruit extract.

Key words: *Antioxidant, P.marsupium, K. roseus, C. aurantifolia, T. arjuna*

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Coccinia grandis (L) Voigt freeze dried powder: Phytochemical fingerprints, proximate analysis and nutritional composition

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The decoction of *Coccinia grandis* (Linn.) Voigt (family; Cucurbitaceae) leaves is one of the medicinal plant preparations which, is effective as an antidiabetic agent. The present study aimed to expound phytochemical fingerprints, proximate and nutritional composition of freeze-dried powder of the decoction made out of *C. grandis* leaves. Liquid Chromatography-Mass Spectrometric (LC-MS) and Fourier-Transform Infrared Spectroscopic (FT-IR) fingerprints were developed. Proximate and nutritional analysis were performed. Two sharp peaks obtained from LC-MS at 16 minute and 17.2 minute could be considered as characteristic peaks for the freeze dried powder of the *C. grandis*. FT-IR fingerprint showed a sharp peak at 1021 cm^{-1} which is characteristic for *C. grandis* freeze dried powder. Proximate analysis revealed that freeze dried powder contained carbohydrate, fat, protein and fiber as 26.7±0.3, 0.3±0.0, 29.8±0.4 and 0.3±0.1%, respectively. Vitamin B_1 and B_2 were present as 0.52±0.01 and 0.38±0.02 mg/100 g, respectively while vitamin C was absent in freeze dried powder. Ca, As and Mg were detected as 3.7, 0.08 and 0.2 mg/kg, respectively while Fe, Hg, Pb and Cd were absent in the freeze dried powder. In conclusion, the results revealed that the freeze dried powder of *C. grandis* leaves is a potential source for a nutraceutical that could be explored by means of nutrition demand other than its medicinal value. The phytochemical fingerprints assured the identity and would be quality control references to minimize the batchwise variation in the mass production of the freeze dried powder of *C. grandis* leaves during commercialization.

Key words: *Coccinia grandis, fingerprints, freeze dried powder, nutrition composition, proximate analysis*

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Polyaromatic hydrocarbons (PAHs) degradation ability of *Pseudomonas stutzeri* isolated from phyllosphere of urbanareas in Sri Lanka

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Polyaromatic hydrocarbons (PAHs) are persistent pollutants which are toxic to all living beings. Biodegradation of PAHs is an efficient way to remediate numerous pollutants. The discharge of such air pollutants gets settled over phyllosphere in a long run through dry and wet deposition and most of the phyllosphere bacteria are able to degrade PAHs. Among them, *Pseudomonas stutzeri* strains have been demonstrated to be a promising microbial agent that is able to metabolize compounds such as PAHs. The objective of this study was to identify the ability of PAH such as phenanthrene anthacene naphthalene and pyrene degradation by *P. stutzeri*. Bacterial isolations were done by the leaf samples collected from Panchikawatta, Orugodawatta, Pettah, Maradana, Colombo Fort, and Sapugaskanda oil refinery sites in Sri Lanka. Out of many isolations, *P. stutzeri* was identified up to species level through PCR amplification and sequencing the amplified 16s rRNA fragments using the primers 1492R and 27F. PAH degradation ability of isolated *P. stutzeri* was screened using plate assay and confirmed through UV-Vis spectrophotometer and HPLC. Toxicity assay and phyto-toxicity assay were performed. HPLC analysis revealed that *P. stutzeri* could degrade anthracene 98.77% while for phenanthrene (81.73%), naphthalene (80.73%), and pyrene (70.46%), respectively. The toxicity assay confirmed that the metabolites of these PAHs degradation were not toxic for the growth of *P. stutzeri* and the phytotoxicity assay confirmed that by-products were not harmful for the phyllosphere. *P. stutzeri* could be useful as a potential biological agent in an effective bioremediation process for polluted environments contaminated with polyaromatic hydrocarbons.

Keywords: *Pseudomonas stutzeri, bioremediation, polyaromatic hydrocarbons, HPLC, UV-Vis spectrophotometer*

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Purification of carbon black generated from passenger car tyre pyrolysis for dry rubber industry

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Waste tyre pyrolysis process has attracted considerable interest as a sustainable solution to manage the accumulation of waste tyres on earth. The process produces three main fractions: gas, liquid and solid. The gas fraction consists of light weight hydrocarbons, liquid fraction contains diesel range hydrocarbons, and the solid fraction is rich in carbon black. Both gas and liquid fractions are useful in industry as fuels however, the solid fraction has not been used in Sri Lanka due to the presence of many organic/inorganic impurities. The current study outlines an efficient and economical route to purify the contaminated solid carbon black for the manufacture of value added products. The pyrolytic carbon black was first passed over a magnetic separator to remove metallic particles followed by size reduction using milling and or sieving. These particles were de-mineralized using dilute acids and/or bases at 60-80 °C for 1-5 h. The treated and non-treated samples were fully characterized by CHN analyses, XRD, FT-IT, TGA, SEM-EDX, and iodine adsorption experiments. It was found that the properties of the purified carbon black were comparable to the properties of commercial grade carbon black: N330. The purified carbon blacks were used as re-enforcing filler for the preparation of rubber carpets. Physio-mechanical properties of the carpets prepared using purified carbon black were in good agreement with the carpet prepared using commercial carbon black, N330, which confirmed the effectiveness and the worth of the purification protocol of the current study.

Key words: *Waste tire Pyrolysis, Pyrolytic tire char, Carbon black, Purification*

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Synthesis and structural characterization of dinuclear zinc complex of N,N'-bis(2-pyrazolyl-4-methylphenyl)formamidinate

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A new tetra-dentate N,N'-bis(2-pyrazolyl-4-methylphenyl)formamidine ligand (H(NNNN)) was synthesized by introducing two flanking pyrazole groups to an ortho position of each aryl group of known N,N'-bis(4-methylphenyl)formamidinate ligand. It was achieved step wise by substituting deprotonated pyrazole to the ortho position of 2-bromo-*p*-toluidine and then coupled with another same unit by half equivalents of triethyl orthoformate using acetic acid as the catalyst at the refluxing temperature of the neat reaction. The treatment of deprotonated H(NNNN) with two equivalents of zinc trifluoromethane sulfonate yielded dinuclear zinc complex, which has $Zn_2C_{44}H_{40}F_6N_{12}O_7S_2$ empirical formula. Single crystals suitable for X-ray crystallographic analysis were grown by layering pentane on the dichloromethane solution of the complex. X-ray crystal structure revealed that two ligands are bridged by two Zn atoms which bridged by a H_2O molecule. The overall charge of the complex is balanced by two triflate counter ions. Each Zn atom has five coordinations, with two amidinate nitrogens, two pyrazolyl nitrogens of two ligands and an O atom of bridging H_2O molecule giving distorted square-pyramidal geometry. The interatomic distance of two Zn atoms is 3.0802 Å. It was further observed that only this complex is yielded with different stoichiometric ratios of ligand to the metal ion.
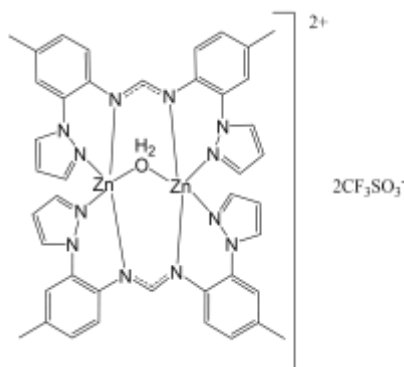
Key words: *Tetra dentate, bimetallic complexes, dinuclear, flanking pyrazole*

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Sysnthesis and characterization of succinyl chitosan nanoparticle and study their applications in the biomedical field

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Chitosan is a deacetylated form of chitin and it is one of the most abundant naturally occurring co polysaccharides. Wound dressing is a promising medical application for chitosan and its derivatives. Chitosan is insoluble in water, which has significantly restricted its applications. Chemical modification through introduction of hydrophilic functionalities is a well known process to increase the water solubility of chitosan. The objective of this study was to synthesize N-Succinyl-Chitosan (N-Suc-Chi) nanoparticles and evaluate its ability to accelerate the wound healing process.Three different N-Suc-Chi derivatives were synthesized by changing weight ratios of succinic anhydride to chitosan as 1:1(N-Suc-Chi 1), 2:1(N-Suc-Chi 2) and 3:1(N-Suc-Chi 3).The degree of substitution (DS) was determined by a titrimetric method. The N-Suc-Chi 3 was characterized by FT-IR spectroscopy, ^{1}H NMR spectroscopy, X-ray diffraction (XRD), zeta potential analysis, and solubility test. N-Suc-Chi nanoparticles (N-Suc-Chi NPs) were prepared with Sodium Tripolyphosphate (TPP) through ionic cross linking method. The morphology, particle size and zeta potential of the nanoparticles were investigated and shown a 58.9 ± 6.2 nm particle diameter with a $+38.0 \pm 2.3$ mV zeta potential. Further, we investigated the ability of N-Suc-Chi NPs to accelerate the wound healing process by *in vitro* scratch assay and WST-1 cell proliferation assay using Human Dermal Fibroblasts (HDF cell). *In vitro* scratch assay results revealed that N-Suc-Chi NPs has higher ability to cell migrate towards the cells free area than N-Suc-Chi treated one.The WST-1 cell proliferation assay was showing the much better proliferation and biocompatibility of N-Suc-Chi NPs.

Keywords: Chitosan, N-Succinyl-Chitosan, wound healing

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Nutritional properties of two formulated diets using fisheries by-products: an alternative for fish meal in fish diets

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Aqua feed industry focuses on using less expensive ingredients with comparable nutritional value to replace fish meal due to its high cost as well as restricted supply of fish meal. Fisheries discards, namely, fish offal and by-catch may contain considerable amounts of proteins and other nutritive compounds, thus may qualify as cheap protein sources in fish feed formulation. Present study aimed to determine nutritional properties of diets prepared by using dried, ground fish offal (Diet A) and by catch (*Hilsa kelee*; Diet B) fully replacing the fish meal (40% by weight), and to compare those with the nutritional properties of a formulated diet (Diet C) containing similar proportion of an imported commercial fish meal (named 999). Other ingredients were common and similar in all the diet formulations, and included red rice bran, maize, soya bean, coconut poonac, maize, wheat flour, vitamin and mineral mixture. Protein content of diet C was significantly higher (46.74±2.339%) than diet A (39.47±0.455%), and B (42.00±0.579%). Total essential amino acids (TEAA) were not significantly different among formulated diets (Diet A: 1.18%; Diet B: 1.19%; Diet C 1.46%). Diet A had significantly higher crude fat content (11.4%) followed by the Diet B and C. Diet C had the higher Omega-3 fatty acids (1.72%) than Diet A (1.06%) and Diet B (1.26%) ($p<0.05$, ANOVA), while n3: n6 ratios were 0.61%, 0.65% and 0.89% in Diets A, B and C, respectively. Material costs (LKR) per one kilogram of diet were 143.3, 155.3 and 291.3 respectively for Diet A, B and C. According to the comparable levels of nutrient content and the lower unit cost, unprocessed fisheries by-products can be used as protein source replacing high-cost fish meal in aqua feed formulation. Feeding trials are needed to evaluate the suitability of diets with alternative ingredients for growth enhancement in cultured fish.

Keywords: *Aqua feed, essential amino acids, fish meal replacement, omega-3 fatty acids*

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MEFV gene polymorphism and gastric microbial diversity among the dyspeptic patients presented to endoscopic clinic Colombo South Teaching Hospital, Sri Lanka

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MEFV gene encodes a protein called Pyrin and it plays a major role in inflammasome activation. Pyrin is suggested to be associated with dysregulated immune response to microorganisms by generating defective signals on the host-gut microbiota signaling pathways. Thus, it was hypothesized that pyrin gene mutations may influence the gastric microbial diversity. Therefore, present study investigated the association of MEFV gene mutations and gastric microbial diversity among dyspeptic patients. Sixty dyspeptic patients (34 males and 26 females) were enrolled for the study. Biopsy specimens were collected for DNA extraction and biopsy urease test. PCR for yeast species was carried out using NL1/LS2 primers. MEFV gene mutations were determined using commercially available FMF strip assay kit based on DNA hybridization. Interviewer administered questionnaire was used to collect the demographic data. Majority of the patients complained of abdominal pain (93%, n=57), followed by nausea (80%, n=48), belching (40%, n=25), emesis (18%, n=11) and abdominal rumbling (13%, n=9). Eleven patients were positive for *Helicobacter pylori* by biopsy urease test while ten patients were positive for yeast DNA. Among the 60 dyspeptic patients, no homozygous mutations were detected, and three heterozygous mutations were identified, i.e., E148Q (45%), P369Q (5%) and M680I (11.6%). There was no significant association found between these three heterozygous mutations and the presence or absence of yeast species or *H. pylori.* Presence of *H. pylori* and the yeast species provide evidence for a non-sterile stomach. Hence in this population, MEFV gene polymorphisms was not a main contributing factor affecting gastric microbial diversity.

Keywords: Gastric microbiota, *Helicobacter pylori,* MEFV

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Standardization of *Plectranthus amboinicus* (Lour.) Spreng aerial parts using phytochemical, physico-chemical and HPTLC parameters

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The majority of Sri Lankan population rely on herbal medicine. Hence, standardization of raw materials is required in Ayurveda preparations. *Plectranthus amboinicus* (Lour.) Spreng (Kapparawalliya) is a herb having morphological ambiguity with other *Plectranthus* species. Thus, the present study was aimed at establishing standardization parameters for the whole aerial part of *P. amboinicus* (Lour.) Spreng. Plants were collected from Western Province, Sri Lanka, oven dried and powdered. Extracts were obtained by cold maceration with methanol and acetone and hot water extraction. Each was subjected to preliminary phytochemical, physico-chemical tests and High Performance Thin Layer Chromatography (HPTLC). All tests were done in triplicate and results were expressed as mean ± SD. Phytochemical screening revealed the presence of alkaloids, tannins, sugars, anthraquinones, diterpenes, triterpenes, terpenoids and proteins in all extracts while phenols, flavonoids and amino acids were detected only in methanol and acetone extracts. Physico-chemical parameters; total ash, acid insoluble ash, water soluble ash, loss on drying, extractability in methanol, acetone and water were 25.65 ± 0.64% w/w, 1.20 ± 0.07% w/w, 10.80 ± 0.35% w/w, 6.73 ± 0.99% w/w, 24.04 ± 3.12% w/w, 5.37 ± 0.01% w/w and 30.81 ± 1.59% w/w. HPTLC fingerprint of methanol extract showed 16 peaks with methanol: distilled water: acetic acid (2:5:3), and that of acetone extract showed 9 peaks for the solvent systems distilled water: methanol : acetic acid (5:2:3) and distilled water: methanol: acetone (4:2:4). Reverse phase HPTLC fingerprint of aqueous extract showed 10 peaks with methanol: distilled water (3:7). Above parameters can be considered as tools of the standardization process of aerial parts of *P. amboinicus* (Lour.) Spreng.

Keywords: *Plectranthus amboinicus (Lour.) Spreng,* physico-chemical, phytochemical, High-Performance Thin Layer Chromatography, fingerprint

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Investigation of antioxidant, anti-inflammatory and acetylcholinesterase enzyme inhibitory activities of Ceylon green tea

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Green tea is rich in catechins and polyphenols and well known for its health benefits. There are limited studies done on health benefits of Sri Lankan green tea. Age related neurological disorders have become a worldwide health concern and closely linked with neuroinflammation and oxidative stress. Therefore, this study was conducted to investigate the neuroprotective activity of Ceylon green tea through three *in vitro* assays to evaluate antioxidant, anti-inflammatory and acetylcholinesterase (AChE) enzyme inhibitory activities. Green tea infusion was prepared in boiling water (2 g/10 mL). Freeze dried tea extract was tested for antioxidant activity based on the ability to scavenge nitric oxide (NO) radical following Griess assay and anti-inflammatory activity based on red blood cell (RBC) membrane stabilization assay. Memory enhancing ability was evaluated by AChE enzyme inhibition following Ellman's method. L-Ascorbic acid, aspirin and donepezil were used as standards. Results indicated Ceylon green tea to be a good antioxidant with IC_{50} of 148.3 ppm (L-ascorbic acid IC_{50}=120.5 ppm). Green tea showed IC_{50} of 67.4 ppm in RBC membrane stabilization assay (aspirin IC_{50} = 27.7 ppm). Ceylon green tea has good antioxidant and anti-inflammatory activities which are comparable with positive controls. AChE inhibitory activity of green tea was much lower than that of donepezil with an IC_{50} of 1500.5 ppm (IC_{50} of donepezil = 0.01 ppm) but was not significant (r = 0.844, p> 0.05). Since the Ceylon green tea possesses good antioxidant, anti-inflammatory and moderate anticholinesterase activities *in vitro*, Ceylon green tea has neuroprotective activity. Further investigations are required to confirm the applicability of Ceylon green tea as a preventive therapy for neurological disorders.

Keywords: *Ceylon green tea, anticholinesterase, anti-inflammatory, neuroprotective*

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The evaluation of quality of life in patients with Peripheral Neuropathy in Type 2 Diabetes Mellitus in three specialized Diabetes centres in Sri Lanka

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Diabetic Peripheral neuropathy (DPN) is the most common complication associated with diabetes. DPN has serious detrimental effects on the physical, emotional, and social functioning of patients. It may show decreased productivity as a result along with a deleterious effect on the quality of life (QoL). The impact on the QoL of patients with DPN and the reliability of the WHOQOL BREF were determined. The cross-sectional study consisted of 136 patients with type 2 diabetes (T2D). Their neuropathy was determined using the Michigan Neuropathy Screening Instrument (MNSI) and QoL was assessed using the WHOQOL-BREF. The majority of the sample was females (74.3%). The mean age of patients was 62 ± 10.31 years. On average the sample had diabetes for 12 years. 38.2% (52) had an abnormal physical assessment while 21.3% (29) has shown neuropathic symptoms. This difference was significant. The observed Cronbach's alpha coefficient for the WHOQOL-BREF was 0.815 (>0.70). The physical domain fared with the least mean score (59 ± 13.15). Overall QoL was strongly associated with psychological, social, and environmental domains ($p < 0.05$), thus stating 50.7% (69) had fair QoL while 26.5% (36) & 22.8% (31) had poor and good QoL respectively. This study provides the extent of the impact on QoL. So the preventive strategies are essential. The WHOQOL-BREF scale exhibited an acceptable degree of internal consistency in the measurement of the QoL of patients with DPN.

Keywords: *Quality of life, Peripheral neuropathy, Type 2 Diabetes Mellitus, WHOQOL-BREF, Sri Lanka*

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Comparison of diagnostic methods and analysis of socio-demographic factors of *Trichomonas vaginalis* infection

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Trichomonas vaginalis causes trichomoniasis, the most common non-viral sexually transmitted disease. Trichomoniasis is often neglected due to nonspecific clinical presentation and the lack of sensitive laboratory tests for diagnosis in clinical settings. Hence, this study was designed to compare the sensitivity and specificity of microscopy and culture with PCR. The socio-demographic factors associated with the disease is also explored.The study was carried out at the National STD/AIDS Control Programme (NSACP), Colombo and STD/AIDS Control Programme in Kandy. Three hundred eighty-five patients (244 patients from NSACP and 136 patients from STD/AIDS Control Programme in Kandy) were tested for the wet mount, Giemsa staining, culture and PCR using a genus-specific primer set (TFR1/ TFR2) and two species-specific primer sets (TV16Sf-2/ TV16Sr -2 and TVK3/7). The culture was performed using commercially available *Trichomonas* culture medium 2 (Oxoid 2) and incubated at 37^0c in the 5 % CO_2 jar for 3 – 5 days. Patients' demographic data and sexual behaviour were obtained with the standard interviewer-administered questionnaire by the clinicians. The sensitivity and specificity of diagnostic tests were calculated compared to the expanded gold standard (PCR). Of the study population, 272 (70.7%) were females, 253 (65.7%) were married and 163 (42.3%) were aged between 26 to 35 years. Of these, six (1.6%) were positive for both wet mount and Giemsa staining, seven (1.8%) were positive for culture, and 17 (4.4%) were positive for PCR. Four out of 17 tested positive patients had trichomoniasis co-infection with non-gonococcal urethritis following 3/17 candiditis, 2/17 bacterial vaginosis, 2/17 syphilis and 1/17 pelvic inflammatory disease. Sensitivies of the wet mount, Giemsa staining and culture were 35.3%, 35.3% and 41.2% respectively and specificities were 100% for all three methods against the expanded gold standard. Trichomoniasis was associated with age over 36 years ($p = 0.033$), not using condoms ($p = 0.039$), multiple sex partners ($p = 0.013$) and presence of other STDs ($p = 0.001$). The study highlighted that age over 36 years, having multiple sex partners, not using condoms, having other STDs increased the risk of acquiring trichomoniasis. Further, the study confirmed that PCR was superior to microscopy and culture methods.

Keywords: *Trichomoniasis, PCR, risk factors, sensitivity*

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Determination of antacid potential of aqueous, ethanolic and hexane extracts of *Evolvulus alsinoides (L.)*

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Evolvulus alsinoides ("Nil Vishnukranthi", "Shankpushpi") is a perennial herb which belongs to the family Convolvulaceae. It is used to cure many illnesses such as fever, amnesia, asthma and gastric ulceration. Vishnukranthi chewable granules were formulated for gastro-protective activity using *E. alsinoides* in our previous study. This study investigates the antacid potential of aqueous extract (aqE), ethanolic extract (EE) and hexane extract (HE) of *E. alsinoides in vitro* by evaluating neutralizing effect on artificial gastric juice and the titration method using Fordtran's model. AqE, EE and HE and the reference drugs, Belcid and ENO were evaluated for neutralizing effects using artificial gastric juice. Each test solution was mixed with artificial gastric juice (pH of 1.2) and the end pH was measured. Each test was triplicated. Neutralising capacity of AqE, EE and HE was determined using Fordtran's method. Test solutions at 37°C were titrated with 0.1N HCl. The mean volumes of HCl required to reach pH of 3.00 were determined. AqE and HE possessed a significant neutralising effect ($p<0.001$) on artificial gastric juice when compared with negative control. According to the titration method, aqE possessed a significant neutralising capacity ($p<0.001$). The EE did not exhibit a significant neutralising effect in both models. However, the neutralizing effect of aqE was comparable with the standard drug Belcid but was less potent than ENO. In conclusion, aqE of *E. alsinoides* exhibits a potent antacid effect on both models in determining neutralizing capacity. Bioactivity guided fractionation of the aqE is recommended in search of gastro-protective agents.

Keywords: *Antacid, Evolvulus alsinoides, Fordtran's model, gastroprotective, neutralizing capacity*

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Anthropometry and vertical jump height of national Taekwondo players

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The main objective of conducting this study is to identify the effect of anthropometric factors on the vertical jump height of Sri Lankan national taekwondo players and identifying the impact of gender differences on anthropometric measurements and vertical jump height. Body fat percentage, Body Mass Index (height and weight) and leg length of players were considered as anthropometric measurements in this study. Sixteen male and sixteen female athletes participated in this census study. Body fat percentage was measured by bioelectrical impedance. Players' height, weight and leg length were measured using a stadio meter, weighing scale and a measuring tape respectively. Body Mass Index was calculated dividing body weight (in kilograms) by square of height (in meters). The highest vertical jump from a stationary standing position was observed and marked and measured using a measuring tape. The relationship between vertical jump height and anthropometrics factors were tested by using F-test of general linear model. Body Mass Index and body fat percentage significantly influenced on the vertical jump height level ($P<0.05$) in both genders and this influence was greater in male players than in female players due to low level of fat percentages in male athletes. Furthermore there is moderately negative relationship between body fat percentage and vertical jump height and no significant effect of leg length on vertical jump height in both genders. Accordingly, body fat percentage needs to be considered in improving vertical jump height. Body fat percentage can reduce with proper diet planning and physical training for higher vertical jumps.

Keywords: *Anthropometric factors, body fat, vertical jump, Taekwondo*

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Development of antioxidants rich herbal tea bags and determination of the effect of infusion conditions on antioxidant activities

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Antioxidants protect cells from oxidative damage. The study was aimed to develop antioxidant-rich herbal tea bags and determine the effect of infusion conditions on antioxidant potential. Herbal tea bags were prepared by incorporating different proportions of *Osbeckia octandra* (Heen bovitiya) leaves, *Camellia sinensis* (green and black tea) leaves, *Vanilla planifolia* (Vanilla) pods, *Zingiber officinale* (Ginger) rhizomes and *Allium sativum* (Garlic) bulbs. Extracts were obtained at 80 ⁰C, 90 ⁰C and 100 ⁰C for 7 minutes and at 100 ⁰C for 3, 5 and 7 minutes. Total phenolic content (TPC), total flavonoid content (TFC) and antioxidant activity using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric-reducing antioxidant power (FRAP) assays were determined for each extract. Data was analyzed with one sample t-test. It was found that TFC, TPC and antioxidant activity were significantly different at different infusion conditions ($p<0.05$). At constant infusion time (7 minutes), TFC, TPC and antioxidant activity of *O. octandra* incorporated black tea bags were higher when brewed at 100 ⁰C compared to 80 ⁰C and 90 ⁰C while they were higher for *O. octandra* incorporated green tea bags when infused at 80 ⁰C compared to 90 ⁰C and 100 ⁰C. At constant infusion temperature (100 ⁰C), values for black tea bags were higher when brewed for 3 minutes compared to 5 and 7 minutes whereas it was higher for green tea bags when infused for 7 minutes compared to 3 and 5 minutes. Hence, it was concluded that antioxidant activity of each extract was significantly higher than tea samples developed without addition of *O. octandra* leaves. Further, to obtain antioxidant rich tea, *O. octandra* incorporated black tea should be brewed in boiling water (100 ⁰C) for a short period (3 minutes) and *O.octandra* incorporated green tea should be brewed for a long period (7 minutes) at a low temperature (80 ⁰C).

Keywords: *Antioxidants, flavonoids, herbal tea, infusion, phenolics*

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Formulation of a novel herbal emulgel using *Leea indica* (Burm.f.) Merr. (Burulla/Gurulla) leaf extract and evaluation of *in vitro* anti-inflammatory and antioxidant activities

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Many topical anti-inflammatory formulations available in the commercial market have limited patient preference due to their unfavorable adverse effects and less effectiveness. The aim of the present study was to formulate a novel herbal emulgel using *Leea indica* (Burm.f.) Merr. (Burulla/Gurulla) leaves grown in Sri Lanka and, evaluate *in vitro* anti-inflammatory and antioxidant activities. Different formulations (Fg1-Fg6) were prepared by incorporating freeze dried powder of 70% aqueous acetone leaf extract. All formulations were tested for their physicochemical stability parameters for 30 days, and they were subjected for *in vitro* anti-inflammatory activity (by Human Red Blood Cell membrane stabilization assay) and *in vitro* antioxidant activity (by 2, 2-diphenyl-1-picrylhydrazyl; DPPH) assay respectively. Among the formulated herbal emulgels, Fg6 showed the significantly high values of percentage inhibition (93.734 ± 0.895 %) compared to the positive control (62.575 ± 0.644 %) of heat induced hemolysis of erythrocytes at the concentration of 12.5 mg/ mL. *In vitro* antioxidant activity of Fg6 and positive control were 3.386 ± 0.007 and 0.364 ± 0.004 mMol Trolox per 100g of emulgel respectively. All formulations were found to be semi-solid, homogenous, washable with water, having no phase separation and pH in the range of 6 to 7. There was no remarkable variation of stability parameters tested during 30 days. It is concluded that the formulated herbal emulgels have promising anti-inflammatory and antioxidant activities and formulation Fg6 can be commercialized as a novel herbal emulgel.

Key words: *Anti-inflammatory, antioxidant, emulgel, Leea indica*

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Analysis of phenolic contents and in vitro sunscreening activity of different solvent extracts obtained from *Nymphaea nouchali* (nil manel) flower

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Natural substances obtained from plants have been recognized as potential sun screening agents due to their UV absorption properties. *Nymphaea nouchali* flowers are being widely used in the treatments in Ayurvedic medicine in Sri Lanka. The aims of this study were to determine phenolic contents and evaluate sun protective activity of *N. nouchali* flower petals grown in Sri Lanka. Two different solvent systems namely, acidified 70% aqueous acetone and acidified 80% aqueous methanol were used to prepare extracts of flower petals of *N. nouchali* by steeping the fresh petals in each solvent overnight in dark conditions. The freeze dried powders of extracts were subjected to preliminary phytochemical tests. The total phenolic, total flavonoid contents and *in vitro* sunscreening activity of two extracts were evaluated by Folin-Ciocalteu assay, aluminiumchloride colorimetric method and spectroscopic measurements followed by Mansur equation for the calculation of SPF values respectively. The results of the preliminary phytochemical screening tests exhibited the presence of phenolic compounds, flavonoids, carbohydrates, reducing sugars, alkaloids, phytosterols and saponins in both extracts. The total phenolic content of two extracts were 302.865± 2.074 (acidified 80% aqueous methanol petal extract/AAMP) and 377.987± 1.309 (acidified 70% aqueous acetone petal extract/AAAP) mg Gallic acid equivalent (GAE)/100 g fresh weight (FW) of petals. Total flavonoid content of extracts were 43.568±0.238 (AAMP) and 69.254±0.716 (AAAP) mg Catechin equivalents (CAE)/100 g fresh weight (FW) of petals. The AAMP showed promising sunscreening activity (SPF=34.26) which is comparable to Dermatone® (reference) at the concentration of 0.35 mg/ml (SPF=33.16). These findings indicated that *N. nouchali* flower petals have high total phenolic, flavonoid contents, and promising sunscreening activity.

Keywords: *N. nouchali petals, sunscreening activity, total phenolic, flavonoid contents*

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Formulation of optimized Dapsone skin cream for the use of Acne vulgaris

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Acne vulgaris is a major health issue among teenagers. Dapsone is used as a treatment option. Dapsone cream is not available in the local market. Objective of current research was to formulate Dapsone topical cream formulation to treat *Acne vulgaris*. Initially, virgin coconut oil base (VCO-base) was used to prepare cream formulations. Emulsion was prepared by magnetic stirring followed by high shear homogenizing. Formulations were tried with different recrystallized Dapsone concentrations (1%, 3%, 5%), co-solvents (1-Butanol, Ethanol, Acetic acid, 2-Propanol) and preservatives (methyl paraben, benzyl alcohol, phenoxy ethanol). Then, vanishing cream base (VC-base) was used. pH test, Viscosity test, microscopic analysis, organoleptic evaluation, particle size analysis and stability tests were performed for formulated creams. Formulated creams were oil in water emulsions. VCO-base formulations were less stable and crystals were observed. VC-base formulations of 1%, 3%, 5% were more stable but 5% formulation showed crystals. pH of VCO-base and VC-base formulations were skin compatible and were within the range of 4.95 - 5.10 and 6.06 - 6.21 respectively. Viscosity of VC-base formulations were within the range of 40 - 55. It was increased with the increased concentration of Dapsone. Among VC-base formulations viscosity of 5% formulation was the highest. Particle size of VC-base formulations (3900 - 4350 nm) were higher compared to VCO-base formulations (237 - 274 nm). It can be concluded that Dapsone can be formulated as oil in water creamy emulsion. Among formulated creams, best optimized formulas were 1% and 3% VC-based formulations considering pH, viscosity, stability and is suitable for topical application for Acne vulgaris with particle size reduction.

Keywords: *Dapsone, virgin coconut oil base, vanishing cream base*

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Short term variation in liver somatic index, erythrocyte nuclear abnormalities and biliary PAH metabolite levels of *Oreochromis niloticus* upon experimental exposure to water-borne crude oil

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Crude oil, in broad sense, is a mixture of organic pollutants that have detrimental effects on both freshwater and marine ecosystems. However, studies that focus on crude oil impact on freshwater fishes are rare. Present study investigated the effects of sub-lethal crude oil exposure on widely distributed freshwater fish *Oreochromis niloticus* in terms of liver somatic Index (LSI), erythrocyte nuclear abnormalities (ENA), and three main PAH metabolite levels in bile within 16-day period. Two groups of immature sub-adult fish of the same brood cohort were maintained, i.e., the treatment group with crude oil dispersed in water (nominal v/v concentration of 50 ppm to simulate a slight oil slick) in three replicates, and a control group with no crude oil in water (15 fish per tank). Fish were fed with commercial diet, and aeration was maintained in a static renewal system. Water quality was monitored at regular intervals. Sampling was done initially, and subsequently on 4th, 8th, 12th and 16th day post-exposure to collect data on body weight and liver weight, to prepare blood smears for erythrocyte counting, and to collect bile for measuring three main PAH metabolites by fixed wavelength florescence (FF). LSI values and standardized bile florescence values at each sampling point were expressed as percentage difference from the control. LSI increased by water-borne crude oil in the fish over 16-day period. Significantly higher ENA values (Kruskal-Wallis test, $p < 0.05$) were found in the exposed group (nuclear buds, notched nuclei, and lobbed nuclei) on 16th day compared to the pre-exposure fish, while micronuclei were absent in all sampling days. FF detected, protein-standardized Naphthalene and Phenanthrene metabolite levels in bile showed more than 30% and 130% increases respectively from day 12 as compared to the control fish, while no discernible trends were seen in pyrene level. The results showed that water-borne crude oil induced short-term changes in LSI, ENA and bile PAH levels in *O. niloticus*.

Keywords: *Bile metabolites, crude oil, ENA, LSI, Polyaromatic Hydrocarbons*

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A Survey on sand flies in selected sites of Dickwella (Matara District), Sri Lanka

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Sand fly (Order Diptera, Family Psychodidae, Subfamily Phlebotominae) is the known biological vector responsible for transmitting the disease Leishmaniasis caused by the haemoparasite, *Leishmania* sp. Leishmaniasis is one of the neglected tropical diseases in the world, and it has been identified as an emerging disease in Sri Lanka. Dickwella area in Matara District is highly endemic to cutaneous form of Leishmaniasis of which the true Sand fly vector species responsible for transmission is yet to be identified. Objective of the current survey was to precisely identify different sand fly species in the area for future disease or vector control measures. Survey was carried out from February to August, 2020 in ten selected sites using sticky light traps. Permanent slides were prepared using dissected head, wing, and terminal abdominal segments of sand flies. Five important morphological characters, i.e., Eye length/ Head length ratio, length of 3rd antennal segment, wing width, R2/R2+3 wing vein ratio, and haltere length were observed. Species identification was done using standard taxonomic keys. Eight sites were positive for foraging Sand flies. Altogether, 117 Sand flies were captured. Total of five different Sand fly species, namely, *Phlebotomus argentipus* and four different species of genus *Sergentomyia* (*S. zeylanica, S. punjabensis, S. modii* and *S. babu*) were discovered. In distinguishing the two genera separately, wing width showed the most significant difference between genera thus it will enable reliable geneus identification. The highest species richness as well as diversity occurred where cattle were reared because it provides ideal breeding conditions for Sand fly. *P. argentipes* showed the highest percentage (29%) occurrence. Further studies are required to identify the potential Sand fly vector species of Leishmaniasis in Dickwella area.

Keywords: *Dickwella, morphological identification, Sandfly species*

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Phylogeographic relationships and evaluation of proximate composition of golden trevally, *Gnathanodon speciosus* (Forsskål, 1775) in Sri Lanka

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Golden trevally, *Gnathanodon speciosus* which belongs to the family Carangidae is an important commodity of food and ornamental fish industries. This fish is widely distributed throughout the tropical and subtropical waters of the Indian and Pacific Oceans. This study focused to determine the phylogeographic relationships of Sri Lankan *G. speciosus* and compare its proximate composition with other carangid species. Samples were collected from three geographical locations in Sri Lanka (Mannar, Kalpitiya and Jaffna) and sequences from partially amplified (649bp) mitochondrial Cytochrome Oxidase I gene region were used to infer phylogeographic analyses. Sequences derived from Sri Lankan samples were identical and sequences from other populations that represent different geographical locations were retrieved from the GenBank (N = 27). Analyses were performed using Maximum Likelihood methods using Kimura-2 parameter model with the support of 1000 bootstrap value. The derived phylogenetic tree indicated major geographic separation between the Indian and Pacific Ocean populations with 3.17% divergence level (P distance). Pacific Ocean populations grouped into two distinct clades as Australian (mean divergence 3.2%) and Malaysian populations (mean divergence 2.3%). Except one sequence from India, all other sequences that represent Indian Ocean populations clustered into two clades which were sister to each other with 100% bootstrap support. Low divergence levels within and among the clades (range 0 - 1.1%) suggest that there is a possibility for genetic admixture *G. speciosus* populations within the Indian Ocean. Comparison of nutritional components among four carangid species (*Caranx ignobilis, Alectis indica, Caranx heberi* and *G. speciosus*) indicated that *G. speciosus* has the highest protein and ash contents and the lowest lipid content. The protein content (45.53%) and moisture content (77.65%) showed significant differences (p<0.005) among selected species while there was no significant differences reported for lipid (8.55%) and ash (2.22%) contents (p>0.005). The gathered information will be a platform for further research of *G. speciosus*.

Keywords: *Phylogenetic relationships, cytochrome Oxidase 1, genetic divergence, carangidae*

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Antioxidant activity of *Mangifera zeylanica* stem bark of different extracts

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Mangifera zeylanica, "Sri Lanka wild mango" is an endemic plant to Sri Lanka. This plant is commonly known as 'Atamba'. In traditional medicine, the stem bark is used for its anti-inflammatory properties. The cytotoxic and apoptotic potential of the stem bark also have been reported. This study investigates the antioxidant properties of the stem bark extracted with two different solvents (methanol, and water). Specimens of *Mangifera zeylanica* stem bark was collected from the two different locations, and the plants were authenticated at Department of National Botanic Gardens, Peradeniya, Sri Lanka. The plant barks were separated into inner bark and outer bark and it was extracted with aqueous and methanol solvents. The aqueous extract was freeze dried and the methanol extract was rotary evaporated. The DPPH radical scavenging assay was carried out to determine the antioxidant activity. The IC50 value of each extract was calculated from the percentage scavenging activity. The results showed that methanol extract of *Mangifera zeylanica* inner and outer bark collected from Galle had IC50 values of 5.679 µg/ml and 11.96 µg/ml respectively while the inner and outer bark of aqueous extract exhibit IC50 values of 26.34 µg/ml and 20.38 µg/ml respectively. The inner and outer methanol extract of *Mangifera zeylanica* bark collected from Rambukkana had IC50 values of 3.054 µg/ml and 81.33 µg/ml while aqueous extract had IC50 values of 3.016 µg/ml and 78.80 µg/ml for the inner and outer bark, respectively. A significant antioxidant activity was observed for the Rambukkana water inner bark with a IC50 value of 3.016 µg/ml when compared with the standard Ascorbic acid with a IC50 value of 3.040 µg/ml.

Keywords: *DPPH radical, IC50, Mangifera zeylanica, bark*

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Comparative evaluation of weight variation, hardness, friability, disintegration, and dissolution parameters of commercially available atorvastatin tablets marketed in Galle, Sri Lanka

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Atorvastatin is a widely used lipid lowering drug. Aims of this study were to compare the physicochemical (weight variation, hardness, friability, disintegration, and dissolution) parameters of one generic (Drug A) and five brands (Drug B, C, D, E, and F) of film-coated atorvastatin 20 mg tablets available in Galle, Sri Lanka and to evaluate physicochemical parameters (PP) just (T_0) and three days (T_1) after opening the package of each sample according to the specifications given in British Pharmacopeia (BP) 2016. One way ANOVA test was used to compare the PP between brands and generic. Independent t-test was used to compare the relationship of PP, at T_0 and T_1 instances in each sample. According to the specification of BP 2016, A, B, C, D, E, and F pass the weight variation, hardness, friability, disintegration, and dissolution tests. The hardness in just after opening all brands and generic was found to be in the range of 4.669 –18.242 kPa. Drug "C" exhibited the highest disintegration time (6.01 min) and Drug "B" showed the lowest disintegration time (2.44 min). When comparing the PP between brands and generic there was no significant difference ($p < 0.05$) among them. Among T_0 and T_1 instances, all samples showed no significant difference ($p < 0.05$) for the tested PP. This study revealed that there was no significant difference of tested physicochemical parameters between generic and brands as well among just after opening and three days after opening the package of atorvastatin 20 mg tablets.

Key words: *Atorvastatin, brands, generic, physicochemical parameters*

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Visual Speech recognition for Sinhala language using CNN

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Visual Speech Recognition (VSR) is an essential tool that is facilitating to understand the speech from the video by the visually impaired people. Moreover, VSR play an important role in analyzing the CCTV footage for a crime investigation where the audio is not available. On the other hand, VSR system for Sinhala language still under research not explored largely. Hence in this research, a preliminary research work is carried out to understand the suitability of convolutional neural network (CNN) to recognize the Sinhala character from the image which contain the mouth region. The proposed methodology train the CNN with the help of lip pose features and corresponding character label. The architecture of the CNN employees' three convolution layers, two fully connected layers and one max pool layer. There is no data set available publicly for Sinhala language visual speech recognition and for the evaluation of the system, own data set was created for five Sinhala characters that has phonetics sound a, e, i, l, m. The data set was augmented to increase the feature domain and the outliers are removed to overcome the ambiguity. The system was trained with fifteen images and tested with ten images, those are containing the lip pose when pronounce five sounds. For the evaluation purpose the confusion matrix is analyzed and the accuracy was determined by the F_1 score. The F_1 score is calculated using the precision and recall and found 0.83, it means that the proposed methodology performs well.

Key words: *CNN, Sinhala, character, visual*

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Defining a Generic Service Description for RESTful Web Services

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A web service is a piece of software that facilitates communication between two devices through a machine processable interface over the Internet. There are two popular architectures of web services namely Simple Object Access Protocol (SOAP) and Representational State Transfer (RESTful) web services. The Web service description is a human and machine readable document that helps to find a web service published over the internet. Therefore web service description requires a generalized format. RESTful is one type of web service which has several ways of describing its description. Among those RESTful web service descriptions Swagger and RAML are popular languages. There are common features in both languages as well as specialized features to each category. However, there is no common format for web service description for RESTful web services. This research proposes generic web service description for RESTful web services. By following the design science research methodology thorough literature survey was conducted specifically to analyze Swagger 3.0 and RAML 1.0 languages. Then a generic mete-model was developed and it is enriched not only with common features of above two languages but also with several new attributes. The meta-model provides guidance for the generic service description. In the process of defining the generic model, meta-model for Swagger and RAML were created. The transformation rules were developed using Atlas Transformation Language (ATL) to transform the Generic Description to Swagger and RAML respectively and vice versa. Results were validated by mapping selected popular web service descriptions to the generic service description.

Key words: *Web service description, REST, Swagger, RAML, ATL*

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Electrodeposition of CdS window layer on ZnS buffer layer for solar cell applications

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The efficiency of the CdS/CdTe solar cell is accompanied by the layer thickness of CdS due to its high light absorption coefficient. At lower thickness, more photons can reach the absorber material and hence increases the short circuit current density (J_{sc}) of the device resulting a device with improved efficiency. This work comprises a study on structure and topography of electrodeposited CdS on glass/FTO and glass/FTO/ZnS substrates using a three-electrode cell. The electrodeposition conditions of ZnS on FTO has been previously reported. For the electrodeposition of CdS, an electrolyte consisted of 0.01 mol/L $Na_2S_2O_3$ and 0.1 mol/L $CdCl_2$ at a pH of 1.7 and temperature of 55 °C was used under a deposition potential of -0.68 V. The deposited CdS thin films were analyzed by X-ray diffraction, atomic force microscopy techniques, and by photoelectrochemical cell measurement. The X-ray diffractograms revealed that CdS in both devices has mixed structures of cubic and hexagonal phases. The surface morphology observed under AFM of CdS grown on two substrates were found to be significantly different and larger grains were observed for glass/FTO/CdS. Hence, more CdS seeds have been formed on glass/FTO/ZnS substrate, resulting higher number of grains in reduced size. According to the PEC cell measurement, the FTO/ZnS/CdS layer has higher open circuit voltage (V_{oc}=0.45V) than that of the FTO/CdS layer (V_{oc}=0.33V), representing minimal pinholes and short paths through the grain boundaries. Therefore, the conventional CdS window layer can be successfully replaced by ZnS/CdS in CdS based solar cells.

Key words: *Electrodeposition, CdS, ZnS, buffer layer, characterization*

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Modeling exchange rate volatility and detection of its attributes

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The objectives of thi study are to find the best model and to detect the attributes of the exchange rate volatility on Sri Lankan rupee (LKR) against the US dollar (USD). The daily exchange rate span from 1st of January 2009 to 1st of January 2020 was collected from the Central Bank of Sri Lanka. The residuals of the conditional mean model of return series were first examined for heteroscedasticity. Then the conditional variance of residuals was modeled as Generalized Autoregressive Conditional Heteroscedastic (GARCH) to capture the volatility clustering and persistence. The asymmetry in volatility was tested with the sign and size biased test and it was modeled as Exponential GARCH (EGARCH) to examine the leverage effect. Finally, both symmetric and asymmetric models were compared to find the best. It is revealed that, the daily returns of exchange rate were highly leptokurtic. Moreover, the GARCH (1,1) model shows the volatility clustering and an explosive process evident in conditional variance of residuals. The asymmetric behavior of volatility to shocks depends on the size of the previous shocks but not the sign. Among two models, the EGARCH (1,1) was the best to capture such dynamics in volatility. This was evident from empirical results for Arab currencies. Recently, the exchange rate volatility increased significantly and made international trade more unstable. This urges careful attention about the attributes that drive exchange rate volatility and the knowledge provided by this study empowers to take precautionary measure to strengthen the international trade for future.

Key words: *Exchange rate, Volatility, Heteroscedasticity, Conditional variance*

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Development of a low-cost high-resolution multi grating Spectrometer controlled by Arduino

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A low-cost and high-resolution spectrometer was developed as a substitute for the very expensive spectrometers available in the market, for the analysis of spectra in the visible region. Collimated light from standard sources were directed towards a transmission grating using a pin hole, slit and a convergent lens. To observe a wider spectral region in single acquisition, a transmission grating with 600 lines/mm was used and dispersed light was directed towards the photodiode array detector (TSL1406RS) by using a focusing lens and a rotatable mirror. Parallel to that another independent transmission grating with 1000 lines/mm was used to acquire a highly resolved spectrum. The whole spectral region that can cover by this grating was directed towards the photodiode array detector by parts using the same focusing lens and the rotatable mirror. An Arduino software program and a software interface (HRS_Graph v1.0) were designed to control all the functions of the spectrometer. The software interface is capable of representing the data which were obtained by the photodiode array detector as a graph. Standard spectral lines were used to calibrate the spectrometer and it was found that this spectrometer can be used to study the region from 352 to 663 nm with the spectral resolution about 0.6 nm. Thus, the reading error of the spectrometer is about ± 0.6 nm. Spectra of a compact fluorescent lamp were acquired by using our spectrometer and compared with standard spectral lines arise due to the elements in the lamp. Acquired spectral lines were in good agreement with their standard values. Approximately 30,000 LKR was spent on this spectrometer and a commercially available one with similar resolution is about 6,000 USD.

Key words: *spectrometer, arduino, grating, high-resolution, photodiode*

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A preliminary study on age-based formant analysis of Sinhala vowels

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The human voice signal helps to identify some details about the individuals using a formant structure. Formants are resonance frequencies generated according to the human vocal tract length. The uniqueness of the vocal tract reveals unique formant structures. This study is mainly relying on the individuality of formants (Formant1 & Formant 2) in different age ranges. The vocal readings were taken from randomly selected 180 people grouping into 6 age ranges ("4-10", "11-20", "21-30", "31-40"," 41-50", "50+") with male and female categories separately so that each age range consists of 15 males and 15 females. The speech material consisted of four Sinhala vowels ("ආ", "ඈ,", "ඕ", "ඌ"), recorded using a smartphone of "Samsung Galaxy J7" in a quiet environment of nearly 25 dB. The other necessary information was collected via a questionnaire. The Praat software was used for the vocal analysis process, and RStudio and Origin software was used for statistical analysis. Correlations among parameters were tested by using Pearson's Correlation theory and Anova tests. This study reveals that the average formant values between young (4-20 yrs.) and adults (>20 yrs.) have 80% of deviation, and it is significant. Generally, formant values decrease with age from 4 to 50+. Furthermore, eight equations were derived for every four letters considering the gender separately. Those equations can be used in human identification software after supplementary researches.

Keywords: *Formant analysis, sinhala vowels, vocal tract, gender, age*

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A Biomedical Image Processing Approach to Detect Diabetic Retinopathy using Convolutional Neural Network (CNN)

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Diabetic Retinopathy is the most popular Eye disease in Sri Lanka that occurred in the working-age population and it is led to vision loss. The phase classification of diabetes retinopathy (DR) was considered a vital step in assessing and managing diabetes retinopathy. Early detection is one of the main challenges, which is extremely important for the successful treatment. The precise identification of the stage of diabetic retinopathy is unfortunately difficult and involves expert interpretation of fundus images. In many adjoining subjects and for the diagnosis of diabetic retinopathy, Convolutional Neural Networks (CNN) have been widely employed. 3,755 retinal images were obtained from Kaggle Database and included in the training and testing dataset. This study proposed the novel retinal image enhanced techniques using Green Channel, Grayscale, Contrast Limited Adaptive Equation (CLAHE), and Gamma Correction that contrast and extract the features of retinal images that needed to classify. Most of the researchers had only used the Green channel and Gray Scale image to predict the result and using Support Vector Machine as a classifier. In this study, using Inception V3 model and VGG 16 model that inside in the CNN as classification, different accurate prediction results were found. The VGG 16 model provided 95.12% accuracy and the Inception V3 model provided 51.03% accuracy. According to two CNN models, VGG 16 is providing better prediction accuracy in novel image enhancement applying retinal images, when compared to other available models.

Key words: *Diabetic retinopathy, Convolutional Neural Network*

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Vein graphite/TiO₂ based composite counter electrode for dye-sensitized solar cells

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The counter electrode plays a crucial role in the performance of dye-sensitized solar cells (DSSCs). It collects and transfers electrons from the external circuit to the electrolyte and facilitates regeneration process of the oxidized dye by catalysing the reduction of I_3^- redox species in the electrolyte. Platinum coated glass substrate has been widely used as counter electrode in the conventional DSSCs due to its high electrical conductivity and high catalytic activity. However, Platinum is an expensive and rare noble metal which is a major hurdle for large scale production of DSSCs. In this work, we have investigated the performance of DSSCs with vein graphite/TiO₂ based composite counter electrode. The power conversion efficiency was able to increase from 3.01% for pure vein graphite electrode to 5.29% for optimized composite vein graphite/TiO₂ electrode. This impressive enhancement in efficiency is mainly attributed to the improvement in the adhesion of graphite to FTO glass substrate upon the incorporation of TiO₂. Furthermore, the electrochemical impedance spectroscopy, cyclic voltammetry and Tafel polarization study reveal that the electrical properties of the graphite counter electrode improved with the incorporation of optimum amount of TiO₂.

Key words: *Dye-sensitized solar cells, vein graphite, counter electrode, platinum free*

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A Modified Public Key Cryptosystem Based on the ELGAMAL Algorithm

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The ElGamal cryptosystem was introduced by Taher ElGamal in 1985. It is one of the most widely used public key cryptosystems and a probabilistic algorithm that was developed based on the Diffie-Hellman key exchange protocol. Unlike the Diffie-Hellman algorithm, this is a complete encryption-decryption system that depends on the discrete logarithm problem. Its security is based on the difficulty of finding the discrete logarithm modulo a large prime. We have introduced a generalized ElGamal algorithm using the Euler phi-function of the plaintext and the prime factorization of the plaintext. The algorithm is designed under the three primary steps of key generation, encryption, and decryption. The encryption process is improved in the sense that it depends on the Euler phi-function of the plaintext and the prime factorization of the plaintext. Modular exponentiation is taken twice during the encryption process, one with the multiplication of the Euler-phi function of the plaintext and the number of distinct prime factors of the plaintext with respect to the chosen prime number modulus and then with the secret encryption key. The key generation and the decryption process for the new system is similar to that of the standard ElGamal cryptosystem. The security of the system depends on the discrete logarithm problem which is known to be computationally hard. The proposed system preserves security against the Chosen Plaintext Attack (CPA).

Key words: *ElGamal Cryptosystem, Diffie-Hellman Key Exchange, Discrete Logarithm Problem, Euler Phi-Function, Chosen Plaintext Attack*

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Application of the Method of Directly Defining the Inverse Mapping to Fingering Phenomenon in the Oil Industry

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Most of the real-world problems can be represented as systems of nonlinear partial differential equations. Perturbation method, Homotopy Analysis Method (HAM), Optimal Homotopy Analysis Method (OHAM), and Method of Directly Defining the inverse Mapping (MDDiM) are some methods that can solve nonlinear differential equations analytically. In this study, we picked MDDiM, which was first introduced by Sujin Liao in 2016. He used this technique to solve a single ordinary differential equation, and after that, Dewasurendra et al. extended this method to solve a system of coupled ordinary differential equations. In this work, we further extended this so-called method to solve nonlinear partial differential equations with two boundary conditions in the fingering phenomenon, which is an oil industry application. The fingering phenomenon occurs during the water injection in the secondary oil recovery process. When a fluid contained in a porous medium is displaced by another of lesser viscosity, instead of regular displacement of the whole front, protuberances may occur, which shoot through the porous medium at relatively speed. This phenomenon is known as the fingering phenomenon, and the protuberances are called fingers. We obtained a six-term solution to the water saturation of injected water by solving the governing equation of the above-mentioned application using MDDiM. In addition, we obtained approximate solutions to the saturation of water at the fixed values of time and represented solutions using graphs. These solutions are accurate enough with the averaged squared residual error 1.8381614×10^{-5} and all the solutions and graphs were obtained using Maple 16.

Key words: *Method of Directly Diffing the inverse Mapping, Fingering Phenomenon, Squared residual error*

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Modeling and Forecasting Monthly National Coconut Production in Sri Lanka using Time Series Analysis

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Coconut is a perennial crop that contributes to the growth of the Sri Lankan economy and plays a major role in determining national development. Sri Lanka is the fourth-largest coconut exporter to the world and the annual production of coconut in Sri Lanka varies around 3000 million nuts. According to the Coconut Development Authority of Sri Lanka, there is a shortage of 250 million coconuts in annual production by 2020. As a consequence of the high reduction of annual coconut yield, coconut prices in the local market have been increased rapidly. The main focus of this study was to model and forecast the monthly national coconut production in Sri Lanka using a univariate time series model. Monthly data on national coconut production from January 2000 to May 2020 collected from the official website of Central Bank was considered for the analysis. The series was tested for stationary using unit root tests. Webel-Ollech overall (WO) test indicated the presence of seasonality. Therefore, the seasonal and non-seasonal differencing techniques were applied to transform the non-stationary series into a stationary series. The assumptions of heteroscedasticity, autocorrelation, and normality for the residuals of the selected model were examined using the Autoregressive Conditional Heteroscedasticity (ARCH) test, correlogram of residuals, and Jarque-Bera test respectively. ARIMA(1,1,1)(3,1,1) was selected as the best fit with the minimum Akaike Information Criterion (AIC) which satisfies all the assumptions except normality. The Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE) of the aforementioned model were 11.5469 and 4.0913 respectively.

Key words: *Coconut production, Time series analysis, Seasonal Autoregressive Integrated Moving Average*

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Application of cauli-flower shaped polyaniline (PANI) and tin oxide (SnO$_2$) composite counter electrode for dye-sensitized solar cells

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In dye-sensitized solar cells (DSSCs), a thin film of platinum (Pt) has been extensively used as the catalytic material in the counter electrode (CE) due to its superior conductivity and high electro-catalytic activity. Recently, the CE as a major component of DSSCs, has received considerable attention due to expensive and limited supply of Platinum (Pt). In order to replace the Pt based counter electrodes by low cost materials with high electronic conductivity and comparable catalytic activity on tri-iodide reduction, various potential alternative materials are being investigated. Conducting polymer is one of the promising candidates for CE materials used in DSSCs as an efficient Pt free CEs. Among conducting polymers, polyaniline (PANI) is one of the most attractive materials, because of its easy synthesis, considerable catalytic activity, and good environmental stability. In this study, polyaniline (PANI) based CEs were prepared by spray technique. In order to improve the adhesion of PANI on conducting glass substrate, SnO$_2$ nanoparticles were mixed with PANI. The SEM images revealed that the sprayed PANI/SnO$_2$ composite based CE exhibits a cauli-flower surface morphology. Impressive 30 % increment in the power conversion efficiency (η) of DSSC was observed from 4.83 % to 6.27 % with the addition of SnO$_2$. This novel PANI/SnO$_2$ composite CE exhibits good stability and performance comparable to that of the Pt coated CE ($\eta = 8.12\%$) in DSSCs operating under similar conditions.

Key words: *Counter electrode, Dye-sensitized solar cells, Polyaniline, Tin oxide*

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The photovoltaic performance of CdS quantum dots sensitized solar cell using Ag/TiO$_2$ photoanode

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Quantum dot sensitized solar cells (QDSSCs) with titanium dioxide (TiO2) photoanode are attracting considerable attention among the third-generation photovoltaics due to their low cost and simple fabrication techniques involve. It is proved that strong light absorption in the visible region due to the surface plasmon resonance (SPR), of metal nanoparticles (NP) can enhance the photoresponses of these QDSSCs by acting as an agent for light trapping and providing electron traps for facilitating charge separation. In this study, the effect of in-cooperation of Ag nanoparticles in CdS quantum dot-sensitized TiO$_2$ photoanodes towards the efficiency enhancement in QDSSCs was studied. CdS deposition on porous TiO$_2$ films was carried out by successive ionic layer adsorption and reaction method. Silver NPs, synthesized by a facile one-pot chemical reduction method, were incorporated with TiO$_2$ photoanode. QDSSCs with FTO/TiO$_2$-CdS/Pt/FTO configuration were fabricated with polysulfide liquid electrolyte. QDSSCs fabricated with pristine TiO$_2$ photoanode exhibited an overall power conversion efficiency of 1.09%, whereas solar cells made with 0.3 w/v% Ag nanoparticle in-cooperated photo anode exhibited 1.37% efficiency under 100 mW cm^{-2} (AM 1.5) light illumination. This is an impressive 26% increase in the overall power conversion efficiency which is mainly attributed to the significant enhancement of the light harvesting capacity of the QDSSCs resulted by ultra-broadband SPR of the Ag NPs.

Key words: *CdS, quantum dots, sensitization, solar cells*

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Explanatory Analysis: Factors that contribute to the happiness of women, who lead households in Jaffna District

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In Sri Lanka, a family is headed by both husband and wife. However, there could be cases where the family is headed by wife. It is mandatory to be happy and be satisfied in his/her own life to lead a family; especially for a wife who leads the family on herself. The main objective of this study is to examine the association between independent and response (happiness) variables in woman headed households (WHH) in Jaffna District. Demographics, health related, economic, and sociological variables were considered as independent variables in this study. A sample of 420 women were selected by using stratified sampling technique. Data were collected through a self-administrated questionnaire. Methods of feature selection such as Lasso regression, forward selection and backward elimination were used to fit statistical models and the best model was chosen based on the minimum Root Mean Square Error (RMSE) values and then diagnostics tests were performed for the best model.

Finding indicated that happiness increased with the family's income level and monthly food expense. However, health expense negatively related with the happiness of women. Women who live in 'Happy' and 'Neutral' surrounding are higher than 'Unhappy'. Based on the selected final feature selection model, it was found that area of living, children's education level, children's minimum age, breadwinner who give support to family, health expenditure, assistance from government, way of getting water, ability to manage home & work and happiness of surrounding environment are associated with the happiness of women in WHHs in Jaffna District.

Key words: *Women Headed Households, Jaffna district, happiness, Lasso regression*

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Comparative study on machine learning performances in recognitioning off-line Tamil handwritten signatures using structure and gradient featuers

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Biometric signatures are commonly accepted for authentication and confirmation of a person because each person has an individual signature and its distinct behavioral property. Handwritten signature recognition can be divided into two categories: off-line and online signature recognitions. For the purpose of the comparative study, the well-known five different classifiers, namely, Naïve Bayes, Naïve Bayes Multinomial, Simple Logistic, J48 and Random Forest are selected in the experimental process by incorporating the structural and gradient features. In this experiment, 50 different Tamil handwritten signatures were considered. Each of the signatures were obtained 50 times from the same person at different mode and occasions. Naïve Bayes yields a recognition rate of 91.73%, Simple Logistic yields a recognition rate of 98.26%, J48 yields a recognition rate of 72.13%, and Random Forest yields a recognition rate of 98.40%. Naïve Bayes Multinomial shows better recognition rate of 98.53%.

Key words: *Naïve Bayes, Simple Logistic, Random Forest, J48, Weka Tools*

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A Method to Compute Unitaries Representing Reducible Minimal Inner Toral Polynomials using Direct Sum

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An inner toral polynomial is a polynomial in two complex variables, $p(z, w) \in \mathbb{C}[z, w]$, such that its zero set is contained in $\mathbb{D}^2 \cup \mathbb{T}^2 \cup \mathbb{E}^2$, where $\mathbb{D}$, $\mathbb{T}$, and $\mathbb{E}$ are the open unit disk, unit circle and exterior of the closed unit disk, respectively. We say the bidegree of $p(z, w) \in \mathbb{C}[z, w]$ is (n, m) if p has degree n in z and m in w. An inner toral polynomial p is called a minimal inner toral polynomial if it divides any other polynomial with the same zero set as itself. In the paper Agler, J. & McCarthy, J. (2005) Distinguished Varieties. Acta Math 194, 133-153, the authors proved the existence of unitary matrices representing inner toral polynomials. Specifically, given a minimal inner toral polynomial $\mathfrak{p}(z, w)$ of bidegree (n, m), there exists a unitary matrix, written in block form as $\begin{pmatrix} A & B \\ C & D \end{pmatrix}$, such that $\det \begin{pmatrix} A - wI_m & zB \\ C & zD - I_n \end{pmatrix}$ is a constant multiple of $\mathfrak{p}(z, w)$. Here, blocks A, B, C and D are matrices with complex entries and of sizes $(m \times m), (m \times n), (n \times m)$ and $(n \times n)$ respectively. We call such unitary matrices unitaries representing $\mathfrak{p}$. In this work we focused on constructing a method to compute unitaries representing reducible minimal inner toral polynomials using unitaries representing its factors. We prove that if the minimal inner toral polynomial $\mathfrak{p}$ is a product of s distinct irreducible factors, say, $\mathfrak{p}_1, \mathfrak{p}_2, \dots, \mathfrak{p}_s$, and if $U_k = \begin{pmatrix} A_k & B_k \\ C_k & D_k \end{pmatrix}$ is a unitary representing $\mathfrak{p}_k$ for $k = 1, 2, 3, \dots, s$, then the matrix $U = \begin{pmatrix} \oplus_D A_k & \oplus_D B_k \\ \oplus_D C_k & \oplus_D D_k \end{pmatrix}$ is a unitary representing p, where $\oplus_D A_k = \begin{pmatrix} A_1 & 0 & \dots & 0 \\ 0 & A_2 & 0 & \vdots \\ \vdots & 0 & \ddots & 0 \\ 0 & 0 & 0 & A_s \end{pmatrix}$, the diagonal-wise direct sum of the block matrices A_ks and $\oplus_D B_k$, $\oplus_D C_k$ and $\oplus_D D_k$ are defined in similar fashion.

Key words: *Inner toral polynomials, distinguished varieties, block matrices, direct sums, unitaries*

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Translation of Sri Lankan sign language to text using hand keypoints and image processing

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Sri Lankan sign language (SSL) is a visual-gestural language used by Sri Lankan deaf community for communication. Hearing-impaired people face communication problems due to difficulty in understanding SSL by others. SSL to Sinhala text interpreting technology helps to fill up this communication gap because Sinhala is understandable to the majority of people. Hand gesture recognition can be achieved by using either vision-based or sensor-based approaches. Vision-based approaches use images/videos captured from cameras and are simple and low cost. Sensor-based approaches need complex hardware so are costly. Skeletal based SSL recognition approaches have shown higher accuracy compared to shape-based methods. Scale Invariant Feature Transform (SIFT) performs better as a keypoint extractor robust to scale and is used in the research to develop a vision-based SSL to Sinhala text translation model. Images of 20 static SSL gestures were collected using a web camera as the dataset required for the training. A Support vector machine classifier with SIFT as the feature detector was used in the methodology and reached an accuracy of 70%. The accuracy varied with multi-color backgrounds and the influence of light intensity was not considered for the study. The proposed low-cost model showed stable results with varying distances to the camera compared to some previous research.

Keywords: *Image processing, sign language, Scale Invariant Feature Transform (SIFT), keypoints*

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RNN and LSTM based Approach to predict the severity of traffic accidents of Highway System: A case study from southern expressway, Sri Lanka

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Due to the growing population and respective use of vehicles on the road, traffic congestions have become a major problem in the cities and the transport systems today. The factors that lead to road traffic accidents are generally grouped into different categories as human factors (road users), vehicle defects, road factors, environmental factors, etc. The current research is focused on developing the ANN method for Traffic Accident Severity Prediction for highway transportation systems. Machine learning and Data mining based approach is proposed to predict better solutions for these scenarios. Simple ANN, RNN +LSTM, and clustering methods are applied in this study. The highway accident data that was considered from 2016 to 2019 for this research was gathered from the Expressway police division Hewagama, Kaduwela Sri Lanka. The Highway accident data set consists of nearly 2200 records that happened in all the 3 highways (E01, E02 and E03) lines in Sri Lanka. According to the last two years (2018/2019) statistics, 488 Accidents (62.48%) happened out of 781 have occurred in the daytime. Clear weather has more impact on road accidents than rainy weather. 74.5% of accidents happened in clear weather. While in rainy conditions only 16.9% of accidents happened on the Highway. Most of the serious accidents happened in with 21.63% fatal accidents. The results showed that 82.4% (location label based model) of the highest accuracy, followed by 73.56% with 2nd model (Range label-based) ANN, then 76.79% with Simple ANN.

Key words: *Traffic Accidents Severity Prediction, Data Mining Methods, Knowledge-based Systems*

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An Application of Wavelet Based Density Estimation in S&P SL20 Index of Colombo Stock Exchange (CSE)

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This study focuses on applications of wavelet based methods in estimating probability density functions (PDF) for returns and log returns of a daily recorded data set of S&P SL20 index of Colombo Stock Exchange (CSE). The density of returns and log returns play an important role summarizing the stock market behavior in CSE. The use of nonparametric methods for such estimations are more popular since they provide more flexible platform to describe PDF representing important features like skewness, peaks and fat tails. The wavelet theory in reconstructing functions has become a powerful structure in various fields. Therefore, wavelet based density estimation methods can be applied as a novel nonparametric approach in stock market indices to obtain probability density functions. In this study, wavelet theory of constructing PDF is used for returns and log returns of S&P SL20 during the period from June 28, 2012 to March 31, 2017. To reduce the computational complexity, Haar wavelets are used with appropriate but low resolution levels. Appropriate resolution levels means levels that give almost successful approximations. After constructing wavelet based densies, their smoothed curves are plotted using MATLAB to observe the shape of density functions. The results show that the wavelet based estimations are well suited for this particular data when the resolutions were used up to level 9. Moreover, it seems that the curves illustrate more details than normal distribution fittings. The goodness of fit test is used to verify the validity of estimations with relative frequencies at 5% significance level. The work justified the applicability of a wavelet based method for estimating probability density distributions, particularly for such data samples in stock market indices.

Key words: *stock market indices, probability density estimation, wavelets*

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Gel-polymer electrolytes based on poly (methyl methacrylate) host polymer for sodium-ion rechargeable batteries

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Research and development works on sodium-ion batteries (SIBs) grow exponentially in recent days because of the abundance of sodium raw materials. Due to the larger size and lower mobility of Na^+ ions, synthesis of suitable electrolytes with sufficient ambient temperature ionic conductivities would be a major challenge faced by the materials research community. In this work, we developed gel-polymer electrolytes (GPEs) based on poly (methyl methacrylate) (PMMA) host polymer matrix and $NaClO_4$ ionic salt dissolved in ethylene carbonate (EC) and dimethyl carbonate (DMC). The optimized $PMMA-NaClO_4-EC-DMC$ GPE composition (10:14:38:38 wt%) showed an ambient temperature ionic conductivity of 8.4 mS cm^{-1}. Variation of ionic conductivity with inverse temperature showed Arrhenius behavior with almost constant activation energies of 0.16 eV for all the compositions studied. DC polarization test showed that the ionic contribution to conductivity is very high (99.8%) and the electronic contribution is negligibly small (0.2%) in the best conducting composition, which is very good to avoid short circuiting inside the battery. Cyclic voltammetric studies on best conducting composition showed that the electrolyte is electrochemically stable for a voltage window of 4 volts (- 2 to + 2 volts). This optimized composition with highest ambient temperature ionic conductivity and negligible electronic conductivity is found to be highly suitable for practical applications in secondary SIBs.

Key words: *Sodium-ion batteries, gel-polymer electrolytes, electrochemical impedance spectroscopy, ionic conductivity, DC polarization*

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Artificial Neural Network Approach for Real-Time Density-Based Traffic Signal Control System

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The lack of efficient traffic light control systems leads to traffic congestion and accidents. This problem causes many issues for society, the economy, and the environment. The research suggests an approach to the implementation of an efficient traffic light control system based on real-time conditions. This research consists of two components. A real-time data capture processing model and an Artificial Neural Network model to predict the outcomes concerning data in real-time. The principal component analysis uses to identify and minimize the dimensionality between the features. Image processing was used to count the number of vehicles in each lane and measure the length of the queue. The data of each lane was sent to the ANN model. The trained model was used to decide on the lane and time limits needed to allow the green phase, depending on the real-time situation and other dependent factors. The final ANN model gives 92% accuracy in the testing process. The introduced ANN model has one input layer, three hidden layers, and one output layer. The introduced traffic lights control system changes dynamically according to the conditions of real-time traffic rather than existing fixed time traffic light control system or traditional computation algorithms. This system decreases the average wait time and enhances traffic clearance performance.

Key words: *Traffic Congestion, Traffic Control System, Image Processing, Artificial Neural Network*

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Sound Absorptive Behavior of Coleus forskohlii: *Plectranthus scutellarioides*

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Sound absorption properties of one of the commonly used short-lived decorative perennial plant types in Sri Lanka, Coleus forskohlii (*Plectranthus scutellarioides*), is studied. The variation of reverberation time (RT_{60}) and sound absorption coefficient (SAC - α) of the plant with the frequency of sound was obtained using the reverberation room method. The experimental setup consists of a hand-held sound analyzer (B&K 2250L), a dodecahedron Omnidirectional B&K speaker (Type 4292-L), and a power amplifier (Type 2734) consisting of an internal sound generator. Measurements were taken for plants with pots and pots alone, respectively, which were placed in the middle of the room. The room temperature and humidity were monitored throughout the experiment. The sound absorption coefficients of plants were calculated using Sabine's formulation. Measurements were taken for a set of 37, 20 and 12 pots of plants. A significant enhancement of SAC is observed due to the plants. The average SAC in the frequency range 1250 to 3150 Hz is increased from 0.166, 0.155, and 0.108 to 0.387 (56.9%), 0.329 (52.9%), and 0.299 (64.0%) due to the plants in compared to pots without plants, for the three sets of measurements with 37, 20 and 12 pots, respectively. A peak of SAC at 1250 Hz is observed in all three samples, and a hump at 2500 Hz is observed, which may be related to the morphological parameters of the plant and is under investigation at present.

Key words: *Sound barriers, reverberation time, sound absorption coefficient*

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Improving the performance of the photocatalytic activity of Cu and S co-doped TiO$_2$ nanoparticles

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Photocatalyst is a light-activated catalyst. Metal complexes and semiconductor catalyst are recognized as photocatalyst materials. Titanium Dioxide (TiO$_2$) has become the most important material due to its high chemical stability, non-toxicity, inexpensiveness and efficient photoactivity. However, due to its wide band gap and the fast recombination of electron-hole pair, it has contributed to the inability to use the sunlight sufficiently as well as hindering for any reaction to happen. To utilize visible light more efficiently in Photocatalytic reactions, it was objected to prepare, Copper and Sulfur co-doped anatase phase TiO$_2$ nanoparticles with different ratios by a sol-gel method via a precursor solution of titanium isopropoxide. The powder XRD pattern confirmed that all the synthesized pure and doped TiO$_2$ nanoparticles samples were polycrystalline of anatase phase. Ti-O bonds in the samples were confirmed through FTIR spectrum. The average particle size determination and elemental analyses were done by SEM coupled with EDX spectroscopy. The photocatalytic activity of the synthesized catalysts was investigated against degradation of methylene blue solution under visible light using UV-visible spectroscopic techniques. The optimal photocatalytic activity was obtained at the 100:0.25:0.25 Ti^{4+}:Cu$^+$:S^{2-} molar ratio. Photocatalytic properties were further improved by doping with CaCO$_3$ to reduce the carrier recombination. The performance was optimized at 100:0.25:0.25:0.25 Ti^{4+}:Cu$^+$:S^{2-}:Ca^{2+} molar ratio. The experimental work conducted here revealed promising results for improving the performance of the TiO$_2$ nanomaterial by doping it with copper and sulfur where the photocatalytic activity was enhanced and shifted to the visible region causing an appreciable increase in its effectiveness for photocatalytic applications.

Key words: *Titanium Dioxide, co-doping, photocatalyst*

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On some properties of the regular multinomial model and algebraic multinomial model associated with biochemical reaction networks

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It is well known that the multinomial model is a generalization of the binomial model in probability theory and some classes of biochemical reaction networks (BCRNs) have multinomial stationary distributions. We use the additional term "regular" to differentiate the classical statistical models with the algebraic statistical models. Algebraic statistics is a fairly new but rapidly developing field of research related to algebraic geometry and plays a central role in systems biology particularly in the study of BCRNs. In this work, we first discuss some statistical and geometrical properties such as entropy, relative entropy and Fisher information of the regular multinomial model of classical statistics elucidating its exponential family structure. This multinomial model turns out to be a differentiable manifold and has rich properties due to its exponential family structure. Next, we describe the (stoichiometric) algebraic multinomial model of data associated with a particular family of BCRNs from the view point of algebraic statistics and discuss its manifold structure. Motivation for this investigation comes from the previous discussion on regular multinomial model. Theory of BCRNs can be described and defined using vector spaces and related algebraic concepts and such networks can be represented by graphs with nodes (species) and edges (reactions). The stochastic analysis of such networks are widely used to understand the dynamical and information processing aspects. According to the statistical model introduced here, the differentiability becomes a key factor for this model to be considered as a differentiable manifold but it can be solved using the algebraic methods and nonparametric information geometry effectively. This would allow one to elaborate on the algebraic exponential family structure of this kind of models and to discuss its information geometry.

Key words: *Mathematical statistics, information theory/geometry, exponential family, biochemical reaction networks, algebraic statistics*

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Chromatic Polynomial of Snow Graph

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The chromatic polynomial is introduced by George David Birkhoff in 1912. It defined as follows: for a given graph G, the number of ways of colouring the vertices with k colours, such that any two adjacent vertices are coloured differently is called the chromatic polynomial of graph G. In this paper, we create a general formula for the chromatic polynomial for a special graph, called Snow graph ($S_{n,1,m}$) which is obtained from the union of wheel graph and star graph. The snow graph has three parameters and the shape of a snowflake. The general formula for the chromatic polynomial of snow graph is constructed using the polynomials of wheel graph and star graphs. So we obtained that the chromatic polynomial of the Snow Graph as $P(S_{n,1,m}) = k\left[(k-2)^{n-1} - (-1)^n(k-2)\right] \times (k-1)^{mn}$; where n is the order of the wheel graph and m is the number of leaves in the star graph. Using this general formula we can find the chromatic polynomial of a Snow Graph with any order.

Keywords: *Chromatic Polynomial, snow graph, wheel graph, star graph*

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Evaluation of the chemical properties, physical properties and sensory attributes of cinnamon (*Cinnamomum zeylanicum* Blume) oleoresin incorporated cookies

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Cinnamon and its oleoresin are commonly used in food and beverages as a natural flavoring agent and preservative. The aims of the present study was to; develop cinnamon oleoresin incorporated cookies, evaluate the sensory attributes, analyze the nutritional composition, discover the Total phenolic content (TPC) and antioxidant activity through DPPH assay and to determine the effect of three different packaging materials (PET/LLDPE, PET/AL/LLDPE, PET/Met.CCP) on physico-chemical properties of developed cookies. Cinnamon oleoresin, extracted by solvent extraction using ethanol, was incorporated in to cookies in three different concentrations (0.5%, 1.0% and 1.5%) and the best formulation was selected through sensory analysis with 30 untrained panelists. Moisture content, pH, nutrients, texture characteristics were tested for, the selected formulation and control samples. Effect of selected packaging materials on physico-chemical properties of the cookies were analyzed every two weeks for two months from the date of manufacturing.

Statistical analysis of sensory evaluation data revealed the best formulation as 0.5% oleoresin incorporated cookies ($p<0.05$) and it is used for physico-chemical analysis. Addition of oleoresin had no significant effect to the nutritional composition and a_w of cookies. Color and pH have been affected by the oleoresin incorporation since lower L* value and lower pH compared to the control. The highest Total phenolic content and antioxidant activity were detected from the oleoresin incorporated cookie (0.645 ± 0.002 mgGAE/g, IC50= 400.387ppm) than control cookie (0.286 ± 0.001 mgGAE/g, IC50= 667.959 ppm). There is a significant effect of packaging material on the physico-chemical properties of cookies during storage ($p<0.05$) and the best as it showed lesser deviations in L*, moisture content, a_w and the textural characteristics of developed cookie even after two months. Therefore, cinnamon oleoresin can be incorporated in to cookies to enhance flavor and antioxidant properties.

Key words: *Cinnamon oleoresin, packaging materials, physico-chemical properties, sensory evaluation*
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Risk Factors on Welfare of Dairy Cows and Calves in Galle and Matara Districts of Sri Lanka

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At present welfare friendly animal products have an increasing demand similar to organic products. Objective of the study was to identify management related risk factors that affect welfare of dairy cows and calves reared in Galle and Matara Districts. A pre tested questionnaire was used in the survey. Tie –up small scale intensive dairy farms (n=67) having average cow number 2 were selected around milk collecting centres and evaluated. General information, fate of male calves, calving management, colostrum feeding, calf- dam separation, painful procedures, feeding, housing, cow-cleanliness, shed conditions and health management were focused in the questionaire. Data were analysed by using IBM SPSS Statistic 22. Jersey crosses were the prominent (85%) cattle breed. Adults (31-65 yrs.) were mainly involved (92.5%) in dairying. Most of the cows had dirty hind limbs and udders (80%). Cleanliness of udder and flank were significantly affected (P<0.05) by the whole shed length. The reason may be there was a significant difference (p<0.05) between given width and length of sheds from the standards (1.7m width x 2.45m length). Slippery floors were observed in 46.66% farms that causes injuries to cows. Body condition score of cows revealed 2.5 (10.4%), 2.5-3 (86.5%) and >3.5 (2.9%) indicating majority a negative energy balance. Male calves (96.66%) were kept in the farm for draft purpose (to pull carts) and few farms (3.33%) sold calves early in life. Calving pens were not found and claves were kept in contact with mother cows. Majority of farms (53.33%) started colostrum feeding within 1-2hrs. of birth. Most of the farms (68%) practiced weaning at 3 months of age. No any farmers practiced painful practices such as dehorning, branding, castration, etc. Feeding and drinking practices were satisfactory. However, feeder height was found as a risk factor for 53.33% of claves. Water was given by damaged buckets (96.66%) restricting *adlibitum* water intake. It is concluded that housing related aspects and feed/water related aspects were found as the major risk factors for the welfare of cows and calves respectively.

Key words: *Calves, dairy cows, management, risk factors, wellbeing*

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Combined effect of leaf chlorophyll and anthocyanin content on the overall aesthetic appearance of coleus (*Plectranthus scutellarioides* (L.) R. Br) var. 'Velvet red' under four different light levels

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Most Coleus (*Plectranthus scutellarioides* (L.) R.Br) varieties change the aesthetic appearance of leaf when exposed to different light intensities. An experiment was carried out to evaluate the changes in chlorophyll and anthocyanin content in leaves that determine the color of *Plectranthus scutellarioides* (L.) R.Br var. 'Velvet red' (coleus) in response to a heterogeneous light environment. Plants were arranged as a completely Randomized design, under full sun light (T1), 40% (T2), 50% (T3) and 70% (T4) shade where the shade was provided with black color polypropylene nets. The experiment was conducted for 60 days. Changes in light levels affected on chlorophyll content, anthocyanin content and as a whole, the leaf color. The highest anthocyanin content and the lowest chlorophyll content were recorded under 0% shade (full sunlight). Leaf color changes were measured using an Image color analysis computer software. According to resulted RGB (**R**ed, **G**reen, **B**lue) histograms, the brightness of red color and the redness of the leaves become more prominent under 0% shade. Moreover, the highest chlorophyll content and the lowest anthocyanin content were recorded under 70% shade. The brightness of red color was reduced and the green color becomes more prominent under 70% shade. Overall, the heterogeneous light environment affects the leaf pigmentation and aesthetic appearance of the 'Velvet red' variety of coleus.

Keywords: *Plectranthus scutellarioides (L.) R.Br, chlorophyll, anthocyanin, RGB histograms, pigmentation*

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The need for more research on mangroves in Sri Lanka; a review on mangrove microbiology, genetics and physiology

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Mangroves, the tidal forests serve numerous ecological services and economic benefits for the well-being of the coastal communities. Hence, they are known as resourceful ecosystems and can be used effectively for new advancements in science. Many research have been conducted in the fields of mangrove ecology, anatomy, floral biology, reproduction etc. However, very few researches have been conducted on mangrove microbiology, genetics and physiology. From early 1980's to 2020, to the best of our knowledge, 169 journal articles (in peer reviewed journals) have been published on Sri Lankan mangroves of which only 1.6% papers covered mangrove genetics. Those studies which were confined to late 1990's and early 2000's and mainly focused on population genomic analysis aiming at studying population structure of some selected mangrove species and/or conservation genetics. Similarly, less than 2% of the published papers were related to mangrove microbiology and even those are not in depth studies. In terms of (eco) physiology, although stress physiological researches have recently been prioritized (<5%), core physiological role of salt (Na+) in mangroves is not well addressed. Therefore, new advancements are very possible if these knowledge gaps are addressed. We encourage carrying out more research on gene expression of mangrove species under different stress conditions to screen genes associated with agronomically important traits. These agronomic performances of crop plants, for example, stress tolerant crop species can be enhanced through genetic engineering. Also, it is encouraged to carry out metagenomics in mangroves. That may be useful in extracting new enzymes and antibiotics that make possible productive prospecting for medical sciences.

Keywords: *Extensive research, knowledge gaps, mangroves, Sri Lanka*

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Application of *Hibiscus rosasinensis* L. Leaf Mucilage with Gelatin as an Edible Coating to Extend the Shelf life of *Psidium guajava* L.

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Guava is one of the most common fruits grown under tropical and sub-tropical climate. The fruits are susceptible to spoilage due to perishability. Application of edible coating is a cost-effective and environmentally friendly technology used to extend the shelf life by retarding perishability and increase the consumer acceptability. The present study was conducted to investigate the effect of gelatin with *Hibiscus rosasinensis* leaf mucilage as an edible coating on the quality and shelf life of guava fruits during storage. Freshly harvested, uniform sized, undamaged, mature guava (var. *Bangkok Giant*) fruits were dipped in leaf mucilage and with different concentrations of 1, 3, 5 and 7% (w/v) of gelatin solutions for 20 min. Then, the fruits were air-dried and stored at the cold storage temperature of 15°C and room temperature of 30°C. Physico-chemical parameters such as ascorbic acid, total sugar, total soluble solids and titratable acidity (as citric acid) were determined at 3 days intervals. Ascorbic acid content decreased from 28.7mg/100g during storage but degradation was slow under cold storage temperature of 15°C. The fruits coated with 5% of gelatin and stored at 15°C showed the highest retention of ascorbic acid, total sugar, total soluble solids and titratable acidity with the values of 28.66 mg%, 8.49%, 12.3°Brix and 0.69%, respectively. According to the sensory evaluation and shelf life studies, the guava fruits coated with *Hibiscus rosasinensis* leaf mucilage with 5% gelatin could be stored for 28 days at 15°C without any significant losses in the quality characteristics.

Key words: *Gelatin, guava, Hibiscus rosasinensis, nutritional quality, shelf life*

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Development and Storage Studies of Aloe Vera-Sour Orange Based Functional RTS Drink Flavored with Ginger

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Aloe Vera is well known worldwide for its functional and therapeutic potential. Aloe Vera gel of the leaf contains several biologically active compounds including vitamins, polysaccharides, amino acids, phytosterols, quinones and saponins. These biological activities include promotion of wound healing, immunomodulatory, antifungal activity, antidiabetic anti-inflammatory and gastroprotective properties. A study was undertaken to optimize the production of Aloe Vera-sour orange RTS beverage flavoured with ginger and to assess its quality and storage stability. The blended juice was prepared replacing 0 (control), 10, 20, 30 and 40% Aloe Vera gel in the sour orange juice with10ml ginger extract. The drink were filled in sterilized bottles, pasteurized at 90°C for 10mins and stored at 5°C for 30 days. Titratable acidity, pH, TSS (°Brix), ascorbic acid and total sugar content of the beverages were monitored during storage according to the Standard AOAC methods. The sensory parameters of colour, taste, flavor, consistency and overall acceptability was assessed on a 7-point Hedonic scale. The titratable acidity, TSS and total sugars increased whereas the pH and ascorbic acid content decreased during storage. In the RTS beverage with 20% Aloe Vera gel, the total sugar increased from 14.1 to 17.2% and the ascorbic acid decreased from 61.4 to 52.7 mg/100ml during the 30 days of storage. The microbial analysis revealed that the prepared beverage was free from any microbial spoilage. The sensory analysis proved that RTS beverage made with 20% Aloe Vera liked the most, by judges with the overall acceptability score of 6.72. The results revealed that the RTS made with 20% Aloe Vera juice were acceptable upto 30 days of storage at 5°C. Utilization of the medicinal plants in fruit beverages will provide health benefits and reduces the risk of diabetes and cardiovascular diseases.

Key words: *Aloe Vera, functional drink, ginger, physico-chemical quality, sour orange*

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Development and Quality Evaluation of Nutritionally Enriched Bread with Pumpkin Cucurbita moschata (Lam.) Poir Flour

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Postharvest losses is a major challenge hampering vegetable production in most developing countries including Sri Lanka. Pumpkin *(Cucurbita moschata)* being a perishable crop owing to its high moisture content has a short shelf-life under tropical conditions. Drying is the most common method used to preserve pumpkin. An electric food-dehydrator can consistently produce a quality product and is easier compared sun drying, over drying and vacuum dehydration. Pumpkin bread was successfully produced with the ingredients of wheat flour, pumpkin flour, fat, sugar, salt, bread improvers, yeast and water. The nutritional and sensory properties of breads supplemented with 5, 10, 15 and 20% (w/w) pumpkin flour and control made with 100% wheat flour were evaluated. The bread incorporated with 10% pumpkin flour was most preferred based on the sensory scores for colour (5.97±0.22), aroma (5.70±0.16), taste (6.17±0.16), mouth feel (5.97±0.13) and overall acceptability (5.87±0.26) on a seven-point hedonic scale. The results of the physico-chemical analysis revealed that the developed bread with 10% pumpkin flour contained the acceptable level of moisture (35.5%), total soluble solid (1.33°Brix), ascorbic acid (3.12mg%), total phenolic content-DPPH method (97.97mg GAE/g) and antioxidant activity-Folin-ciocalteau method (19.57µg/ml). Based on the total plate, mold count and EC-Broth test, the developed bread were not affected by any of the microbial spoilage due to inactivation of microbes during drying and baking at high temperature of 200°C. The mixture of 10% pumpkin flour with 90% wheat flour was found to be successful for the production of nutritionally enriched bread with improved physico-chemical and organoleptic qualities within the universally accepted standards.

Keywords: *Bread, nutritional enrichment, physico-chemical quality, pumpkin, sensory properties*

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Optimization of a Standard Molecular Protocol for Amplification of *CtsK* Gene Responsible for the Disease Pycnodysostosis: A Preliminary Study

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Incidence of bone fragility and related fractures due to genetic disorders indicate a high prevalence in Asia. Pycnodysostosis (PKND) is an autosomal recessive disorder caused by mutations in *CtsK* gene encoding for Cathepsin K. PKND causes bone fragility due to retarded ossification; hence precise screening or early detection is important. Overall aim of the proposed study is to develop a complete and precise gene based biomarker, to identify *CtsK* mutations contributing to PKND. This plot reports the startup work on one objective achieved, based on control optimization of a molecular protocol to amplify and isolate a selected region in exon 2 of *CtsK* from healthy blood samples. Human DNA was extracted using FlexiGene[TM] QIAGEN DNA extraction kit with additional cell lysis, washing and purification steps using cell lysis buffer, ethanol and isopropanol respectively. Nanodrop[TM] quantification indicated DNA of sufficient quantity (average 500ng/µl) and quality; A_{260}/A_{280}; 1.6-1.8 and A_{260}/A_{230}; 1.4-2.2. Polymerase Chain Reaction (PCR) was performed using known primers 5$'$CTCTGTTTCCCTGCCAAATG$'$3 and 5$'$CTCAGGTCTCAGCCTTCCTG$'$3 of concentration 10pmol/µL each with dNTP concentration each of 200µM using 1X FIREPol® Master Mix at conditions; initial denaturation; 95℃, 3 minutes, denaturation; 95℃, 30 seconds, annealing; 55℃, 30 seconds, elongation; 72℃, 40 seconds and final elongation; 72℃, 5 minutes. PCR amplicons were subjected to Agarose Gel Electrophoresis (1.7%, 40V; 3 hours). Results showed a clear single band of 220bp; validated by previously published work. In conclusion, the objective was achieved. Results imply that local infrastructure and expertise could be exploited to complete the proposed aim of the study.

Key words: *Bone health, Cathepsin K, CtsK, Fragility Bone disease, Pycnodysostosis*

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Salinity Tolerance Capacity of *Chlorococcum* sp. Isolated from Wahawa Geothermal Springs in Sri Lanka

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The algae species inhabiting the geothermal springs must tolerate extreme temperature and saline conditions present in geothermal springs compared to their counterparts living under normal environmental conditions. This study investigated the salinity tolerance capacity of the green algal species *Chlorococcum*, isolated from Wahawa geothermal springs in Sri Lanka, with the intention of investigating further, the taxonomy, ecology and applications in extreme saline conditions. Isolated *Chlorococcum* sp. was exposed to a salinity series prepared using Bold Basal Medium (BBM) in conical flasks with seven different NaCl concentrations (25, 1000, 2000, 5000, 10000, 20000, 40000 ppm), at average temperature 45±3 ˚C under 12 h/12 h light/dark with average natural day light intensity 1311 µmol m^{-2} s^{-1} for seven weeks. Growth of *Chlorococcum* sp. was measured spectrophotometrically, measuring the optical density at 750 nm every week. An exponential growth pattern of *Chlorococcum* sp. was observed in all salinity levels during the 7-week period. The highest growth rate 34 cells mL^{-1} day^{-1} was observed under 25 and 5000 ppm NaCl concentrations and the lowest rate (7 cells^{-1}mL^{-1}day^{-1}) with the highest salinity (40000 ppm) by indicating that tested *Chlorococcum sp.* can survive under broad salinity range (25–40000 ppm) although the growth rate is significantly different (P=0.0000). *Chlorococcum* spp. occur in both terrestrial and aquatic habitats and some *Chlorococcum* spp. are known to be halophytic. Thus, the isolated *Chlorococcum* sp. from Wahawa geothermal springs might be a morphotype of these halophytic *Chlorococcum* spp. The broad salinity tolerance of the tested *Chlorococcum* sp. warrants further investigations towards ecological and economical applications.

Key words: *Chlorococcum sp., Geothermal springs, Salinity, Tolerance*

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Assessment of different inoculation methods for early screening of irradiated Kolikuttu banana for Fusarium Wilt

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Fusarium wilt caused by *Fusarium oxysporum* f.sp. *cubense* (Foc) is a major threat for commercial cultivation of kolikuttu (AAB; silk) banana. Banana plants can be screened to identify resistant/less susceptible plants for this disease using different screening methods. These include i*n-vitro* methods, early screening using double pot technique, field screening in 'hot spots' and sick plot screening. The present experiment was conducted to increase the efficiency of early screening for Fusarium wilt in double pot technique under protected house conditions. Four to six weeks old tissue cultured plants derived from gamma ray treated shoot tips of kolikuttu variety Agra were subjected to screen using 3 different inoculation methods. The inoculum was freshly prepared and confirmed by PCR using race 1 specific set of primers (Macrogen). In the first treatment, the roots of plantlets were wounded and dipped in spore suspension prepared approximately with 1.0×10^6 spores/ml for 2 hours and established in the pots filled with washed river sand. In the second treatment, the potting medium was inoculated with precolonized maize kernels at a concentration of spores approximately 1.0×10^6 spores/kg of sand. Two to three weeks after planting in pots, the plants were needle injected with 2ml of same concentrated spore suspension and added 3 ml to the potting medium in the third treatment. Number of infected plants was counted at weekly interval and results showed that the development of visual symptoms was comparatively rapid in the combined method and within 14 weeks 90% of the plants exhibited the symptoms. The symptomless plants were further screened under sick plot conditions.

Keywords: *Double pot technique, Fusarium wilt, inoculation, silk banana*

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Effects of Sodium Chloride Induced Salt Stress on Yield and Selected Physiological Attributes of Brinjal Cultivars

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Salt stress affects almost every aspect of Plant Physiology at both whole plant and cellular levels through osmotic and ionic stress. Brinjal is grown in the Batticaloa district to a limited extent; as it is highly susceptible to salt stress. Considering this, an experiment was conducted in the Sandy Regosols of the Batticaloa district to evaluate salt stress responses of 'Thirunelvely Purple', 'Palugamum White' and 'Padagoda' brinjal cultivars on the Relative Water Content, leaf Chlorophylls a, b and total Chlorophyll contents and fresh fruit yield. Chlorophylls a, b and total chlorophyll contents were determined using a spectrophotometer. Treatments 1, 3 and 5 were 'Thirunelvely Purple', 'Palugamum White' and 'Padagoda' brinjal cultivars watered with distilled water at 2 days interval. Treatments 2, 4 and 6 were treated with 100mM NaCl solution. Salt stress significantly ($p<0.05$) reduced the Relative Water Contents of all the tested brinjal cultivars. The highest amounts of Chlorophylls a (1.03 mgg^{-1}), b (0.72 mgg^{-1}) and total Chlorophyll (1.74 mgg^{-1}) were found in the 'Thirunelvely Purple' and the lowest Chlorophylls a (0.54 mgg^{-1}), b (0.43 mgg^{-1}) and total Chlorophyll (0.96 mgg^{-1}) were recorded in the 'Palugamum White' under salinity. Salt stress significantly ($p<0.05$) reduced the yield of tested brinjal cultivars. The highest yield (20.1 T/ha) was obtained in the 'Thirunelvely Purple' and the lowest (11.3 T/ha) was found in the 'Palugamum White' under salt stress condition. Based on the measured physiological attributes, 'Thirunelvely Purple' was identified as the most salt tolerant brinjal cultivar which may be suggested for cultivation in the saline tracts of the Batticaloa district.

Key words: *Brinjal, chlorophyll content, relative water content, salt stress, yield*

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Naturally sourced bioactives potential to combat oxidative stress and reduce the risk of chronic diseases; Case study Sri Lanka, Edible flowers

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Edible flowers have been used traditionally for culinary purposes as well as in phytotherapy. Recently they have gained renewed interest as a potential source of bioactives. In Sri Lanka though certain edible flowers have been used in cooking as well as in Ayurveda, their bioactive potential has not been fully investigated. This study aims to evaluate the content of bioactives and antioxidant capacity of selected edible flowers in Sri Lanka. Unexplored and underutilized edible flowers with health potential were selected and random sampling was done for the study. Extracts of eight edible flowers were analysed for total phenolic content (TPC), total flavonoid content (TFC) and total carotene content (TC). Antioxidant capacity was evaluated using DPPH radical scavenging assay, ferric reducing power (FRAP) and inhibition of lipid peroxidation. The highest TPC and TC was noted in the extracts of *Vinca rosea* (337.17±0.31µmol gallic acid equivalents/g of dry weight [DW]) and *Cassia auriculata* (525.81±0.25 µmol β carotene/g DW) respectively. Highest TFC, ferric reducing power and inhibition of lipid peroxidation was demonstrated by the extracts of *Calendula officinalis.* Considering the DPPH radical scavenging ability the highest and lowest percentage of inhibition was noted in the extracts of *Tamarindus indica* and *Vinca rosea* respectively. The present work reveals that the studied flowers are quite good sources of bioactives with promising antioxidant capacity. This could be used to combat oxidative stress which is identified as the major cause for the initiation and progression of inflammation and cell proliferation.

Key words: *Antioxidant activity, bioactives, edible flowers*

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Exploring the Constraints Faced by Stakeholders in the Value Chain of Organic Fertilizer in the North-Western Province of Sri Lanka

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Production to bypass the increasing demand of organic food products has become a challenge, because 'organic fertilizer supply' is not tally with the demand. This paper examines the stakeholder perceptions on key constraints they faced through the organic fertilizer value chain with special reference to the North-Western province of Sri Lanka. A personal interview-oriented survey was carried out with 140 stakeholders and selected using 'purposive sampling', including producers, stakeholders in value addition sector, storage facility providers, wholesalers, retailers, farmers and extension service providers using a semi-structured questionnaire comprised of 10-point likert-scale supported 25 constraints as attitudinal statements. The scores provided on the scale were subjected to Exploratory Factor Analysis technique to test for their 'validity' and then Aggregated Mean Scores were derived. The Cronbach's alpha value was used to test the 'reliability' and it was 0.74. The results revealed that those constraints can be catalogued objectively into 08 key factors as: Market, Technical, Production, Health & Environment, Financial, Human Resources, Institutional, and Government. Majority of stakeholders were largely affected by the first three factors, i.e. '*Market*' [Wholesalers (7.82), Value addition sector (7.47), Storage facility providers (7.33)]; '*Technical*' [Extension service providers (8.87), Producers (7.47), Retailers (7.46)], and '*Production*' [Farmers (7.02)]. Overall, the results highlight that, to create an effective mechanism that minimizes the effect of those constraints identified, setting novel technology-oriented production facilities with high market accessibility and differentiation of 'organic' from others in the market (e.g. certification, labelling etc.), regular monitoring, and regulatory enforcement is warranted to safeguard the industry.

Key words: *Constraints, organic fertilizer, stakeholder perceptions*

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Identification of Optimum Preculture Conditions Prior to Cryopreservation of *Innala* (*Solenostemon rotundifolius* (Poir.) J.K. Morton)

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Innala (*Solenostemon rotundifolius* (Poir.) J.K. Morton) is an important crop that needs to be conserved due to increased risk of cultivar loss in Sri Lanka. In case of long-term conservation, it can be effectively conserved via cryopreservation, as other *ex-situ* conservation measures are less effective for *innala*. The aim of this study was to develop a vitrification-based cryopreservation protocol for two *innala* accessions (TJ01 and TJ04) while assessing the effect of preculture medium and preculture duration on moisture content of tissue cultured samples and viability of cryopreserved samples of *innala*. Murashige and Skoog medium supplemented with three sucrose concentrations (0M, 0.3M, and 0.4M) for three durations (1, 2 and 4 week) were used for preculturing of *in vitro* grown *innala* shoots with 94.5-95 g/100g initial moisture content. After preculturing the excised shoots were dipped in loading solution, followed by ice-cooled ½PVS2 (plant vitrification solution 2), each for 15 minutes. Then shoots were directly plunged in liquid nitrogen for 24 hours and were soaked in unloading solution for 15 minutes subsequent to thawing at 40 °C. Finally, they were observed for 10-weeks after transferring to the regeneration medium. The viability of cultured shoots was tested using 2,3,5-Triphenyl tetrazolium (TTC). The highest moisture reduction in both accessions (18-23 g/100g) was resulted in 0.4M medium, for 4-week duration. It can be concluded that preculturing of shoots of accession TJ01 for 1-week in 0.3M medium as the most optimum combination exhibiting average of 57.58% viability for cryopreserved shoots and 80-100% survival for non-cryopreserved shoots.

Key words: *Accession, cryopreservation, innala, moisture content, Solenostemon rotundifolius*

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In vitro plantlet regeneration of Apple (*Malus domestica* Borkh.) from field grown plants in Sri Lanka

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Apple (*Malus domestica*), is a popular fruit crop in Sri Lanka. Favourable climatic conditions for apple cultivation exist in the local upcountry region where fruit bearing trees are reported. In this study, conditions for successful *in vitro* establishment of apple shoot tip cultures were evaluated using juvenile shoots from field-grown plants. Initial pre treatment with a systemic fungicide (0.2% w/v Captan) prior to shoot collection and a subsequent surface disinfection procedure using a fungicide (0.05% v/v Carbendazim) and different sterillants (20% Sodium Hypochlorite/Clorox and Tween20) was performed on shoot tip and nodal explants. Surface sterilized shoots were aseptically established on Murashige and Skoog's (MS) media having 0%, 0.05%, 0.10% v/v Carbendazim, with 10 replicates each for shoot tip and 20 replicates each for nodal explants. Assessment of contamination rate and survival percentages indicated that use of MS + 0.10% v/v Carbendazim is more suitable ($p < 0.05$) for *in vitro* culture establishment. Shoot multiplication experiments were conducted using different levels (0.0, 0.5, 1.0, 1.5 and 3.0 mgL^{-1}) of 6-Benzylaminopurine (BAP). Out of the treatments tested, 3mgL^{-1} BAP is the most suitable ($p < 0.05$) for multiple shoot induction (4.72 + 1.71) but produces dwarf shoots. However, 1mgL^{-1} BAP gives the highest mean number of shoots per explant (2.39+1.91) without reducing shoot height (2.58 + 1.31 cm). While further studies on root induction and acclimatization are ongoing, the present findings indicate the possibility to use *in vitro* techniques for producing apple plants locally as a promising prerequisite for establishing field cultivations.

Keywords: *Apple, BAP, carbendazim, shoot tip culture*

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Bioprospecting of indigenous lactic acid bacteria abundant in buffalo curd as a starter culture

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Traditional Sri Lankan buffalo curd is a good source of indigenous lactic fermenting bacteria. Due to the traditional undefined culture inoculation pattern in the buffalo curd production it has carried forward highly adaptive lactic acid bacteria which have the capability of controlling post-acidification and syneresis in curd. Thus, this attempt was directed towards the isolation of indigenous lactic acid microflora from artisanal buffalo curd to be used as a starter culture and checking their potential in producing high quality yoghurt with low post-acidification and low syneresis. Lactic fermenting bacteria were isolated from curd samples collected from small scale buffalo curd producers in areas such as Kantale, Suriyawewa, Tissamaharama, Ampara and Kurunegala using De Man, Rogosa and Sharpe (MRS) agar and M17 agar medium. Chemical and sensorial characteristic development capabilities of isolated monocultures were tested and their probiotic activity was evaluated by antibiotic susceptibility tests. The pH and titratable acidity of the coagulated yoghurts were checked to evaluate post-acidification and syneresis of the yoghurts were determined using the centrifugation method. Forty-eight lactic acid bacterial strains were isolated from different buffalo curd samples and out of them twenty isolates were able to coagulate tested milk samples. Ten monocultures showed low post-acidification and low syneresis in prepared yoghurt samples during cold storage. Therefore, these monocultures can be used to formulate polyculture based defined starter cultures for the production of fermented dairy products.

Key words: *Buffalo curd, monocultures, post-acidification, syneresis*

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Factors affecting adaptation of crop diversification by paddy farmers in '*Pavatkulam*' irrigation scheme, Northern Province, Sri Lanka

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Crop diversification is the process of cultivating more than one crop in a farm filed for a given period of time. Generally, insufficient water availability limits rice cultivation. Majority of farmers are reluctant to practice crop diversification due to high production cost and inadequate marketing facilities over non-rice crops. The present study was conducted to explore feasibilities and socio-economic constraints faced by farmers during crop diversification. Data were collected through piloted and validated questionnaire and supplemented with secondary data during *Yala* seasons in 2018 and 2019. The yield of paddy/acre increased 64% with introduction of non-rice crops cultivations inpaddy land ($r = 0.64$, $p \leq 0.05$) under '*Pavatkulam*' tank. There was apositive correlation between the income from paddy land along with crop diversification, where the mean net profit is Rs. 12,058/ac,withextent of cultivated non-rice crops ($r=0.58$, $p \leq 0.05$).The risk involved in water availability is high in study area and "Resource rich" farmers are benefitted from crop diversification by minimizing risk by having own-wells for irrigation. Findingsof this study indicated that inclusion ofcrop diversification in cropping agenda during *Yala* season increased yield of paddy and famers' income significantly ($p \leq 0.05$). However, majority were reluctant to adopt crop diversification practices. A conferrable portion of 'poor resource' farmers (31%), who did adopt crop diversification, gained an increase in their income by 30% from on farm agricultural activities. The constraints faced by 'poor famers' need to be alleviated by implementing government policies on extension of agro–based industries to absorb excess yield during harvesting period by maintaining reasonable price levels for diversified crops.

Keywords: *Crop diversification, 'Pavatkulam' irrigation scheme, Northern Province, Sri Lanka*

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Safe use of Pesticides – Investigating the knowledge gap of *Piper nigrum* Pepper farmers in Kandy District

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Sri Lankan Export Agriculture market faces frequent issues and trade barriers related to pesticide contamination. To secure the export market, Sri Lanka needs to strictly adhere to the global standards in agricultural exports. Research data is lacking on the pesticide usage of spice crop farmers in Sri Lanka hence this study aims to assess the awareness of Pepper (*Piper nigrum*) farmers on safe usage of pesticides. The main aim of this study is to assess the awareness of Black Pepper (*Piper nigrum*) farmers regarding the safe usage of pesticides. The study employed a qualitative research methodology and primary data collection was done through an interview survey with 80 farmers representing 20 Divisional Secretariat Divisions in the Kandy district. Findings of the study confirm the existence of a gap between expected and existing knowledge of farmers regarding the safe usage of pesticides. Their pesticide-use practices such as wearing safety clothes, disposal and storage were contrary to the expectations, despite their knowledge on the harmful effects of pesticides on humans and the environment. Study reveals that farmers mainly rely on agriculture extension agents, pesticide sellers and fellow farmers for information rather than the instructions in the pesticide container. According to the data, the most reliable source of information of the farmers is the recommendation of agriculture extension agents. Conducting awareness programmes for farmers on the safe use of pesticides through extension agents is the best method to overcome the problem.

Key words: *Pesticide, safety, awareness, pepper (Piper nigrum), farmers*

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Development and evaluation of the quality of a ready to serve (RTS) drink using Sea lettuce and *Annona muricata* L. (Custard apple)

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The food industry has shown the growing demand for healthy, nutritionally rich ready-to-serve drinks to satisfy the thirst while obtaining the health benefits. Furthermore, consumption of underutilized foods, rich in functional properties would lead to promote a healthy nutrient diet. Further, sea weed is an underutilized food source that behaves as rich nutritional delivery medium. Therefore, the present study focused on the development and quality evaluation of a RTS drink produced using custard apple and a model species: sea lettuce (*Ulva faciata*). Dried powder of *Ulva faciata,* 1.5%, 3.5%, 5.5% (w/v) enriched custard apple RTS drinks and a control sample (100% of custard apple) were tested to select the best combination of the RTS drink by conducting a sensory analysis using a 5-point hedonic scale. Chemical properties (Titratable acidity, pH and Total soluble solids) and proximate composition of the drink were determined according to the standard methods. Chemical and microbial quality changes of the drink were evaluated at the refrigerated (4-8°C) condition for the period of 21 days and the coliform test was performed to ensure the product. Results revealed that 1.5% (w/v) enriched custard apple RTS drink was the most acceptable in terms of overall acceptability and it contains 8.03±0.51% of proteins, 0.53±0.02% of fat, 88.58±0.15% of moisture, 0.65±0.11% of ash, 0.34±0.02% of fiber and 1.85±0.28% of carbohydrates. Titratable acidity, pH and TSS of the drink were 0.29% of citric acid, 3.47 and 10.70°Brix respectively. The drink fulfilled the SLS chemical and microbial requirements for 14 out of 21 days of storage period and *E. coli* was absent. Thus, the developed drink was microbiologically safe for human consumption for 3 weeks. As a conclusion, the RTS drink containing 1.5% (w/v) *Ulva faciata* dried powder and custard apple is rich in nutritional properties and can successfully be promoted in the society as a healthy drink.

Keywords: *Custard apple, RTS drink, Ulva faciata, proximate composition, Sensory properties*

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Effects of excess iron (Fe) on seed germination and early-seedling growth of five selected low land rice (*Oryza sativa* L.) varieties

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Fe content varies (470 – 1200 mg/kg) in the soil of the low-country wet zone (LCWZ) of Sri Lanka. Generally, rice plants grow in the presence of 60-300 ppm of Fe levels in soil. Therefore, iron (Fe) toxicity in the soil is one of the major constraints for rice production in the LCWZ. Thus, selection of rice varieties with tolerance to Fe toxicity is considered as a viable solution. However, most of the recommended rice varieties for LCWZ have not been systematically tested against Fe toxicity. In the present study, five recommended rice varieties for LCWZ were tested for the level of Fe tolerance at the germination and the early-seedling stages. Seeds and five-day-old seedlings of five varieties (Ld408, Ld371, Ld 368, Ld365 and Ld355) were exposed to different levels of Fe^{2+} namely 150 ppm (Control), 450 ppm, 650 ppm, 850 ppm, 1050 ppm and 1250 ppm at pH 5.5 for seven days respectively. The experiment was carried out in a modified flow and drain hydroponic system. There was a Fe^{2+} concentration-dependent significant ($P<0.05$) reduction in seed germination of the tested varieties compared to the control experiment. However, varieties Ld408, Ld371 and Ld365 showed more than 80% seed germination rates even at the highest Fe^{2+} concentration (1250 ppm). Therefore, results infer the comparatively higher tolerance in seed germination of Ld408, Ld371 and Ld365 in the presence of high level of Fe^{2+}. Four varieties except Ld368 showed significant increase in the number of roots in all the treatments compared to that in the control experiment. This indicates the presence of root initiation mechanism in those varieties even at the presence of Fe^{2+} in the growth media. The lowest leaf bronzing score (LBS) was reported in Ld408 under all the treatments indicating the presence of shoot tolerance mechanism under excess Fe^{2+}. The overall results infer the varietal-specific negative impact of excess Fe^{2+} on seed germination and seedling growth of rice. Among the tested varieties, Ld408 showed a higher tolerance to excess Fe^{2+} compared to the other four varieties evaluated in the study.

Key words: *Fe toxicity, seed germination, early-seedling, tolerant, low-country wet zone*

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The preliminary study on effect of music on the shoot development of chilli plant: *Capsicum annuum* L.

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Music promotes or restricts the growth of plants (depending on the type of music). Present study was conducted to investigate the effect of music on the germination and growth of chilli plants *(Capsicum annuum* L*)*. To avoid errors, homogeneous seeds from the variety Galkiriyagama were obtained from Gannoruwa seed certification and plant protection center, Kandy, Sri Lanka and the experiments were carried out under the green house conditions at the Department of Botany, University of Ruhuna, Sri Lanka. Two hundred eighty-eight seeds of *C. annuum* were selected randomly and were divided into 3 groups according to the 3 categories of music (classical-CL, rock-R, natural environment-I). Completely Randomized Design (CRD) was used with two replicates in such a way assign 48 seeds per replicate for each category. They were planted in six similar sized seed trays with equal amounts of soil which contained uniform mixture of compost and surface soil. "Group CL" was exposed to classical music; "group R" to rock music while "group I" was kept in silence treating as the control group. Music was supplied separately, every day from 7 am to 10 am and from 1 pm to 4 pm for 30 days continuously at a 10cm distance away from the seed tray with an intensity of 82 dB, maintaining equal environmental conditions. The number of germinated seeds, height of shoot and number of leaves were recorded. The measurement on shoot height was recorded once in 3 days. One-way ANOVA statistical test was used to observe whether there was a significant effect of the type of music on the height of the plant shoot. This statistical analysis showed that the mean height of the plant shoot was significantly different among the three groups ($p<0.05$). It was found that the chilli plants exposed to classical music showed the highest length of shoots and those exposed to rock music showed the least. Therefore, this study implies that classical music is the most appropriate type of music that improves the growth performance of *C. annuum.*

Keywords: *Variety, significant difference, germination*

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Investigation of the potential of *Piper chuvya* (Miq.) C. DC. as a healthy alternative for tobacco in cigar (bidi)

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Reduction of 'bidi' consumption in the society is essential as it causes severe impairments on human health due to the usage of tobacco as a filler in the product. This study was planned to introduce a potential alternative for tobacco used in cigar. Genus *Piper* is characterized by a prominent mucilage canal in internodes. An air exchanging region is formed by destructing of internodes mucilage canal tissues upon drying which allows smoke to pass through to one end of the internode while the other end continuously burn. Most suitable *Piper* species was selected by considering the diameter of air exchanging region of dried internodes. Internodes with higher diameter of air exchanging region pass more smoke through the internodes. Cross sections of oven-dried samples of the first four internodes from the tip were micro-photographed by Olympus BX43 Camera microscope and diameters of air exchanging regions were measured by "image-J" software to select the plant species and the internode with the highest diameter of air exchanging region by comparing the diameters of each species. A dried sample of the third internode of *Piper chuvya* had the comparatively highest diameter of air exchanging region of dried internodes. In this regard *P.chuvya* was selected in above test and it was treated with a *Curcuma longa* solution used as a healing remediation for respiratory disorders in Ayurveda, with the aim of developing a value added product. Along with that, non-treated plant sample and a commercial bidi sample were qualitatively analyzed by GC-MS method to compare the composition of the smoke followed by a sensory evaluation. Sixty untrained panelists including 30 smokers and 30 non-smokers were participated in sensory evaluation. Higher amounts of hazardous compounds such as Pentadecanoic acid and Octadecanoic acid were detected in the cigar smoke but less in *P.chuvya* smoke. The non-treated sample was favored by smokers in the sensory evaluation. It was revealed that non-treated *P.chuvya* can be developed as a healthy alternative for tobacco in cigar after investigating the health effects of the smoke.

Key words*: Healthy alternative, bidi smoking, sensory analysis, Piper chuvy*a

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Development of the low-cost cotton fabric based electroanalytical device for cadmium determination

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High levels of cadmium in water can affect the health of humans and animals adversely due to its toxicity and carcinogenicity. Onsite low-cost detection tools are extremely useful than common methods such as spectroscopic methods and potentiometric methods to determine water quality. This study was conducted to develop a low-cost, onsite, and eco-friendly microfluidic cotton fabric based electroanalytical device for the detection of Cd^{2+}ion in water. Cotton fabric is used as the platform for the device and the microfluidic device is fabricated using a graphite paste working electrode modified with coconut shell powder, stainless steel as the counter electrode, and a silver pseudo-reference electrode. The determination of Cd^{2+} was carried out using differential pulse anodic stripping voltammetry. The optimized conditions are 0.1 mol dm^{-3} HCl as the supporting electrolyte, 2 min deposition time, 100 mV pulse height, and 50 mV pulse increment. Due to the abundance of Cu^{2+} in water, interference of Cu^{2+} was investigated. The developed microfluidic device is capable of producing a linear correlation between peak current and the concentration of Cd^{2+} in the range of 20 - 200 ppm.The developed microfluidic device with a graphite paste working electrode modified using coconut shell powder can be used effectively for Cd^{2+} determination with the limit of detection of 0.11 mM.

Keywords: *Modified graphite electrodes, stripping voltammetry, microfluidic cotton fabric based devices*

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Fluorescence spectroscopy to identify quality of coconut oil and sunflower oil

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Scientists pay much more attention towards fluorescence spectroscopy as it is more sensitive and selective than other spectroscopic methods. The fluorescence techniques are widely used to identify the quality of foods such as milk, fruits, and water. The objective of this research is to investigate the correlation between fluorescence intensity and thermal degradation of coconut oil (Saturated fatty acids) and sunflower oil (an unsaturated fat). Coconut oil and sunflower oil were thermally degraded at constant temperature for different time intervals. The fluorescence intensity of fresh sunflower oil (12347.09 a.u.) was higher than fresh coconut oil (11052.13a.u.). In both oils, the fluorescence intensity decreased with thermal degradation. Furthermore, according to the correlation obtained between fluorescence patterns and thermal degradation of oils, it is clear that it is possible to use this technique to develop useful sensors to detect quality of coconut oil and sunflower oil.

Key words: *Fluorescence intensity, coconut oil, sunflower oil, food industry, sensor*

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Vulnerability assessment of the coastal zone of Sri Lanka to sea-level rise scenario; A GIS based study

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Coastal regions are impressionable to human-driven climatic change scenario and it exacerbates the coastal hazards and associated risks. This study therefore aimed at identifying and assessing the coastal vulnerability of Sri Lanka (2020) over the potential sea-level riseand storm surges. GIS-based study was carried out to identify the highly vulnerable coastal areas by using two criteria; coastal geomorphological slope and type of the coastal ecosystems (barrier effect).Google earth pro satellite imagery data with 750m eye altitude were used to extract the shoreline and contour lines at 0m, 2m, and 4m elevations. The image processing with ArcMap 10.3 coupled with field validation and community interviews were carried out subsequently. According to the results, the coastal areas without effective geographical barriers and with low elevation (angle < 5º) were identified as 'highly vulnerable areas". In terms of geomorphological slope, 81% of the Sri Lankan coast, particularly in northern and eastern coasts, is highly vulnerable to sea level rise scenario. Only 40% is highly vulnerable, especially southern and western coastal areas when barrier effect was considered. Overall, 1/3 of the Sri Lankan coast is at risk,when future sea level rise (30 cm by 2050: source IPCC) is considered. Some lagoons and estuaries where mangroves were removed, bays, river delta, coastal cities, roads, fishery harbours, industrial regions and ports were identified as places highly vulnerable for the sea level rise. Coastal inhabitants stated that many coastal changes have taken place in recent decades. Construction of mixed barrier models along with the coastal conservation is suggested as the most pragmatic solution for highly vulnerable areas in Sri Lanka.

Key words:*Climate change, geomorphological slope, coastal ecosystems, sea level rise, coastal protection*

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Synthesis and Characterization of Carboxylic acid Derivatives of Chitosan for Production of Nano Fibers

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Due to its easy availability and vast applicability, chitosan immerged as a prominent research interest in biomedical field, water purification, agriculture, food production and, cosmetics and skincare industry. Improved chemical characteristics of chitosan derivative nano fibers grabbed the attention of scientific community as it improves the applicability of the chitosan. In this study, Chitosan -aspartic acid, -lactic acid, -gallic acid and azelaic acid derivatives were synthesized. Obtained chitosan carboxylic acid derivatives were used to prepare nano fiber scaffolds using interfacial polymerization method. The molecular weight of the used chitosan was calculated using viscometric method and it was 2.15×10^6 g mol^{-1}. Characterization of prepared carboxylic acid derivatives of chitosan was done using UV-Visible spectroscopy and FTIR spectroscopy. The results suggested that derivatives were completely amide bonded and free from carboxylic acid salts of chitosan, ester bonded carboxylic acid moieties or free carboxylic acids. Solubility test suggested that all the derivatives showed better solubilities in common solvents compared to pure chitosan. Degree of substitution was calculated for aspartic acid and azelaic acid derivatives of chitosan and those were 0.12 and 0.35 respectively.

Key Words: *Interfacial polymerization, Nano fibers*

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Extraction, characterization of essential oil in leaf extract of *Toddalia asiatica*

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Essential oil is a mixture of low molecular weight constituents that are responsible for its characteristic aroma. They are used in several industries as raw materials such as perfumes, cosmetics, food flavor and pesticides *etc*. Objective of this project was to isolate and characterize the insect repellant volatile oil of *Toddalia asiatica* leaves. Essential oil from 40 g leaves of *Toddalia asiatica* was isolated by steam distillation. After the extracting of the oil qualitative tests were carried out for the detection of functional groups present. 2,4-dinitrophenyl hydrazine test revealed that the essential oil contained carbonyl functionality. In order to determine the components present in essential oil extracted, GC-MS analysis was done. Main constituent present in essential oils are trans-ethoxy-1-butene (53%), limonene (9.8%), 3-mthyl-2-butenal (4.8%), 2-metheyl-2-hexene (2.5 %), caryophylline oxide (1.3 %), bis(2-ethylhexyl) phthalate (6.4 %) and other minor components by GC yield. This results shows the essential oil of leaves of *T. asiatica* contained well-known insect repellant compounds.

Key words: *Toddalia, essential oil, limonene, steam distillation*

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Determination of measurement uncertainty in chloride analysis in groundwater by APHA 4500Cl- method

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Testing laboratories must be able to provide reliable results when performing analytical tests for clients or for regulatory purposes. The concept of measurement uncertainty has become important in the area of analytical quality, providing a single measure of accuracy of analytical results. Chloride (Cl^-) ion- is one of the major inorganic anions in water and wastewater. Chloride content of the Jaffna district is varying from 200mg/L to 1200mg/L depends on the location of the area. In this study all possible uncertainty sources associated with testing of chloride in groundwater is taken into account. The measurement uncertainty sources are grouped according to input quantities and schematically presented in the form of the so-called "fish-bone" diagram. Sampling and analysis of groundwater chloride is done based on methods stipulated by American Public Health Association (APHA). "A grade" volumetric apparatus were used for the analysis and analytical balance was calibrated by accredited calibration laboratory. The titrant $AgNO_3$ was standardized by the primary standard (NaCl, Normality 0.0141, purity 99.9%). Groundwater samples were collected from various location of Jaffna district and chloride concentration was determined. Uncertainty of standardization of titrant $AgNO_3$, Sample measurement, Volume of titrant $AgNO_3$ are 0.0142, 0.0035, 0.0033 respectively and combined uncertainty is 7.1mg/L for chloride concentration of 473.7mg/L. It was found that 473.7 ± 14.2, K=2, which is around 3% of chloride concentration. The uncertainty associated with standardization of titrant $AgNO_3$ is comparatively high.

Key Words: *Measurement uncertainty, Chloride, standard solution*

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Quantification of heavy metals in some rice varieties of South Korea and Sri Lanka and assessment of potential health risks to human

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Asia is the biggest rice (*Oryza sativa*) producers and consumers among the global population. Arsenic, Lead and Cadmium are some toxic heavy metals mostly reported in the Asian rice. Heavy metals can affect human health and lead tonumerous health issues. Study was conducted to assess the heavy metal toxicity of rice obtained from Sri Lanka and South Korea. Five parboiled rice samples representing five different areas in South Korea and 13 rice varieties (SL1- Samba, SL2- Kekulu white, SL3- Kekulu white, SL4- Keeri samba, SL5- Samba, SL6- Nadu red, SL7- Kekulu red, SL8- Kekulu samba, SL9- Kalu heenati, SL10- Madathawalu, SL11- Suwandel, SL12- Pachchaperumal and SL13- Nadu white) from the North Central Province of Sri Lanka were tested for As, Pb and Cd. Rice samples were digested using the microwave digestion system and tested for heavy metals using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Concentrations of the three metals of all 18 samples were below than the maximum acceptable levels, As (700 ppb), Pb (200 ppb) and Cd (200 ppb). SL10 from Sri Lankan samples showed the maximum As level, 144.56 ppb while SL6 contained the maximum Pb level, 29.25 ppb and SL11 showed the maximum Cd level, 78.02 ppb. The potential health risk to human body was calculated based on the Provisional Tolerable Weekly Intake (PTWI) for different sampling regions separately. Acceptable Estimated Weekly Intake (EWI) values per capita of all the regions were lower than the actual weekly consumption. Hence the consumers are safe from As, Pb and Cd through consumption of rice from the tested areas.

Key words: *Rice, heavy metals, ICP-MS, PTWI*

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Homeostatic model assessment of a Sri Lankan polyherbal mixture in streptozotocin induced diabetic rats

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The homeostatic model assessment of insulin resistance (HOMA-IR) and homeostatic model assessment of β-cell functions (HOMA-β) are being recognized as important indices in evaluating the preclinical efficacy of novel antidiabetic agents. The present investigation was aimed to evaluate the effect of hexane extract of a Ayurvedic polyherbal mixture made from *Allium sativum* L. (cloves), *Murraya koenigii* L. Sprengel (leaves), *Piper nigrum* L. (seeds) and *Garcinia queasita* Pierre (dried fruits) on insulin resistance and β-cell functions in streptozotocin (65 mg kg^{-1},ip) induced diabetic rats. Insulin resistance and β-cell functions were evaluated using HOMA-IR and HOMA-β indices respectively. Wistar rats(b.w: 220 ±20 g, 10-12 weeks of age) were divided into four groups (n=6/group). Group one and two were healthy untreated control rats, and diabetic untreated control ratsand received distilled water. Group three and four were diabetic rats and treated with glibenclamide (0.5 mg kg^{-1}) and hexane extract (25 mg kg^{-1}) daily for 30 days, respectively. On the 30th day, fasting (8h) serum glucose and insulin concentrations were estimated, HOMA-IR and HOMA-β were calculated and the results were compared with respect to the diabetic control, statistically by one-way ANOVA followed by Dunnett's post hoc test. An improvement was observed in HOMA-β index of hexane extract treated rats (75.9 %) and glibenclamide treated rats (79.5 %) (p<0.05). The HOMA-IR index of the glibenclamide and the hexane extract treated rats was lowered by 25.4 and 23.4 % respectively. In conclusion, the hexane extract of the polyherbal mixture possess potent preclinical efficacy as indicated by the glucose homeostasis model assessment by up lifting β-cell functions while lowering the insulin resistance in diabetes rats.

Key words: *Clinical efficacy, hexane extract, homeostasis model, diabetes mellitus, polyherbal mixture*

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Removal of fluoride and hardness from natural water using KOH activated carbon

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Prolonged intake of drinking water having excess fluoride and hardness can cause adverse health effects such as fluorosis, cancer, arthritis, and kidney diseases. In the present study, potential of KOH activated carbon (KOH-AC) derived from coconut coir dust, was evaluated for removal of excess fluoride and hardness in natural water in batch process. Clean dry coconut coir (30.0 g) was treated with KOH, pyrolysed at 450 °C under nitrogen atmosphere. The KOH-AC (yield-31%) has a MB number of 392.74 mg g^{-1}, iodine value of 590.29 mg g^{-1}, surface area of 100.285 m^2 g^{-1} and pH$_{PZC}$ of 6.58. The PXRD confirms the existence of graphitic amorphous structure, while FT-IR spectrum revealed that the functional groups present in raw coir retained in KOH-AC. Experiments were carried out with a standard NaF solution (3.0 ppm) and natural hard water (total hardness = 400 ppm) to optimize adsorbent dose, contact time and pH of adsorbate for maximum removal of fluoride and hardness, respectively. All experiments were triplicate. The highest fluoride removal of 79% was achieved from 3.0 ppm NaF solution with 8 g L^{-1} of KOH-AC and 30 min contact time at a pH of 2. The highest total hardness removal of 90 % from above natural water was achieved using 2 g L^{-1} of KOH-AC and 60 min contact time at higher pH values (8-10). When natural hard water samples (total hardness > 300 ppm) collected from 6 sites were treated with KOH-AC, total hardness was reduced by 50% and fluoride by 27%.

Keywords: *KOH-AC, Water softening, Defluoridation, Adsorption*

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Survival of Skin Resident Bacterial Flora (SRBF) in the presence of facial cleansers

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Human skin has a balanced Skin Resident Bacterial Flora (SRBF) which is beneficial for healthy skin maintenance and different factors are responsible for their well-being. Since facial cleansers are such potential factors as a widely used personal care product, their effects on human facial SRBFwere studied in terms of toxicity. A dose- response analysis was performed by exposing *Staphylococcus aureus* and *Staphylococcus epidermidis*, which represent human facial SRBF, to a commercially available facial cleanser containing a high number of chemical ingredients, at eight different concentrations from 100 mL L^{-1} to 0.1 mL L^{-1}. The concentrations were prepared depending on previous data of the average amount of cleanser usage at once. The percentage survivals and the EC_{50} values calculated according to the bacterial growth were compared to evaluate the toxic effect of the cleanser. The percentage survivals of both the test organisms were decreased with time when increasing the test concentrations.The EC_{50} values for *Staphylococcus aureus* were decreased from 2.928 mL L^{-1} to 0.5717 mL L^{-1} and the EC_{50} values for *Staphylococcus epidermidis* were increased from 1.761 mL L^{-1} to 19.34 mL L^{-1} from 24 h to 48 h resulting more toxic effect towards *Staphylococcus aureus* compared to *Staphylococcus epidermidis*at the end of the incubation according to the EC_{50} values.The product was negatively affected on the survival of both the test organisms at higher concentrations without any significant difference in the toxic effect at both the time intervals (P= 0.063) with revealing the necessity of future aspects.

Key words: *Skin resident flora, Facial cleansers, Toxicity, $EC_{50,}$ Percentage survival*

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Removal of phenol from synthetic wastewater using Ag nanoparticles loaded on Gamboge (*Garcinia Gummi-gutta* L.) based Activated carbon

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In the present study, silver nanoparticles (AgNPs) were successfully synthesized through a green route using an aqueous extract of *Garcinia gummi-gutta* L. in which aqueous extract acts as **a** capping, stabilizing and reducing agent. Activated carbon (AC) was prepared using gamboge and two activating agents: $ZnCl_2$ and H_3PO_4 in order to explore AgNPs loaded onto Gamboge based AC for the removal of phenol from synthetic wastewater. The synthesized AgNPs were characterized using Ultraviolet-visible spectroscopy (UV-Vis) which exhibits a characteristic wavelength at 422 nm. Dynamic light scattering (DLS) analysis showed that AgNP clusters have an average diameter of 104.4 nm. AgNPs loaded onto AC were used to remove phenol from synthetic wastewater through photocatalytic degradation. AgNPs loaded onto AC prepared using $ZnCl_2$ have higher removal efficiency for phenol when compared with AgNPs loaded onto AC prepared using H_3PO_4 at optimized experimental conditions. The highest phenol degradation efficiency, 80.13 % was detected with AgNPs loaded onto AC prepared using $ZnCl_2$ under optimum conditions of pH 7, photocatalyst dosage of 5 g L^{-1} and initial concentration of 100 mg L^{-1} in irradiation time of 6 h. Results of this study suggested that AgNPs loaded onto AC prepared using a low cost biomass, Malabar tamarind (Gamboge), can be efficiently utilized for the removal of phenol from wastewater.

Keywords: *Silver, nanoparticles, Gamboge, activated carbon, phenol*

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TiO$_2$ Coated Glass Beads for Photocatalytic Degradation of Methylene Blue

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Availability of clean water has become a global issue due to the pollution of water bodies. Anatase form of TiO$_2$ powder is reported as a photocatalyst for degradation of many organic pollutants. Separation of anatase powder from water is difficult. Therefore, the objective of this research was to develop anatase coated glass beads (9.5mm) and to study their photocatalytic activity on aqueous solutions of methylene blue under solar irradiation. Experiments were carried out in triplicate. Concentration of methylene blue solutions were determined using UV-VIS absorption spectroscopy (λ_{max} = 658 nm). Surface of glass beads modified with HF acid (5 % v/v) were coated with anatase and air-annealed at 450 °C. Average weight of the coating of a glass bead was 0.03 g. Powder XRD showed presence of anatase only. SEM showed porous morphology. Rate of degradation of 10 ppm methylene blue increased twice when number of glass beads increased from 5 to 10. Rate of degradation decreased 4.5 times when concentration of methylene blue increased from 5 to 20 ppm. Annealing temperature at 650 °C did not affect the photocatalytic degradation rate of methylene blue (10 ppm). Reusability studies on glass beads used for three times showed almost the same photocatalytic efficiency. 100 % photocatalytic degradation of 10 ppm methylene blue solution occurred in 100 min. (10 glass beads). Control experiments showed the requirement of anatase coating and solar irradiation. Coated glass beads prepared at 450 °C in the above manner is suitable to degrade methylene blue under solar irradiation.

Key words: *Anatase, photocatalysis, glass beads, methylene blue*

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Effect of glycerol and chitosan on physicochemical and microstructural properties of kithul (*Caryota urens*) starch films

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Edible film formation ability of kithul starch and chitosan with and without glycerol as a plasticizer and the corresponding physico-chemical, structural, and morphological characteristics of films produced were assessed in this study. Kithul starch extraction yield from kithul flour was $64 \pm 0.54\%$ and showed monoclinic structure crystallinity (type A pattern) by XRD. Granule morphology (shape, size, surface appearance) of kithul starch showed a wide range of spherical shapes with a small portion of oval and irregular globules by SEM. The average lengths of spherical, oval and irregular globular granules were 19 µm, 59 µm, and 28.67 µm and the average widths were 18 µm, 33µm, 20.89 µm respectively. Films were produced by solvent casting methodology where glycerol and or chitosan were added at varying concentrations viz., 0.4%, 0.9%, 1.4% and 1.9% (w/w). Film thickness, moisture content, film solubility, moisture content was measured and found a gradual incremental effect with the variation of higher glycerol concentration. Film opacity and swelling index decreased with increasing glycerol concentration. The intensity variation of XRD peaks revealed that the crystallinity of starch films was increased with glycerol concentration. In SEM analysis of kithul starch films, surface roughness and unevenness were increased with glycerol concentration. In kithul starch/chitosan films higher sticky nature and wrinkles have developed with the increase in chitosan content. Further studies are needed to prove the films containing kithul flour are a promising material for use as packaging material for maintaining food safety and extending the shelf life.

Key words: *Kithul starch, bio-gradable films, physicochemical, microstructural properties, opacity*

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Study of the effectiveness of six-week upper body strength training programme on upper body strength of baseball players in Sri Lankan Tri Forces

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The purpose of this study is to determine the effectiveness of an upper body strength training programme to increase upper body strength of baseball players of the Tri Forces in Sri Lanka. Thirty athletes, aged (29 ± 7) and BMI (24 ± 1) were recruited for a 6-week training programme. Before commencing the programme, athletes were randomly assigned to one of two training groups: a control group (n=15) and treatment group (n=15). The upper body weight training programme was followed by the treatment group. The control group engaged only in their regular baseball training. Upper body strength was measured by using One Repetition Maximum (1RM) bench press test. Both test results were evaluated by using pre-test and post-tests. Pre and post 1RM bench press test results of the treatment group which engaged in the upper body weight training programme was significantly different ($p<0.0001$). Furthermore, a significant difference exists between pre-test and post- test results in the control group as well ($p<0.0001$). However, the difference is much less than the treatment group's 1RM bench press data. Therefore, the study concludes that the upper body strength training programme increased the upper body strength of baseball players of Sri Lankan Tri forces.

Keywords: *1RM bench press test, upper body strength, weight training programme, baseball*

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Perceptions of Beche-de-mer market actors on Sri Lanka standard specification (2018)

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Beche-de-mer (processed sea cucumber) is produced primarily at small-scale processing plants. To get high competitive price at the export market, Sri Lanka Standard Institute has recently developed beche-de-mer processing standard which guides beche-de-mer market actors. Prevailing high diversity of processing methods do not lead Sri Lankan market actors to adhere to better management of infra-structure, reduction of cost and time during processing. Present study aims to explore degree of adherence and determine the perceptions by beche-de-mer market actors for the Sri Lanka standard specification. Therefore, perceptions of beche-de-mer market actors on the proposed standard were evaluated, and the study was conducted with randomly selected 50 fishers and 25 processors including exporters in Northern Province by using interviewer administered questionnaires separately. Data were statistically analysed using SPSS 16.0 and Minitab18. The results show that all processors strongly agreed to all 15 standards regarding cleaning, type of water, cleaning of water, contaminant, evisceration, processing, salting, hygiene, storing, food additives, drying, packaging, physical requirement, appearance and shape. While fishers strongly agreed to latter 10 standards regarding cleaning, type of water, cleaning of water, contaminant, evisceration, processing, salting, hygiene, storing and food additives. Further, all the processors have positive attitudes, while 30% of fishers have negative attitudes towards the standard. Responsible authorities need to conduct strong awareness programmes to create more positive attitudes towards the standards that may uplift sea cucumber industry to international standards.

Keywords: *Beche-de-mer, degree of adherence, Sri Lanka standard specifications*

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An investigation of some factors associated with injuries of university rugby players in Sri Lanka

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Rugby players face a higher risk of injury compared to other athletes. This study was conducted to understand the key factors associated with injuries of university rugby players. The study was conducted as a census study. The sample consisted of 100 players who took part in the Sri Lanka University Games 2019 Rugby competition. The participants were in the age range of 23 ± 3 years, free from injuries for 6 months before the start of the season, and free from systemic injuries. Data were gathered using a pre-validated, structured, self-administered questionnaire. Out of 100 total responses, 76 players sustained injuries and 28.9% of them had recurrent injuries. Of the injured players, 65.8% were given field-side treatment by a qualified medical professional and 76.3% were referred for further medical attention. Almost half of the injuries were sustained during matches and 52.8% of those injuries occurred in the second half of the game. Majority of the injuries were caused due to contact and more than half of the injuries were trauma injuries. A majority (63.2%) of the players had not worn stipulated protective gear. There were significant associations between injury incidence and injury recurrence (p=0.003), contact injuries and aspect of play (training or match) (p=0.013), and contact injuries and type of injury (p=0.002). According to the findings, physical conditioning, skills practice, match situation-related practice and developing knowledge of the mandatory use of protective gear could be identified as the key areas that could be addressed to minimize injury incidence in inter-university rugby.

Keywords: *Injury prevalence, injury surveillance, university rugby*

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Sports nutrition knowledge and dietary habits of Sri Lanka national-level basketball athletes

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Nutrition has a direct impact on the performance of national-level basketball players. This study aimed to examine the nutrition knowledge and dietary habits of national basketball male athletes. The sample included 30 subjects (age range: 20-25 years; mean BMI: 22.1 kgm^{-2}) who represented Sri Lankan men's national basketball team. The sports nutrition knowledge and dietary habits of participants were assessed using a self-administered questionnaire. Nutrition knowledge questions focused on energy and refuelling, hydration, supplements, and protein intake. The mean nutritional knowledge score of participants was 53%. Participants' knowledge of supplements was inadequate (mean score for the section: 37%). Regarding dietary habits, 16 participants (53%) consumed high-carbohydrate foods after training/competitions while majority of athletes consumed high-protein foods before (n=20, 67%) and after (n=25, 83%) training/competition. Meal skipping was not common in all participants. The majority of participants (n=28, 93%) consumed fluids before, during and after exercise. Fourteen participants (47%) reported consuming alcohol. Dietary supplements use was reported in 43% of participants (n=13). It can be concluded that the participants of this study showed a moderate level of sports nutrition knowledge. Overall, the national male basketball players showed healthy dietary habits that help improve sports performance.

Keywords: *Basketball, dietary habits, nutrition knowledge*

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Barriers related to delay in seeking medical advice among patients with chicken Pox: A hospital based study

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Chickenpox is a common benign illness caused by varicella-zoster virus. Delayed initiation of treatment for chicken pox is known to delay the healing process and increase the days of hospitalization. The aim was to describe the barriers related to delay in seeking medical advice among patients with chicken pox admitted to the Isolation Unit of National Institute of Infectious Disease (NIID), Angoda. A descriptive cross-sectional study was conducted at the Isolation Unit of NIID, Angoda. Two hundred and fifty adult patients were recruited to the study. Ethical approval was obtained from Ethics Review Committee of Lady Ridgeway Hospital prior to data collection. Interviewer administered questionnaire was used to collect data and Statistical Package for Social Sciences (SPSS) was used to analyze the data. Majority of the participants 82.4% (n=206) believed that it is not necessary to seek medical treatments as chicken pox will cure spontaneously. One hundred eighty-five participants (74%) were influenced by others not to seek medical treatments. Sixty-five participants (26%) had not sought early medication due to difficulty in transportation while 61 (24.4%) had no help to seek medication. Forty-seven participants (18.8%) have not taken medical treatments since they wanted to hide their illness from others. Forty-four (17.6%) were alone at the home and 69 (27.6%) participants had economical difficulties for seeking early medication. Personal belief of the participants and influence by others play a major role in delay in seeking medical advice for chicken pox. An awareness programme is highly recommended to reduce these barriers and improve community awareness on Chicken pox and seeking early medical advice.

Keywords: *Barriers, delay in seeking medical advice, chicken pox*

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Demographic transition in Sri Lanka: an analysis of population and vital statistics 1981-2019

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Demographic factors and their transition are important to make effective decisions regarding the public health of a country. Therefore, the objective of this study is to identify the transition of the demographic factors in Sri Lanka over the past 3 decades and especially in census years. We considered the data from 1990 to 2019, and the census year 1981. Bar charts, stacked bar charts, line graphs, population pyramids, maps, and radar graphs were used to visualize these data. According to the results, the total population in Sri Lanka has increased up to 2018. The working-age population and the old-age dependency ratios have also risen in Sri Lanka. Colombo, Gampaha, Kurunegala, Kandy, and Kaluthara were observed as the districts with the highest population in 1981, 2001, 2012, and 2019. Sinhalese and Buddhists have the maximum population, and it was noticed that the birth and the annual population growth rates have decreased while the death rate has increased. Adult female, adult male, under 5, and infant mortality rates have also decreased but the infant mortality rate is very low, and the adult male mortality rate is very high. A life expectancy year at the birth of a male is always lower than that of a female. Furthermore, the survival to age 65 of the female is greater than that of males. Finally, the fertility rate fluctuates over 3 decades in Sri Lanka. It can be concluded that Sri Lanka is currently experiencing a demographic bonus and immediate actions should be taken to use this window opportunity effectively.

Key words: *Demographic, fertility, mortality, Sri Lankan population census*

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Investigation of physical fitness and body composition profiles of elite karate Kumite athletes in Sri Lanka

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In Sri Lanka, most karatekas and coaches give less attention to physical fitness components and body composition as a means of improving performance. This study aimed to assess the physical fitness and body composition profiles of elite male and female karate Kumite athletes and investigate the relationship between these two. The participants were male (n=25) and female (n=18) karate Kumite athletes in the Sri Lankan National pool. The tested physical fitness components include agility, flexibility, reaction speed and leg power. The body composition of each participant was determined using bioelectrical impedance. Body composition and physical fitness profiles of male and female athletes were compared using the Mann-Whitney U test. Relationships between body composition and physical fitness parameters were determined using Spearman correlation. All statistical analyses were conducted at 5% level of significance using SPSS. Physical fitness levels of national-level Kumite athletes are above average or near excellence compared to standard norms. Female athletes have significantly higher ($P<0.05$) subcutaneous and total fat percentages compared to males. Male athletes have significantly higher ($P<0.05$) skeletal muscle mass compared to females. A strong positive relationship ($P<0.05$) exists between leg power and skeletal muscle mass of participants. Subcutaneous and total fat percentages show a strong negative correlation ($P<0.05$) with leg power. Thus, the leg power of participants is positively affected by skeletal muscle mass whereas it is negatively affected by body fat.

Keywords: *Kumite, body composition, physical fitness*

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The Antioxidant potency of the methanolic leaves extract of *Pancratium zeylanicum* L. (Wal Lunu)

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Non-communicable diseases have been responsible for most global deaths, and cancer has become the second leading cause. As modern synthetic drugs and other medications lead to unbearable side effects, the focus has been directed towards natural plant-based remedies. Having a rich history of Ayurveda treatments and ancestral knowledge, Sri Lankan traditional practitioners use natural plant-based remedies to treat and cure cancers. Natural plants with potential antioxidant properties may yield promising therapies for cancer treatments. According to the information gathered from traditional medical practitioners of Sri Lanka, *Pancratium zeylanicum* (Wal lunu) is a valuable medicinal plant used to treat cancer patients. This study's objective was to determine the antioxidant activity of a traditionally reputed plant for anticancer properties in Sri Lanka. The plant was collected from Anuradhapura district according to the traditional medical practitioner's guidance. In vitro DPPH (2,2-diphenyl-1-picrylhydrazyl) antioxidant assay was carried out to methanol extract of *P. zeylanicum* leaves and standard ascorbic acid (positive control). *P. zeylanicum* leaves showed an IC_{50} value of 0.02g/ml. In comparison, standard ascorbic acid IC_{50} was 0.019g/ml. These experimental results reveal that *P. zeylanicum* leaves extract poses high potent antioxidant activity. Therefore, it can be further investigated for medicinal properties that can be used in cancer therapies.

Keywords: *P. zeylanicum, Antioxidant activity, Traditional Medical Practitioners, DPPH, Sri Lanka*

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Establishment of a cord-blood bank and possibility of using genetically regulated hematopoietic stem cells through transcription factor mediated differentiation system: an internet-based study

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System level priorities need to be implemented on cancer control and prevention as around 78% upsurge in new cancer cases are predicted by 2030 in Sri Lanka. One such priority is developing capacity of national health researchers to use genetic advancements in manipulating biologics for cancer treatment. The objective of this study is to highlight the clinical implications of establishment, development and effective Patient, Public Involvement and Engagement (PPIE) in a Cord Blood Bank (CBB), thereby, facilitating the use of genetically regulated Hematopoietic Stem Cells (HSCs) through Transcription Factor Mediated Differentiation System (TFMDS) derived from Umbilical Cord Blood (UCB) as a novel, state of the art approach in restoring post oncological patient immunity in Sri Lanka. Published literature in PubMed and Google-Scholar on the effect and impact of HSC, UCB, CBB and application of TFMDS genetic regulation in clinical oncology was analyzed. Analysis showed that application of TFMDS to *RUNX1*, *FOSB*, *SPI1* transcription factors in HSC triggers formation of *CD43+* cells contributing to enhanced immunity. Furthermore, UCB is an excellent source of HSC due to speedy availability and reduced incidence of graft versus host disease allowing transplantation of grafts with limited HLA disparity, extending donor pool. Authors suggest that establishment of a CBB and recruitment of UCB to obtain and administer genetically regulated HSCs through TFMDS as an effective clinical tool in boosting collapsed immunity in pediatric and geriatric post oncological patients. Remarkable stress is suggested on strategies to implement PPIE in this regard, allowing practicality in Sri Lankan context.

Key words: *Cancer-Immunity, Sri Lanka, HSC, CBB, TFMDS*

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Antifungal activity of *Psidium guajava*, *Musa* sp. and *Vigna radiata* against *Candida albicans*

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Psidium guajava (Guava) and *Musa mysore* ("Embul" banana) are common tropical fruits while *Vigna radiata* (Green grams) is a commonly consumed grain in Sri Lanka. *P. guajava* has been used for medicinal purposes since ancient times. But the medicinal value and therapeutic potential of them against fungal infections have not been proven scientifically. This study aims to determine the antifungal activity of the aqueous extracts of *P. guajava* leaves, *M. mysore* fruit, and *V. radiata* seeds for their antifungal activity against *Candida albicans* (ATCC 10231). The agar well diffusion assay method has been used in the study. The percentage Zone of inhibition (ZOI) of each extract was determined after incubating the extracts for 48 hours at 37℃. The potency of each extract was determined against Nystatin which was used as the Positive control. When compared with Nystatin (100 mg/mL) *P. guajava* exhibited a considerable inhibition at 500 mg/mL. The percentage ZOI according to the concentration of 500 mg/mL, 250 mg/mL and 125 mg/mL was calculated as 91.33%, 68.8%, and 55% after 24 hours and 50%, 42.5%, and 38.75% after 48 hours, respectively. *M. mysore* fruit, and *V. radiata* did not exhibit any zone of inhibition even at 500 mg/mL after the incubation at 37°C for 24 and 48 hours.
The phytochemical analysis revealed that, both aqueous and methanolic extracts of *P. guajava* contains Triterpenoids, Cardiac glycosides, Alkaloids, reducing sugars, and *Musa* sp. contains Cardiac glycosides and Flavonoids. *V. radiata* shows a trace amount of Cardiac glycosides in methanolic extracts and moderate amount of Saponins in aqueous extracts. Hence, it can be stated that *P. guajava* leaves is a potent antifungal against *Candida albicans*, and it can be used to develop new antifungal agents against *Candida* infections.

Keywords: *Antifungal, Candida albicans, aqueous extracts, Psidium guajava*

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Investigation of physico-chemical and phytochemical properties of different extracts of *Eclipta prostrata* (Linn.) grown in Sri Lanka

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Eclipta prostrata (Linn.), commonly known as '*keekirindiya*' in Sinhala and '*karippan'* in Tamil belongs to the family Asteraceae. Even though *E. prostrata* is used in traditional system of medicine in Sri Lanka, a detailed pharmacognostical study has not been carried out for the plant of Sri Lankan origin. Powder microscopy and detailed anatomical characteristics of *E. prostrata* were reported in our previous study. Depending on the geographical differences, environmental factors and availability of macro- and micro-nutrients, presence of secondary metabolites and their quantities might change. Thus, the aim of this study was to investigate the physico-chemical and phytochemical properties of different extracts of *E. prostrata* grown in Sri Lanka and Thin Layer Chromatography (TLC) fingerprinting. Whole plant was sequentially extracted into hexane, dichlolomethane, ethyl acetate, methanol and water using continuous Soxhlet extraction. Physico-chemical and phytochemical analysis were performed as per standard protocols. Total ash, acid insoluble and water-soluble ash content were 17.1± 0.3%, 0.4± 0.0% and 9.5± 0.2%, respectively. Water extractable matter (cold: 6.0± 0.0%, hot: 7.9±0.1%) was higher than that of ethanol extractable matter (cold: 1.0±0.0%, hot: 1.8±0.1%). Flavanoides, tannins, saponins, monoterpenes, quinones, steroids, coumarins, cardiac glycosides and phenolics were found in hot aqueous and methanol extracts. Sesquiterpenes, steroids, oil and fats were found in hexane, dichloromethane and ethyl acetate extracts. The TLC fingerprinting revealed an abundance of secondary metabolites in different fractions of *E. prostrata*. Further studies are warranted to isolate and characterize medicinally important compounds from different parts of *E. prostrata* grown in Sri Lanka.

Keywords: *Keekirindiya, Karippan, TLC fingerprinting, secondary metabolites*

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The effect of upper and lower limb fat percentages on the performance of butterfly stroke in under-19 national level male swimmers

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Swimming can be categorized in to four major styles, i.e., breaststroke, back stroke, butterfly stroke and front crawl. Current Sri Lankan Swimming shows great improvements in butterfly stroke with respect to the world level. This study has focused on butterfly stroke performances with upper and lower limb fat percentages. Apart from high performances, coaches always have a secondary objective to decrease the amount of fat. Therefore, this study was carried out to explore the impacts of body fat on butterfly stroke performances. In this study, thirty (30) under-19 national swimmers were selected randomly and were asked to perform the 50m butterfly with jump start and data was collected using observational method on under-water distance, number of underwater kicks, stroke count and time taken to complete the 50m course. Then the body fat percentages were measured by using a bio-impedance analyzer. According to the analysis, underwater distance per kick (Mean = 1.12m ± 0.19, range 0.72–1.47 m, $r^2 = 0.72$, $p<0.01$) and when stroke frequency (Mean= 0.854 ± 0.131, range 0.798-0.897) added to the model, r^2 explained 0.85 variance. These two parameters were the major contributors for high performances. Moreover, underwater performances had a critical impact on 50m Butterfly Swim time ($r= 0.86$, $p<0.01$). Furthermore, results showed that to have a better performance underwater, it is ideal to maintain upper limb fat percentages between 17 and 22, and lower limb fat percentage between 15 and 21. To have a better surface swimming performance it is better to maintain an upper limb fat percentage within the range18-22. Finally, it was concluded that both underwater and surface swimming performance variables had mixed impacts on overall performances.

Keywords: *Butterfly stroke, upper limb, lower limb, performance, fat percentage*

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The effect of a 24-session Pilates training programme on core strength, leg power and flexibility of school-level sprinters

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This research was conducted to determine the effect of Pilates training on core strength, leg power and flexibility of school-level sprinters. The major objective was to compare the effect of Pilates training on core strength, leg power and flexibility of male and female school-level sprinters. Under-16 male (n=12) and female (n=18) sprinters participated in 24 sessions of Pilates training, three times per week. Each exercise session focused on the core strength, leg power and flexibility, and those characters of each of the participants were measured before and after the training programme. Core strength was assessed using trunk flexor endurance test, trunk extensor endurance test, right trunk lateral endurance test and left trunk lateral endurance test. Leg power was assessed using the vertical jump test. Flexibility was measured using the sit-and-reach test. Pre- and post-test results were compared using the Wilcoxon Signed-Ranks Test. Mann-Whitney U-test was used to compare improvements in test parameters of male and female subjects. Strength, leg power and flexibility of both male and female sprinters were significantly greater (P<0.05) after the 24-session Pilates training programme compared to before training. The improvement in leg power, flexibility, trunk flexor endurance, right-trunk lateral endurance, and left-trunk lateral endurance was not different (P>0.05) in male and female groups. The improvement in trunk extensor endurance was greater (P<0.05) in males compared to females. It can be concluded that the 24-session Pilates exercise programme was equally effective in improving core strength, leg power and flexibility of both male and female Under-16 sprinters.

Keywords: *Core strength, flexibility, leg power, Pilates training*

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In vitro antioxidant activity of different solvent extracts obtained from *Leea indica* (Burm.f.) Merr (Burulla) leaves grown in Sri Lanka

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The importance of natural antioxidants has been arisen due to the carcinogenic nature of the synthetic antioxidants. *Leea indica* (Burm.f.) Merr. is a medicinal plant used in traditional Ayurvedic medicine in Sri Lanka to treat various diseases. The present study was aimed to evaluate in vitro antioxidant activity of *Leea indica* (Burm.f.) Merr. (Burulla) leaves grown in Sri Lanka. 70% aqueous acetone and 80% aqueous methanol extracts were prepared by steeping method and subjected to the determination of total phenolic and total flavonoid contents by Folin-Ciocalteu assay and aluminiumchloride colorimetric method, respectively. In vitro radical scavenging activity and antioxidant activity of the extracts were evaluated using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay and ferric-reducing antioxidant power (FRAP) assay. Total phenolic contents were 4891.776 ± 64.965 (70% aqueous acetone) and 3413.859 ± 85.493 (80% aqueous methanol) mg Gallic acid equivalent /100 g dry weight of leaves. Total flavonoid contents were 1711.220 ± 22.829 (70% aqueous acetone) and 920.867 ± 39.833 (80% aqueous methanol) mg Catechin equivalents /100 g dry weight of leaves. The results of DPPH assay showed significantly high antioxidant capacity (13.418 ± 0.312 mMol Trolox equivalents/100 g DW of leaves) for 70% aqueous acetone extract compared to the value (9.421 ± 0.431 mMol Trolox equivalents/100 g DW of leaves) obtained for the 80% aqueous methanol extract. Antioxidant activity by FRAP assay was 17.796 ± 0.343 (70% aqueous acetone) and 12.422 ± 0.490 (80% aqueous methanol) mMol Fe (II) equivalents/100 g DW of the leaves. It can be concluded that the leaf extracts of *Leea indica* (Burulla) possess promising in vitro antioxidant activity which should be further investigated.

Keywords: *Antioxidant activity, DPPH assay, FRAP assay, Leea indica*

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Price, availability, and affordability of cardiovascular medicines: a cross sectional survey of selected community pharmacies in Galle Municipal Council & Bope-Poddala MOH Areas (Galle District) in Sri Lanka

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Approximately 75% of global deaths from cardiovascular diseases occur in low and middle-income countries due to less access to essential cardiovascular medicines. Access to medicines is hindered by poor availability and unaffordable prices. The objective of this study was to assess the price, availability and affordability of cardiovascular medicines in community pharmacy sector in Galle municipal council and Bope- Poddala MOH areas, Southern Province, Sri Lanka. A descriptive, cross-sectional study was conducted in sixteen community pharmacies to collect data on price and availability of selected cardiovascular medicines. Thirty cardiovascular medicines were selected on the basis of WHO model list of essential medicines 2019 and national essential medicines list of Sri Lanka 2014. Average availability of surveyed cardiovascular medicines in community pharmacy sector was 82.50%. Among selected cardiovascular medicines, 76.67% medicines had high availability, 10% medicines had fairly high availability and 13.33% medicines had very low availability. Median price ratio (MPR) of lowest priced generic equivalents (LPGs), highest priced generic equivalents (HPGs) and prominent brands were ranged from 0.12 to 7.46, 0.18 to 7.46, and 0.18 to 7.46, respectively. The percentage price variation between minimum price and maximum price of selected cardiovascular medicines ranged from 0.00% to 2037.21%. The cost for purchasing LPGs, HPGs and most prominent brands were ranged from 0.02 to 5.12, 0.02 to 6.65, 0.02 to 5.86 days wages, respectively. This study demonstrates that, some cardiovascular medicines are still unavailable and unaffordable to the community. Also, a wide inter-brand price variation can be observed in community pharmacies.

Key words: *Cardiovascular diseases, affordability, community pharmacies*

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The Diversity and abundance of butterflies in selected edge habitats of Dandeniya Aparekka reserved forest, Sri Lanka

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Dandeniya Aparakka reserved forest is a lowland rainforest situated in the Matara district of Southern Province, Sri Lanka. No Comprehensive study has been previously conducted there to study its butterfly fauna. The present study investigates the diversity and abundance of butterflies in the Dandeniya reservoir area (N $5^0 59' 19''$ and E $80^0 39' 14''$). Four Transects of 100 meters (Trails 1 to 4) were selected and the Pollard walk method was used to study butterflies. Butterflies were identified with the help of a field guide to confirm identification. The active time of butterflies along with the vegetational strata they were present was recorded. Abundance, Shannon Weiner Species diversity index (H'), and Species richness was calculated. During the period of the survey, a total of 33 species of butterflies belonging to, Lycaenidae (6 species), Nymphalidae (17 species), Papilionidae (7 species), and Pieridae (3 species) were found to be present in the area. The endemic *Troides darsius*, *Cethosia nietneri*, and *Idea Iasonia* were recorded. *Jamides celeno* (79) showed the highest abundance while the highest percentage abundance (55%) was shown by the butterfly species who show activity in all three vegetational strata. Trail 4 showed the highest diversity (2.7781), followed by Trail 1 (2.6144), Trail 2,(2.3782), while Trail 3 (2.2406) showed the lowest diversity. This result indicates the presence of diverse butterfly fauna in the Dandeniya reservoir area, but surveys must be continued for a longer period to study trends in butterfly abundance.

Keywords: *Dandeniya Aparekka reserved forest, butterfly fauna, diversity indices*

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Application of Assignment Problem for Absenteeism Management in an Apparel Industry

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Absenteeism management is a big challenge to run the industries, private sectors and the governmental organization in this current world. The study was conducted in a randomly selected cell of MAS Kreeda Vaanavil, Kilinochi for 40 days to overcome the interruptions caused by the absentees during the active time of apparel industries. The selected cell consisted of 6 modules and each module consisted of 7 to 10 team members including a team leader. An operation research technique named assignment problem was used in this study to handle the good quality and finalized data from the selected cell. A package named Solver Add-ins of MS Excel was used to solve the assignment problem. Initially, the skill matrix was prepared for a selected cell by direct observation and one-on-one interview method. In a module, 7 different tasks with 7 work stations were allocated for 7 team members to share the work load. If there were one, two or three absentees in a module at a time then it was possible to assign the task optimally for each employee without any mismatch by using the assignment problem. Apparel industries were the most time based competitive industries and manual assigning of the task for the employees in an optimal way was not practically feasible. Thus, this study has come up with an idea to solve the absenteeism in which every single task was assigned for a specific employee at an expected level so as to ensure the good flow of production.

Key words: *Absenteeism, assignment problem, cell, module, skill matrix*

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The Chromatic Polynomial of the Scorpion Graph

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In 1912, Geory Birkhoff introduced the chromatic polynomials for planar graphs as a result of solving the four-color problem and Hassler Whitney generalized Birkhoff's idea for any kind of graphs in 1932. It became one of the central objects in Algebraic graph theory. Let G be an undirected simple graph of order n. One can color vertices of graph G with k number of colors so that any adjacent vertices are colored differently. The chromatic polynomial $P(G, k)$ gives the number of ways of coloring vertices of a graph using k number of colors. The chromatic polynomials have been derived for several types of graphs such as cycle, complete, ladder, null and star graphs. In our work, we present the chromatic polynomial for the Scorpion graph $S_{(n,m,l)}$ where $n, m, l \in \mathbb{Z}^+$. The Scorpion graph is defined by introducing tree graphs, path graphs to few levels of the ladder graph. A graph obtained from the ladder graph, L_n, with n levels for $n > 5$ by adjoining the star graphs, $K_{1,m}$, for each vertex on the 1st level and the nth level, and path graphs, P_{l+1}, for each vertex on 2nd level to 5th level to represent the legs of the Scorpion. Then the number of vertices of the Scorpion graph is $2(n + 2m + 4l)$. In this work, we give an overview of the construction of the chromatic polynomial of ladder graph and finally chromatic polynomial of the Scorpion graph. The chromatic polynomial of the Scorpion graph $S_{(n,m,l)}$ is $P(S_{(n,m,l)}, k) = k(k - 1)(k^2 - 3k + 3)^{n-1}(k - 1)^{4m+8l}$ for $k \in \mathbb{N}$. The Deletion – Contraction method has been used to give the combinatorial proof to the above result. As a future work, we are planning to generalized this work for different body shapes.

Key words: *Chromatic polynomial, ladder graph, scorpion graph*

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Handwritten Character Recognition using Convolutional Neural Network in the Context of Sinhala Language

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Handwritten character recognition is widely used for the English language. Among other South Asian languages, Sinhala characters are unique, because of their shape, which are having mostly curves and dots. These unique characteristics make it difficult to create a model to recognize Sinhala handwritten characters. It is more challenging to recognize the handwritten characters rather than printed characters because the handwriting of each individual is varying from each other. Therefore a little attention has been given to improve the Sinhala handwritten character recognition. Convolutional Neural Network (CNN) is playing a vital role in character recognition by supporting the more efficient image classification. In the CNN architecture four convolutional and max-pooling layers and two hidden layers were used for the experiment. CNN's performance was evaluated by training and testing the dataset by increasing the number of character classes. When it reaches 100 character class it shows reasonable accuracy of 90.27% for testing and around 97% of accuracy recorded for training. In total, around 110 thousand image data (250 per each character) were used for the experiment. This model performed better than similar models.

Key words: *Convolutional Neural Network, handwritten character recognition, sinhala language*

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Time Series Model to Forecast Monthly Average White Raw Rice Prices in Colombo, Sri Lanka

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Rice is the staple food of Sri Lanka consumed vastly by a great portion of the population almost every day. White rice is consumed directly as well as converted to rice flour to make sweets and some other food items. Due to government policies, trade agreements, and weather conditions, paddy harvest subject to considerable variations. Ultimately the retail price of raw rice fluctuates drastically. Early researchers did not take much effort to forecast Colombo district prices. But in this study, we mainly focus on Colombo because as it is the main commercial city in Sri Lanka. One common and powerful tool to overcome the above problems is the development of a future forecasting model to forecast the prices of rice. The data consists of open market monthly average retail prices of white raw rice in main markets in Colombo district in the period from January 2007 to October 2019 which are captured from the official website of the Central Bank of Sri Lanka.Auto-Regressive Integrated Moving Average (ARIMA) models were employed to achieve the aforementioned objective and the best model was selected based on Akaike Information Criterion (AIC) and the Bayes Information Criterion (BIC). It was observed that ARIMA (2, 1, 3) model is better than all competing models for the average white rice prices. Then, the testing data set is used to evaluate the performance of the fitted model. As the performance measurements of the selected model observed that the Root Mean Squared Error (RMSE) is 2.3071 and Mean Absolute Percent Error (MAPE) is 2. 319.The findings of this study would be more beneficial for policymakers, researchers as well as farmers. Artificial Neural Network methods will be studied for further improvements in the study.

Key words: *Akaike information criterion, Auto-Regressive Integrated Moving Average, Bayes Information Criterion, Mean Absolute Percent Error, Root Mean Squared Error*

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An Efficient Power-Line Interference Removal System for Electrocardiograms

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Even though many adaptive notch filter based literature techniques for removing Power-Line Interference (PLI) noise with harmonics are available, these known techniques are often inefficient for Electrocardiogram (ECG) signal PLI noise removal. Inefficiencies occur mainly due to a number of facts: (1) the adaptive notch filters that create distortions in the ECGs, (2) the need of significantly larger filter lengths to achieve the required narrow bandwidths, (3) the requirement of complicated multiple-notch filter designs, and (4) the inconsistencies in filtering efficiencies. Thus to remove the PLI noise efficiently without corrupting the ECG signal's important characteristics, a novel Adaptive Quadrature Notch Filter (AQNF) based technique is proposed and developed. In the proposed AQNF, the quadrature signal is generated by convolving the input signals with new response functions. The performance of the proposed system was tested using ECG records from the MIT-BIH arrhythmia database. The clean records were contaminated by PLI noise with harmonics and then filtered using the new AQNF technique. The signal to noise ratios (SNRs) and heartbeat rates of the filtered ECG output signals were estimated with different input SNRs for the proposed and typical techniques. The AQNF that has a simpler but consistently efficient multi-notch filter design, achieved a narrow bandwidth using a short filter length while not distorting the ECG signal. Compared to the typical technique, the proposed AQNF implementation shows significant improvements in the filtered ECG SNRs and the accuracy of the estimated heartbeat rates. The proposed technique can be used for efficient and robust ECG signal conditioning and subsequent analysis.

Keywords: *Electrocardiogram, Power-line Noise, Adaptive Quadrature-Notch-filter*

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A Novel Cryptosystem using continued fractions

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The need for secure communication is something that is of paramount importance. Cryptography is the practice and study of techniques for secure communication in the presence of adversaries. Over the years, many researchers developed symmetric and asymmetric key cryptosystems using different approaches to gain higher security than the existing algorithms. In the present work, we introduce a new symmetric key cryptosystem to communicate securely among *n* number of users. Although most symmetric key cryptosystems are based on block cipher and stream cipher systems, this method is different, as we use a technique similar to the RSA cryptosystem for the encryption process and decryption process. First, an *n* number of users should agree on two large primes *p* and *q*, and each of them should share a key through a private information link. Then the key generation of the proposed algorithm is developed using continued fraction method with these shared keys. In addition, each user must compute encryption keys and decryption keys and both these keys are not shared with the private information link as an advantage. The encryption process and decryption process are done by using developed modular exponentiation. The double encryption process makes the encrypted message large making it difficult to find the corresponding keys to the adversary. Furthermore, the proposed algorithm is more efficient, because the user can identify if there is any man-in-the-middle attack as a security analysis.

Key words: *Block cipher, Stream cipher, RSA cryptosystem, Continued Fraction, Man-in-the-middle attack*

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An Efficient Numerical Approximation to Poisson Problem in Two Dimensions

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A numerical solution to the two-dimensional Poisson problem via Finite Element Method is studied in this work. The solution is tested on a squared domain (convex) and an L-Shaped domain (non-convex). The L-Shaped domain is mainly compared with uniform and graded meshes. Poisson equation $-\Delta u = f$ arises in many varied physical scenarios such as heat conduction, electrostatics, Newtonian gravity potential, the motion of an inviscid fluid (Navier Stokes Equation), and the motion of biological organisms in a solution. Although exact solutions to Poisson's equation are known, solutions to such physical models are complicated and difficult to calculate due to the singularities caused by non-smooth geometric boundaries. Numerical methods become necessary to efficiently model solutions of these partial differential equations. Exact solutions to various boundary value problems are still not known. Therefore, we will demonstrate the accuracy of this numerical method by comparing approximate solutions with their projections. A MATLAB program was developed to solve this system with inputs, such as Dirichlet boundary conditions and a nonhomogeneous constant source function f. Piecewise continuous linear finite elements are used to approximate the solution. The convergence rate $r = log_2 \left| \frac{e_{i-1}}{e_i} \right|$ of H^1 and L^2 norm errors are calculated. Here, $e_i = \left\| u_{p_i} - u_{h_{i+1}} \right\|$ is the norm error between the projection values of the ith refinement and the finite element solutions of the $(i+1)^{st}$ refinement. Numerical results indicate that the convergence rate is optimal for the H^1 and the L^2 norms. Thus, it can be seen that our numerical results agree with a priori error estimates.

Key words: *Finite elements, graded mesh, L-shaped domain, a priori error*

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Conversion of the Convolutional Neural Network implemented on Keras API to plain Python script

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Artificial Neural Network (ANN) is a memory-based network designed to simulate the neuron functionality of human brain. The Convolution Neural Network (CNN) is an ANN capable of identifying the spatial textural features of digital images and classifying the images into categories. These characteristics allow CNN to classify clouds into categories using digital images. In order to implement ANNs on general purpose computers, a Python-based high-level deep learning library called Keras Application Programming Interface (API) was introduced recently. A CNN was built using Keras API, trained the model to classify clouds into categories and converted into Python script under this study. The CNN was able to classify the test data set into categories with 95% accuracy. Weights and biases parameters of the CNN were saved to a file. The model built by using Keras API was analysed and converted to pure Python code. The saved weights and biases file was analysed to implement in Python script. A methodology was developed to read and write weights and biases into a single file. The outputs of the pure Python code and Keras API model were tested against the test data set. The output of the test data set was identical for both models. The CNN model coded on Keras API can be successfully converted into pure Python code by the methodology utilized in this study.

Key words: *Keras, Artificial Neural Network, Convolution Neural Network, Python*

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A study on how consumer preferences can be used to improve content-based recommendations

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Recommendation Systems (RS) support users to find items that are interesting and more aligned with their tastes. RS are used in diverse application areas to recommend movies, music, books, etc. The current generation of recommendation systems is often classified into content-based, collaborative, and hybrid approaches based on the filtering methods used by them. During the analysis of the research articles, limited content analysis and overspecialization problems in the content-based approaches have been identified as important research areas. These problems occur mainly due to the lack of product descriptions and consider only product descriptions. In this research, we investigate how the above problems could be addressed by complementing product descriptions using consumer preference data such as product reviews available, for instance, in e-commerce sites. We propose, to extract *Context of Use, Ratings, and Transaction Quality* details from product reviews in addition to generic product descriptions available. Since the descriptions about products are increased, it reduces the limited content analysis problem and since the descriptions are obtained from customer reviews that contain other users' opinions, it reduces the overspecialization problem. The proposal is tested using a content-based recommendation algorithm available in GitHub which was improved to use *Context of Use* details extracted from product reviews. The product recommendations obtained by using this improved algorithm and the original algorithm were compared and the results show that the recommendations obtained by considering the *Context of Use* from product reviews yield a more focused set of recommendations than when the *Context of Use* is not considered.

Key words: *Content-based filtering, Limited Content Analysis and Overspecialization, Context of Use*

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A two-dimensional numerical study on the development of two-phase flow inside a vertical solar collector pipe imposed by a homogeneous heat flux

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Direct solar heating systems have become a renewable energy solution for manufacturing processes. However, research on the use of parabolic trough reflectors in producing distilled water is relatively rare. In such investigations, in general, the receiver tube mounted in the focal line of the parabolic trough absorbs the concentrated solar irradiance and transfers the absorbed energy to the heat transfer liquid without a phase change. In this study, the flow distribution inside a two-dimensional pipe (receiver tube) was studied as a time dependent two-phase flow problem as a test case for the real experimental three-dimensional solar collector system. The evaporation and condensation phenomenon of the process was modeled using the volume of fluid method together with the energy equation as used in many researches for two-phase problems. The simulation was carried out in a rectangular domain with an open outlet which is typically used in water heating systems. The intended boundary value problem considered vertical adiabatic walls and heat flux with an imposed linear intensity of 15 kW/m as the typical concentrated solar irradiation is around 55 kW/m^2. The implementation was performed using ANSYS Fluent 14.0 software. Under these conditions, the bubble generation and evaporation were observed after 9 s which was in agreement with the experimental process. The corresponding volume fractions and velocity profile are visualized in the simulation. The results had a good agreement with the evaporation and condensation processes obtained so far by the other researchers. The experimental setup for this scenario has already been developed. Thus, the simulation approach needs to be further improved by identifying the actual heat flux and validated by experimentally measured data.

Key words: *Solar collector pipe, parabolic trough reflector, two-phase flow, volume of fluid method*

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An innovative approach in Offline Sinhala Handwritten Character Recognition using Feature Extraction Techniques and SVMs

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Offline Sinhala Handwritten Character Recognition (HCR) is a most challenging task due to the large number of characters with complicated structures and, similarity between characters, and there are intra-personal differences among the handwritten characters of the same person. This paper proposes a different approach for multiclass classification to recognize offline Sinhala handwritten characters using feature extraction technique and support vector machines (SVMs). The proposed method used a feature set: basic, density and histogram of oriented gradients (HOG). The proposed approach is optimally selected feature set at each decision node of Unbalanced Decision Tree (UDT). The dataset consist of 18 vowels of Sinhala handwritten characters and 25 samples per each vowel were considered for the experimental. One-Versus-One (OVO) yields a recognition rate of 83.34%, One-Versus-All (OVA) yields a recognition rate 86.11%, Directed-Acyclic Graph (DAG) yields a recognition rate 87.78%, and UDT yields a recognition rate 90.56%. The selection of optimal features using forward feature selection technique at decision nodes of UDT shows better recognition rate of 94.45%.

Key words: *HCR, Intra-personal difference, SVM, HOG*

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A novel cryptographic scheme on a variation of hill cipher

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Cryptography has always been an active and engaging area of research. It is the science of keeping information secure by transforming into a form that unintended recipients cannot comprehend. In the world of today, making messages secret has become of paramount importance, especially with the advent of electronic messaging and the internet. Even there are many encryption algorithms exist, the need of new non-standard encryption algorithms is in much demand to address the advent of technology. In the present work, the main cryptography technique we use is the Hill cipher which was invented by Lester S. Hill in 1929. It is a polygraphic substitution cipher based on matrix theory in linear algebra. Here, the encryption algorithm takes plaintext letters as input and produces ciphertext letters for them. To encrypt a message, we first convert the keywords into key matrices. But every possible matrix is not a candidate for a possible key matrix since in order to decrypt, we need to have an inverse key matrix, and not every matrix is invertible. In order to be a usable key, the matrix must have a non-zero determinant which is co-prime to the length of the alphabet. Our method is better at securing data that will be transmitted in an open network as it uses different keys for each plaintext block instead of using one key matrix for all blocks. The main objective of our work is to encrypt a text more securely using a technique different from the conventional Hill Cipher. In conclusion, the key aspect of our algorithm is that the keys must be kept confidential. In future, we plan to explore more on this algorithm to dive into the security aspect as well as to incorporate the security and implement a computer program to handle longer texts.

Key words: *Cryptography, encryption, decryption, plaintext, ciphertext*

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Enhanced Agriculture Ontology with Images to Effectively Retrieve Pest and Disease Knowledge

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User-centered agriculture ontology has been developed in a previous study for Sri Lankan context, which represents domain knowledge in agriculture such as crops, pests, diseases, and fertilizers. Even though, this is a solution for farmers that they can access scattered knowledge in one place, the represented knowledge is in only the textual format without supported meta information such as images, video, and annotations. Thus, it is difficult for farmers to understand the information/knowledge provided through the ontology. Considering this fact, the necessity of ontology enhancement with meta-information was identified. In this study, as an initial step, pest and disease management was selected. After several field visits and the literature analysis, the ontology representation was extended by defining symptoms' events with the relevant images. Ontology design patterns to represent N-ary relationship were adapted to handle the relationships among the concepts which have associations more than two concepts. To make the retrieval process efficient, the image-annotations were introduced with the support of experts and annotated them with images. This enables farmers to query knowledge by uploading images and tagging keywords. Then, the ontology provides the knowledge with supported images. The validity of content of the ontology has been assessed manually with respect to the answers and images of the questions related to the diseases given by the experts and the reliable sources. Finally, a system was implemented to demonstrate the feasibility of accessing information through the enhanced ontology. The Protégé tool and OWL API were used to model the ontology and connected it to the system respectively. The Stanford CoreNLP and WordNet APIs were adopted to check the similarity between the farmers' input-keywords and the ontology annotations. In future, the system will be improved with a decision tree to resolve the conflicting answers generated by the ontology.

Key words: *Ontology enhancement, Image-annotation*, *Ontology design patterns*, *Agriculture*

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A Machine Learning Approach for Rhythmic Analysis of North Indian Classical Music

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Music plays a vital role in our day-to-day life, especially in today's digital age. Computational musicology is an interdisciplinary area in which computational methods are used to analyze musical structures. While western classical music is extensively explored, North Indian classical music remains to be explored computationally. However, rhythmic analysis in North Indian Classical music is important as it serves in a multitude of applications e.g., intelligent music archival. Rhythm in North Indian classical music revolves around the primary concept of *Taal* - the cycle of beats of specific syllables and beats. Taken together, the main objective of the proposed study is to apply machine learning for the recognition of *Taal*. A dataset consists of 151 excerpts (2mins; 44.1 kHz; stereo; .wav), belonging to four popular *Taals* namely; Teentaal, Ektaal, Jhaptaal and Rupak. Acoustic features about fluctuation, onsets, event density, tempo, metroid, and pulse clarity will be extracted using MATLAB MIRToolbox. Support Vector Machine, Decision Tree, Naive Bayes, Random Forest, and k-Nearest Neighbor were applied on feature extracted data using Jupyter Notebook IDE with Python language. Among these classifiers, SVM obtained a higher accuracy (54.83%). When concerned with the evaluation metrics, SVM Obtained 66.67% with the cross-validation (5-fold). Further, SVM obtained higher accuracy when considering only the highly influential features that returned from the correlation metrics method. Even though the findings of the study would be limited by the consideration of a smaller dataset, the study would make a promising contribution through computationally exploring rhythmic patterns of a great musical tradition.

Key words: *Taal Recognition, North Indian Classical Music, Rhythmic Analysis, Computational Musicology*

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Sinhala speech recognition using hidden Markov based model and deep neural networks based model for number sequences

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Speech recognition for Sinhala, which is a less-resourced language, has seen only a few pieces of research for Automatic Speech Recognition. Identifying the performance of the Sinhala speech in the modern approaches and toolkits will be helpful for the future works of Sinhala speech recognition. Although numbers are written mostly similarly in most of the languages, the verbal pronunciation differs according to the language. Through this research, an attempt has been made to recognize the number sequences spoken in Sinhala Language using the Hidden Markov Model based Speech Recognizer and to compare it with the performance of Deep Neural Network Based Speech recognition model which used a Multilayer Perceptron Architecture.

Readily available state-of-the-art Automatic Speech Recognition toolkits such as Kaldi ASR toolkit, PyTorch-Kaldi are used to build the Speech Recognition Models. A speech corpus of Sinhala number sequences was also proposed exclusively for this study where the corpus was used to compare the performance of the two models. Finally, a rule-based approach was proposed which will map the spell out of numbers in Sinhala to their numeric forms. The Hidden Markov Model-Based approach produced an average accuracy of 18.04% of Word Error Rate and it was improved with the use of Deep Neural Networks to a Word Error Rate of 4.20%.

Key words: *Speech Recognition, Hidden Markov Model, Deep Neural Network, Kaldi, PyTorch-Kaldi*

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Markov Chain Model for predicting the Share Price of Canadian Stock Market

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The stock prices are vital in the investor's point of view to make decision regarding their investment. So, the success of the investor, especially in the stock market, depends a great deal on the choice of the decision taken by the investor. Therefore, this paper studies a Markov chain application on stock market price. This paper provides a Markov chain analysis for forecasting the stock prices of five Canadian banks; Royal Bank of Canada (RBC), Toronto-Dominion Bank (TD), Bank of Nova Scotia (Scotia bank) (BON), Bank of Montreal (BMO) and Canadian Imperial Bank of Commerce (CIBC) in Canada. The closing prices of each trading day of each bank were obtained from the Yahoo finance website between Jan 2019 and April 2020. Two methods have been adopted to describe the state of the system. For each bank, the states were considered as gains or losses for model 1 and large increments, low increments, small increments, small losses, moderate losses, and high losses for Model 2. The Transition probabilities, steady state probabilities and mean recurrent time were obtained for these two models and compared among the banks. Based on the model 1, it is revealed that the chance of getting gain (55%) is comparatively high for all the banks. According to model 2, the chance of getting small increment is high for each of the five banks. This is a good sign for investors; they do not get any considerable large loss. Also, noted that, for BON shareholders there is 48% chance of getting small increment in the near future.

Key words: *Markov chain, closing price, steady state probability, stock market, transition probability*

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A Study on National Economy using a Higher order Dynamical System

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Higher order Dynamical systems are now used in all areas of Science. In particular, higher order dynamical systems in economics have been developed rapidly because of the dynamic nature of the economy in the view of applications and use of the computer technology in the view of analyzing tools.
In this work we have developed a second order affine dynamical system that models the economy. This dynamical system is a variation of the Samuelson accelerator-multiplier model which was first developed in 1939.

Three assumptions on Consumer Spending, Investment and Government Spending were considered in this model by which we could understand how each component of the model affects the long-term behavior of the economy. Once we understand how the behavior of the economy get affected by those assumptions, we can modify the existing components.

In this work we have modified the Government Spending assumption and investigated on how alternate approaches could affect the economy both positively and negatively. Results indicated that Immediate Government Response can stabilize unstable situations. So chaotic behavior is not applicable in these cases. If there is a delay in the Government Response, such as 1or 2-time unit delay in action, the response could have either a deleterious effect or no effect at all. We further observed that, greater the delay, the effect of the government control could get worsen.

Key Words: *Dynamical System, delay, immediate government response*

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User-friendly interface design to disseminate best agricultural practices

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The main purpose of the Good Agricultural Practices (GAPs) is to produce foods by applying ecologically sustainable agricultural methods that are safe and wholesome to consumers. Therefore, farming with GAPs can eliminate vast environmental and health problems in modern industrial agriculture. Information and Communication Technology (ICT) has become one useful tool in modern agriculture that provides day-to-day information to the farmers for successful farming. "Govi-Nena" is one of such mobile applications is developing to provide real-time information to farmers in Sri Lanka. Therefore, the aims of this study to design user-friendly interfaces to disseminate guidelines of GAPs and potato was selected as the test crop in designing the model. First, primary data were gathered through two pre-tested questionnaires from 100 potato farmers in Nuwara-Eliya and Badulla districts to evaluate the present status of potato cultivation in Sri Lanka. The secondary data was collected from various reliable sources such as books, previous records, research articles, the internet etc. Then user-friendly interfaces designed according to the modern User Interfaces (UI) and User Experience design (UX) theory, to disseminate guidelines for GAPs. It was included important guidance, knowledge and vital information on GAPs for potato cultivation in Sri Lanka. These user-friendly interfaces will help farmers to get the guidance of the GAPs such as land preparation by conserving the soil and minimize soil erosion, accurate knowledge and vital information and also facilitates a history record book and adversary services for farmers on the right time and easy manner through "Govi-Nena" mobile-based application.

Key words: *Good Agricultural Practices (GAPs), Information and Communication Technology (ICT), User Interfaces (UI), User Experience design (UX)*

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Fabrication of a dual sensor hot-wire anemometer to measure wind direction

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Hot-wire anemometers are wind measuring instruments that work on the principle of convectional heat transfer that takes place from an electrically heated hot-wire. They are well popular for the reliable, error-less wind measurements. In addition, their less maintenance cost, lack of mechanical parts and taking comparably less space are some advantages over the other wind measuring instruments. Single sensor hot-wire anemometer allows only for measuring wind velocity. But, dual-sensor hot-wires anemometer allows two-dimensional airflow measurements, which will yield wind velocity and wind direction. A dual-sensor hot-wire probe (X-probe) was constructed using Nichrome (NiCr) as hot-wire material. Dual sensors were fixed to the prongs of the hot-wire anemometer, being perpendicular to each other. X-probe calibration was conducted for velocity fixed winds obtained from a wind generator. It was performed for different orientations of X-probe, facing the wind flow generated by the wind generator. Voltages across two hot-wire sensors were analyzed for different orientations of the two hot-wires of the sensor. Each pair of voltages exhibited a unique variation with different orientations of the two hot-wires sensors to different wind flows. Each set of voltages was plotted and fitted to King's law formula which contains three parameters. Parameter values were used to create a calibration curve. X-probe was tested inside the laboratory using the wind generator and it produces a very accurate value of wind direction and velocity. The look-up table method was used to extract the wind direction and wind velocity. Wind measurements in the outside environment were tested using the X-probe and it showed a fluctuation of the wind velocity and direction.

Key words: *Dual-sensor hot-wire anemometer, X-probe, wind direction*

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