

IRCUWU 2020



INTERNATIONAL RESEARCH

CONFERENCE

"Sustainable Business Transition through Information & Knowledge Dissemination"

2020

29 -30, July

Uva Wellassa University of Sri Lanka



IRCUWU 2020

International Research Conference - 2020

*“Sustainable Business Transition through Information and Knowledge
Dissemination”*

July 29 – 30, 2020

Uva Wellassa University

Badulla

Sri Lanka

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Acknowledgments

The International Research Conference of Uva Wellassa University (IRCUWU2020) is held as the first ever on-line conference in the history of Uva Wellassa University. It would not have been a reality without the guidance, contribution, dedication, and well wishes received from a number of personalities.

Vice Chancellor, Chairman of the Research Committee, and Organizing Committee of IRCUWU2020 extend their profound gratitude to the Chief Guest, Professor Min Qingfei, Professor in Information Systems, Dalian University of Technology, Dalian, China, and the Guest of Honour, Senior Professor Asoka S. Karunananda, Department of Computational Studies, University of Moratuwa, Sri Lanka for sharing their invaluable experience and thoughts with us.

A warm appreciation also goes to all Chairpersons and Panel Members of the eleven (11) tracks for their indispensable contribution to this strenuous event. Further, the authors and presenters deserve boundless appreciations for their contribution and for sharing their valuable research findings in a myriad way of exploring the world of work.

This work would have not been reached to the audience without the prompt and dedicated co-operation extended by the Editorial Board members and Reviewers who also made a significant contribution to maintain the accepted standards in scientific publications.

A special gratitude with appreciation is also conveyed to the staff of IT and Audio-Visual Unit of Uva Wellassa University for their precise and state of the art efforts made in live streaming the event enabling an uninterrupted on-line conferencing facility to the event.

Last but not least, sincere appreciation goes to all committed academic and non-academic members of Uva Wellassa University as well as those who actively engaged in the IRCUWU2020 for its success.

IRCUWU 2020

Uva Wellassa University (UWU) has generated an exemplary studios milieu for the “Value Addition to the National Resource Base” and also continues to produce well-rounded graduates capable of contributing to the national development with innovative solutions.

With the prime objective of expanding the knowledge horizons while paving the way towards sustainable development, UWU takes pride in opening its International research Conference (IRCUWU2020) for the fourth consecutive time under the theme of “Sustainable Business Development through Information and Knowledge Dissemination” that facilitates a large number of national and international researchers, scientists, economists, engineers, graduates and professionals to share their novel ideas and research findings in all aspects of Science, Engineering and Management. For IRCUWU2020, five hundred and sixty-six (566) abstracts were received from both local and international researchers. The abstracts went through a comprehensive reviewing and editing process resulting in only three hundred and eighty-eight (388) presentations under the following tracks.

1. Agriculture
2. Aquaculture & Fisheries
3. Business Management
4. Computing & Information Sciences
5. Engineering
6. Environmental Sciences
7. Food Science & Technology
8. Hospitality & Tourism
9. Humanities & Social Sciences
10. Material & Mineral Sciences
11. Library Sciences

Considering the constraints in mobility and physical gathering caused by COVID-19 outbreak, IRCUWU2020 is organized as a fully on-line research conference in which all presentations take place through an on-line platform. Accordingly, IRCUWU2020 is recorded as the maiden on-line research conference of UWU and also as the biggest on-line conference organized by a national university of Sri Lanka.

Chancellor's Message



It is a great pleasure for me to convey my wishes to the International Research Conference of Uva Wellassa (IRCUWU2020) organized by the Uva Wellassa University under the theme of Sustainable Business Transition through Information and Knowledge Dissemination”.

Living in the information era, all human activities including businesses greatly rely on information and knowledge. Information improves decision making, enhances resource use efficiency, and create a competitive advantage in business operations. Knowledge is considered useful or processed information that is adapted to a purpose. It paves the way for anticipating, identifying, and solving problems effectively and efficiently. Hence, the dissemination of information and knowledge plays a pivotal role in the sustainable business transition.

Uva Wellassa University is being the Centre of Excellence for Value Addition, creates a conducive learning environment to build basement for the upcoming entrepreneurs in Sri Lanka. The IRCUWU2020 provides a marvellous platform to bring scholars together to share their ideas, perceptions, and research findings while enhancing the thinking ability of human beings which will eventually influence human evolution for a sustainable world.

In this significant annual event, I wish to express my blessings to the Vice Chancellor, Academic Staff, Non-academic Staff, and Students for making this scholarly event a great success.

Most Venerable Bengamuwe Sri Dhammadinna Nayaka Thero
Chancellor
Uva Wellassa University
Sri Lanka

Vice Chancellor's Message



It is with great pleasure, I send this message on the occasion of the IRCUWU 2020, organized by the UWU. Indeed, it is a very special occasion, since we organize the IRCUWU 2020 as an online conference this time.

International Research Conferences are great opportunities not only for researchers and scientists, but also for students, policy makers and other stakeholders as well. International Research Conferences provide a great opportunity to connect with the participants from different perspectives and views, learn from them and make new relationships.

Research Conferences pave the way for scientific cooperation by meeting and connecting with researchers from different countries. Furthermore, presenting your research in a conference helps you in different ways. It presents your work to the scientific community and helps you to improve your work by getting feedback from the experts in your field.

The COVID-19 pandemic has changed the entire landscape of human activities while unveiling the gaps in human knowledge, systems, processes and technologies. The new situation reiterates the importance of the generation of new knowledge and its dissemination. In this context, the theme of the IRCUWU 2020, "Sustainable Business Transition through Information and Knowledge Dissemination", becomes extremely important. I firmly believe that the IRCUWU 2020 would provide a fruitful platform to share research findings and exchange views for wider interaction among scholars from different countries, despite the restrictions imposed due to the COVID-19 pandemic.

It is my honour to welcome and thank our Chief Guest, Professor Min Qingfei, Faculty of Management & Economics, Dalian University of Technology, China, and the Guest of Honour, Senior Professor A.S. Karunananda, Department of Computational Mathematics, University of Moratuwa, Sri Lanka. Further, I wish to express my sincere gratitude to the Organizing Committee and all members of the UWU family for their untiring efforts tested to make the IRCUWU 2020 a success.

Finally, I wish all participants, presenters and panellists to have a pleasant and productive experience in attending the online IRCUWU 2020.

Prof. (Dr). J.L. Ratnasekera
Vice Chancellor
Uva Wellassa University
Sri Lanka

Research Committee Chairmen's Message



I am very much pleased to forward this message as the Chairman of the Uva Wellassa University Research Committee on the International Research Conference of this year (IRCUWU2020). Uva Wellassa University, having established in 2005 conducted its maiden Research Conference in 2010 and thereafter it was conducted as one of the annual flagship events of the University with the collaboration of all faculties. Furthermore, the conference was elevated as an International Research Symposium in 2017 and from 2019 it was further advanced to an International Research Conference of Uva Wellassa

University (IRCUWU).

This year's theme of the conference is "Sustainable Business Transition through Information and Knowledge Dissemination" which is very much aptly theme with the current situation of the country as well as the currents trends of the globe. Though the whole world is struggling to keep their day to day activities clotted with the COVID 19 pandemic, we are strenuously marching towards to present more than 400 research papers that were selected from the circumspect double-blind peer review process from more than 550 papers submitted. Thereby, we aimed to academically contribute to the post-COVID reconstruction debate of the country and assist in reaching a fast and sustainable recovery path.

Uva Wellassa University, since its inception, as a trend setter for many decades in the academic arena of Sri Lanka, organizes the IRCUWU2020 as a historic event not only at UWU but also in the country as this is the biggest fully pledged academic conference conducted online in the Sri Lankan history. Inaugural Session, Keynote Session, with more than 375 research papers are conducted online.

I congratulate the Coordinator, Secretaries, and all members of the organizing committee for making IRCUWU2020 a success and capitalizing the opportunity created by COVID 19 pandemic to set a new trend in delivering the academic conference and demonstrating that we are dedicated to delivering the results on targeted dates whatever the odds encountered. I also congratulate and wish all the presenters who submitted their papers and agreed excitedly to attend the online conference keeping your confidence on us.

Research Committee of Uva Wellassa University wishes you all a very fruitful IRCUWU2020 where you will be able to disclose, discuss, debate, and agreed on your findings.

Dr. P. H. T. Kumara
Chairman/Research Committee
Uva Wellassa University
Sri Lanka

IRCUWU 2020 Coordinator's Message



It has been a great privilege and honour for me to forward this message on the occasion of the International Research Conference of Uva Wellassa University (IRCUWU2020). Striving towards the vision to become the Centre of Excellence for Value Addition to the National Resources, Uva Wellassa University has been making a remarkable contribution to the research and innovation in the field of Agriculture, Science & Technology, and Entrepreneurship & Management.

International Research Conference of Uva Wellassa University is one of the landmark annual events of the university that receives a high reputation and attracts the attention of the researchers, practitioners, industrialists, and many other allied professionals in diverse disciplines within and outside of the country. IRCUWU2020 is organized under a very topical theme, “Sustainable Business Transition through Information and Knowledge Dissemination”. The theme and the impact of the IRCUWU2020 become extraordinary relevance with the eruption of the Global Pandemic of COVID-19 that halts the entire world stands still and switches to the online mode.

Given the restrictions imposed on the mobility and public gathering due to COVID19, UWU being an Entrepreneurial University sets an example by grabbing the opportunity and organizing the IRCUWU2020 as a fully pledged online research conference. Consequently, IRCUWU2020 becomes a historical event not only in the history of UWU but in the country at large since it is the largest online research conference organized so far with excess of 388 research articles presented via online platform over two days.

As the Coordinator IRCUWU2020 it is my humble duty to express my deepest appreciation and gratitude to the Vice Chancellor of Uva Wellassa University, Chairman and Members of the Research Committee, Editorial Board, Reviewers and Panellists, Chief Guest, Guest of Honour, Secretaries, Track Coordinators and all academic, and non-academic and all other members for their invaluable contribution deployed to make this novel and challenging event a great success.

Finally, I wish to congratulate all the authors and presenters for being selected for this online conference and wish you all a very productive and unforgettable experience at this conference.

Dr. M.G.P.P. Mahindaratne
Coordinator / IRCUWU2020
Uva Wellassa University
Sri Lanka

Chief Guest's Message



It is my great pleasure to be the Chief Guest at the Uva Wellassa University Annual Research Conference, and to address the conference theme of “Sustainable Business Transition through Technology and Innovations”. Uva Wellassa University emphasizes technopreneurship highlighting the pivotal role of science and technology in creating a prosperous country and successful careers for her graduates.

From my point of view, digital technology as the new general-purpose technology is transforming almost all aspects of human society. Especially during the global pandemic of COVID-19, we are witnessing tens of millions of students studying online with the support of a massive platform like WeChat or Zoom. More online business meetings, cooperation, or negotiations are facilitating by digital technologies. The giant E-commerce companies like Amazon, Alibaba, and JD were easing people's anxieties by delivering food and other daily necessities to millions of families effectively. We suddenly realized that digitalization is not an objective but imperative.

My country is launching a "New Infrastructure" campaign to offset the economic impact of the COVID19 and boost sustainable growth. The country is often quick to respond with massive investment to shore-up growth when facing economic difficulties. But this time, instead of a massive infrastructure overhaul, China is seeking more targeted investments in projects that facilitate innovation and social development. Those "New Infrastructure" projects are focused on seven areas: 5G networks, industrial internet, inter-city transportation, and inner-city rail systems, data centers, artificial intelligence, ultra-high voltage, and new energy vehicle charging stations.

Twenty years ago, when I was a PhD student, I studied how China's local companies can benefit from using ERP systems which originated from western countries. Then, e-commerce and mobile-commerce attracted my attention when I became a junior faculty. Now, my graduate students and I are trying to explain why and how new digital technologies, like live-streaming and AI, are transforming e-commerce/m-commerce. We are also carefully observing the huge potential impacts of block-chain technology on society and the economy.

I do believe Uva Wellassa University, as an important and promising research institute, can play a pivotal role in developing such digital technologies and transferring its use to Sri Lanka society. Hope this year's conference provides a forum for discussing these issues and I wish it every success.

Dr. Qingfei Min
Professor of Information Systems
School of Economics & Management
Dalian University of Technology, China

Speech of Guest of Honour



Artificial Intelligence for Business Transformation

Introduction

Artificial Intelligence (AI) has become a buzzword in the modern world. AI develops intelligent solutions with smart sensing, communication, navigation, exploring uncharted territories, decision making, forecasting, and discovering patterns and trends even under situations with unstructured, incomplete, noisy, and inherently uncertain conditions. AI has gone into all sectors including business, manufacturing, healthcare, transportation, defence, and education in the society and has shown its potential to solve problems that cannot be solved otherwise. More notably, AI has changed the way people do things in All organizations and the way of life of individuals in all sectors. Nowadays, AI solutions are built into devices ranging from wearable devices to massive space crafts. AI has now won recognition as the fuel for the fourth industrial revolution. With the rapid developments of AI, we are heading to an era of man-machine coexistence, where machines can not only work on par with humans but also enables machine-machine communications. Among other areas, AI has revolutionized the world of business. Competitive advantages of all major companies such as Google, Facebook, IBM, Tesla, Microsoft, are Amazon, are powered by AI solutions. Now people cannot live without AI. This write up gives a glimpse of AI and the contribution of AI for business.

What is AI?

In 1956, the father of Artificial Intelligence, John McCarthy, defined AI as the Science and Engineering of building intelligent machines. As such AI strives to understand intelligence and develop intelligent machines. Since its inception AI began as a set of modules in Computer Science and AI has now evolved as a distinct degree area under Computing. The field of AI is concerned with two forms of intelligence as logical/analytical-based intelligence and training-based intelligence, which eventually evolved as Symbolic AI and non-symbolic AI, respectively. The Symbolic AI and non-symbolic AI has been the foundation for broad areas of AI, namely, Artificial Cognitive Systems (ACS) and Machine Learning (ML).

The early developments of AI were very much dominated by the ACS approach to AI. For instance, the DART program which handled the entire Gulf War, Deep Blue which defeated the grandmaster of Chess, PathFinder that explored unknown environment in Mars are examples for ACS solutions. On the other hand, ML techniques have tremendously contributed to the recent developments such as Google Self-driving cars, Google Assistant, IBM Watson, Tesla Self-driving trucks, and AlphaGo in AI. It should be noted that ACS technologies have a special ability to provide not only solutions but also reasons for solutions. However, ACS solutions are possible only for structured and algorithmic domains. In contrast, ML solutions can model rather incomplete, noisy, and dynamic data generated in huge volumes by multiple sources like social media networks, online transactions, R&D projects, real-time billing in telecom networks, etc. In the recent past, Deep Learning has emerged as a subset of ML

(Figure 1). Deep Learning algorithms such as Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN) have shown their potential to learn not only from numeric data but also from the text, images, audio, and video signals. However, ML solutions, in general, suffer from the inability to give justifications for the answers generated by ML algorithms. In response to this issue, explainable AI (XAI) is now emerging. In the future, hybrid solutions of ACS and ML will come forward. In general, a given problem can be solved by more than one AI technique. For instance, Natural Language Processing can be done by both ML and ACS techniques. On the other hand, a given problem can be solved by multiple Deep learning techniques or typical machine learning techniques.

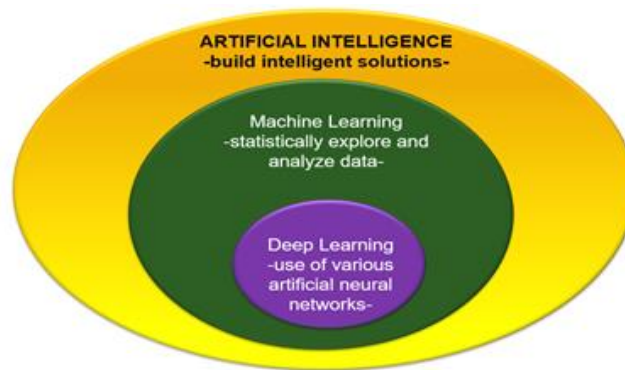


Figure: AI, ML and Deep Learning

AI for Business transformation

The marketing department in any organization has a vital role in promoting its business. In this sense, marketers are expected to develop strategies to gain high profits in the business. For example, customer profiling and reaching the right customers at the right time is essential to get maximum benefits by exploring competitive advantages. Nowadays, many businesses including Amazon, Coca-Cola, Facebook, Spotify, and Google use AI techniques for reaching the right customers at the right time with the right content for them. AI technology like Chatbots can communicate with multiple customers at the same by implementing the role of multiple marketers at different locations. Such Chatbots work much faster and more accurately than human marketers. Next, discuss some selected applications of the use of AI for business.

Customer Profiling: In Business, it is commonly agreed that ‘knowing about the audience’ is a key factor for the success of any business. As such, personalized customer experience has been a major concern in all businesses. In such situations, a business requires to attend many tasks including data collections, data analysis, interpreting the results, forecasting, and presenting the results to the relevant parties. There are powerful AI technologies to support all these tasks. Many search engines are powered by AI to collect all text, images, audio data, and video data. A simple keyword search on a search engine now uses AI techniques such as Natural Language Processing and Machine Learning. Many Chatbots use the entire Internet as the knowledge base and execute searching and use ML to generate answers. IBM Watson demonstrates intelligent searching and ML to give smart answers.

Predictive analysis: AI techniques can effectively analyse customer profile and do

predictive analysis to decide on which item a customer buy next time. Further, AI can also identify the next best customer. This kind of analysis can be done by simple ML techniques such as regression, and decision trees without going into Deep Learning techniques in AI. Many of us have experiences about how customer profiling works in situations like online hotel booking, online shopping, etc. Identification of losing a customer in advance, known as Churn prediction, is of great importance for a business. AI techniques such as Artificial Neural Networks have been used for churn prediction. This activity can also be considered under data classification, pattern recognition, discovering trends, where ML techniques have shown unprecedented power.

Content generating: Generating the right content at the right time for the right person/audience is a challenging task in modern business. Customers are always disturbed by irrelevant content displayed to them. As stated, many AI techniques can be used to search and generate content. However, this should be done with the support of relevant AI technology. This is so crucial because, in general, a given problem can be solved by more than one AI technique. For instance, researchers have shown Artificial Neural Networks are adequate for generating numeric-based content. On the other hand, Convolutional Neural Networks are suitable for Content generation related to graphical data or images. Nowadays, people are producing sequential data, and modelling them has been a real challenge. Text, audio, and video data are some examples of sequential data, where data in one instance has a connection with previous instances of data. Recurrent Neural Networks (RNN) have shown promising results in generating content from music, videos, and text data. It should be noted that the Chatbots using text-based data are also sequential, thus RNN is used for Chatbots as well.

Digital marketing software: Nowadays, many AI-based software tools are available for marketing and business in general. For examples, MarketMuse software analyses thousands of web sites and generate contents; Import.io Extracts and transforms data into various forms and gives insight about data; Acrolinx captures, crates and analyses data to generate contents; NetBase extracts real-time social information in different languages and use Natural Language Processing and suggest actions. NetBase also let us know which part of the world your business is catching up now. Although these kinds of marketing software are user-friendly, some knowledge of AI is essential to use them. This is why many professionals are interested in following at least a basic course in AI.

AI in Sri Lanka

In 1998, Sri Lanka Association for Artificial Intelligence was established to promote AI education and Research in Sri Lanka. Since then AI has been introduced to computing curricula, developed doctoral qualified human resources in AI, in 2008 first-ever MSc in AI in Sri Lanka was launched, and BSc Hons in AI will be introduced as another intake from GCE (A/L) very soon. Sri Lankan software industry and service sectors are rapidly expanding with AI start-ups and solutions.

Summary

This write up described the applicability of Artificial Intelligence for transforming business. In this sense, we gave a glimpse of AI showing the power of AI for solving problems that cannot be solved by other techniques. We also explained how various AI

techniques have been used for implementing various aspects in marketing such as customer profiling, predictive analysis, churn prediction, pattern recognition, content generation for various forms of data such as numbers, texts, images, audio, and video. We have also stated the relevant AI techniques to implement the above purposes in marketing. A brief note on AI in Sri Lanka has also been mentioned.

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Extraction of Crude Protein from *Sargassum crassifolium* Harvested from the South Coast of Sri Lanka and to Determination of the Functional Properties of the Crude Extracts

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Oceans provide an attractive domain for nutrient sources with the rising global population and decreasing available land and freshwater resources. Marine macroalgae, *Sargassum crassifolium* has a higher growth rate around the country. It has 9–20% protein content which changes based on the environmental conditions. This study aimed to compare different effective processes to extract crude protein and studying the functional properties of the crude extract from *S. crassifolium* harvested from Matara, Sri Lanka. Proximate composition was determined and extracted crude protein from *S. crassifolium* using different protocols (water, salt, ethanol, and alkaline). Extracted crude protein was lyophilized and used for protein quantification and all extracts were analysed by using 15% SDS-PAGE. Selected best yield ratio was used to observe antioxidant properties and antimicrobial properties. Raw seaweed contains 82.61% \pm 0.47 moisture, 2.45% \pm 0.47 crude fat, 10.29% \pm 0.35 protein, and 3.52% \pm 0.19 ash respectively. Based on yield analysis 1:3 (water extraction), 4% (salt extraction), 1:3 (alkaline extraction) and 1:4 (ethanol extraction) were selected as best. Developed protocols containing 13.34% \pm 0.97 (Water extraction), 17.69% \pm 1.39 (Salt extraction), 4.39% \pm 0.44 (Alkaline extraction) and 9.74% \pm 0.56 (Ethanol extraction) crude protein respectively ($p < 0.05$). All treatments showed a low-intensity band pattern with 15% SDS-PAGE, confirming the characteristics of the protein. For DPPH radical scavenging activity, the salt extract showed higher activity with 58.94% \pm 1.52, and ethanol extract showed the highest iron-chelating and low malondialdehyde concentration ($p < 0.05$). Results of Total Plate Count showed less antibacterial activities among crude protein extracts of *S. crassifolium* ($p < 0.05$). These results conclude that crude protein produced from *S. crassifolium* has good antioxidants, metal chelating, and antibacterial properties which can be used in the food industry.

Keywords: *Sargassum crassifolium*, Crude protein, Antioxidant, Metal chelating, Antibacterial

Extraction of Crude Protein from *Hilsa kelee* and Determination of its functional properties

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Karattaya (*Hilsa kelee*) is a marine pelagic species. *H. kelee* is a seasonal fish species and has high catch from April to September. However, it does not have a high market demand due to its bony structure and sharp tough bones which make it hard to eat. Due to that, it generates a large quantity of waste and currently used only in the production of fish meal. Therefore, the objective of this study was to develop a simple nontoxic method for extracting crude protein from *H. kelee* and to determine the functional properties of the extract. Collected fish samples were blended and treated with 04 different ratios as a sample: distilled water 1:1, 1:2, 1:3 and 1:4 to separate sarcoplasmic proteins followed with salt extraction with 5%, 10%, 15% and 20% (w/v) concentrated NaCl at 1:10 ratio to separate myofibrillar proteins separately. Crude extraction was lyophilized and selected the best ratio and concentrate by using the yield and SDS-PAGE analysis. Antimicrobial properties, antioxidant properties, and metal chelating properties of selected extracted crude protein were determined. All treatments were replicated (n=3). *H. kelee* contained moisture, ash, crude protein $67.39 \pm 2.23\%$, $5.07 \pm 0.92\%$ and $20.38 \pm 2.38\%$, respectively. In yield analysis of water extraction 1:4 ratio showed the highest yield compared to other treatments ($p < 0.05$). In salt extraction, there was no significant difference between yields ($p > 0.05$), therefore 5% (w/v) was selected as the best sample for further experiment. Antioxidant activities of extracted Fish Protein Concentrates (FPC) were higher in the salt extracted sample than the water extracted sample ($p < 0.05$). FPC had a negative response to the Fe^{2+} chelating activity. No inhibition was observed against *E. coli* and Total Plate Count (TPC) up to 20,000 ppm concentration in all FPC. It concludes that extracted FPC contains strong antioxidant properties. However, they do not exhibit Fe^{2+} chelating properties and antimicrobial properties.

Keywords: *Hilsa kelee*, Fish Protein Concentrate, Extraction, Antioxidant property

Development of a Simple Non-toxic Scale-up Method for Extracting Crude Collagen from Yellowfin Tuna (*Thunnus albacares*) Skin

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During processing, a greater quantity of fish is dumped as waste which causes a major environmental impact. Therefore, it is crucial to investigate possible ways to minimize the waste and use of these wastes at the industrial level. Thus, the current study was aimed to develop a simple, non-toxic, and scale-up method to extract crude collagen from yellowfin tuna (*Thunnus albacares*) skin. Collagen extraction was carried out through a pre-treatment process where the skin was agitated with 0.1 N NaOH for 48 hours. Two different acid types, lactic acid (0.4 M, 0.5 M, 0.6 M) and acetic acid (0.5 M, as in the previous study) were compared. Sodium chloride (10% w/v) was used to precipitate crude collagen. Extracted collagens were lyophilized and yield was calculated. For the agitation purpose, specially prepared agitator (30 L capacity and 50 rpm) was used. Then, 10% SDS-PAGE (sodium dodecyl sulfate and polyacrylamide gel electrophoresis) analysis and FTIR (Fourier-transform infrared spectroscopy) analysis were carried out for the identification of the extracted crude collagen. The highest yield of collagen was obtained from 0.6 M lactic acid-treated fish skin compared to the rest and it was 14.46 ± 0.56 % based on the wet weight of the skin ($p < 0.05$). All the crude collagen extracts of different concentrations exhibited Amide A, Amide B, Amide i, Amide ii, and Amide iii which are the characteristic spectra of collagen in the FTIR spectrum. Based on the SDS-PAGE analysis it was revealed that the crude collagen extracts have two α -bands and one β -band which is a characteristic of type I collagen. Thus, this study revealed the tuna skin is a good source to extract type I collagen for the commercial and industrial uses.

Keywords: Fish collagen, *Thunnus albacares*, Lactic acid, Acetic acid, Extraction

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Exploring the Demand for Microlivestock Products in Galle District

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Demand for food of animal origin is growing faster than production due to improved health education, higher per capita income, and increasing in the tourist industry in the country. Microlivestock species are an important source of animal protein as a result of the rapid increase in the human population. The purpose of this study was to analyze the contemporary demand and awareness of microlivestock products in Galle district during November and December 2019. Data were collected from 100 foreigners and 65 hotels (3-star and above) by using stratified and simple random sampling techniques. A pre-tested questionnaire was given to both parties and collected data were analysed using descriptive statistical methods. According to the study, most of the tourists and local consumers preferred to have turkey meat (31%) and followed by duck (25%), rabbit (16%), geese (15%), and quail (13%) meat respectively. Among them, 25% preferred to have quail eggs and 23% for duck eggs. The study further revealed that the total of microlivestock meat (turkey - 1139 kg, duck - 634 kg, rabbit – 97 kg, quail - 22 kg) and egg (quail - 7050) were consumed in the selected hotels during the period. 58% of hotels preferred to purchase microlivestock products from near farms. The majority of consumers preferred to eat the meat of geese and turkey, quail eggs, duck meat, and eggs while rabbits as pets. The study concluded that there was an adequate awareness related to microlivestock products within the Galle district, but lack of availability of microlivestock products in the Galle area was a problem. Therefore, there is a potential for expanding the microlivestock industry in the district with proper guidance.

Key words: Microlivestock, Demand, Awareness, Galle district

Identification of Common Pathogenic Bacteria and Suitable Antibiotics for Treatment of Bovine Mastitis in Badulla District

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Mastitis is a common problem in dairy farms which is caused by multiple pathogens. Ad hoc use of antibiotics can lead to the development of antibiotic resistance in common mastitis-causing bacteria. Identification of common pathogens and their resistance to antibiotics is important for future mastitis treatment plans. The present study was conducted to identify the prevalence of different mastitis-causing bacteria and antibiotic sensitivity of bacteria isolated from milk samples of dairy cows with mastitis in the Badulla district. The study considered milk samples received by Veterinary Investigation Centre, Badulla. A total of 55 milk samples from lactating cows were collected and California Mastitis Test (CMT) was used to detect the severity of mastitis. Milk samples were collected from all four quarters of affected cows. Bacteria in CMT positive milk were cultured and identified using colony morphology, Gram staining, and biochemical tests including catalase, urease, citrate, Triple Sugar Iron Agar, Sulfide Indole Motility test, etc. Sensitivities of the isolates were tested against five antibiotics; Amoxicillin, Cephalexin, Enrofloxacin, Gentamycin, and Neomycin using Kirby-Bauer method. Statistical analysis was done by one-way ANOVA. The pure and mixed bacterial infection in total mastitis cases were 90% and 10%, respectively. Hindquarters (55%) were mainly affected than the forequarters (45%). There is no significant difference between the association of mastitis severity and the affected quarter ($p>0.05$). The prevalence of mastitis is more common in 5 to 7 years of age. The prevalence of *Staphylococcus* spp. was high (72%) followed by *Escherichia coli* (6%), *Klebsiella* spp.(6%), *Streptococcus* spp.(4%), *Pasteurella* spp.(4%) and *Bacillus* spp. (4%). Bacterial isolates were most sensitive to Enrofloxacin and Gentamycin. Around 75% of the isolates were resistant to one or more antibiotics. In conclusion, *Staphylococcus* is the most predominant pathogenic bacteria present in mastitis milk and, Enrofloxacin and Gentamycin are the most suitable antibiotics for treatment of bovine mastitis in Badulla district.

Keywords: Bacteria, Mastitis, Antibiotic Sensitivity

Rumen Protected Fat Preparation using By-products Generated in Coconut Processing Industry

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Rumen protected fat (RPF) is an energy supplement used in dairy cattle feeding. Yet, none of the studies were conducted in manufacturing RPF in Sri Lanka. Hence, the present study was conducted to optimize the fusion method of preparing RPF using by-products generated in the coconut processing industry in Sri Lanka. Amongst 03 by-products generated (i.e. sludge oil, low-fat coconut residue oil, and paring oil), paring oil was selected as the suitable fat source for preparing RPF due to its favourable physiochemical properties and ease of extraction. The fatty acid profile of the paring oil was determined using Gas Chromatography (GC). For producing RPF using fusion method, paring oil was mixed with CaO (aq) and heated using direct heat. In the experiment, RPF samples were prepared using CaO percentage in the range of 11%-14% with the time, temperature combinations ranging 10 – 120 minutes, and 150 – 300 °C, respectively. The best time, temperature, and CaO% were finalized as 30 minutes, 250 °C, and 13.5%, respectively. The crude fat content, ash content, and pH of the final product was assessed. The stability of the final product in the rumen was assessed by comparing it with a commercial RPF using *in vitro* gas production technique. According to GC results, Lauric acid was identified as the highest available fatty acid in paring oil. The crude fat and crude ash content of the final product was $77.77 \pm 0.32\%$ and $22.16 \pm 0.37\%$, respectively. As confirmed by the *in vitro* gas production technique, rumen-protected fat produced from paring oil and commercial rumen-protected fat had indicated similar stability under *in vitro* rumen conditions. The final product showed no significant difference ($p < 0.05$) in pH up to 5 weeks. The current method yielded 1.11 kg of rumen-protected fat from 1 kg of paring oil. Considering the above results, the current process was identified as a successful method of preparing rumen-protected fat using paring oil generated.

Key words: CaO, Coconut processing industry, Fatty acids, Fusion method, Paring oil

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Vulnerability of Farming Communities Practicing Livestock Monocultures or Crop-Livestock Integrated Systems to Climate Change: A Case Study in Ampara District

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Livestock either as monocultures or as crop-livestock integrated systems is an integral part of the socio-economic fabric and physical landscape of Ampara District, where the population remains largely rural. This study used Livelihood Vulnerability Index (LVI) and Intergovernmental Panel on Climate Change Vulnerability Index (VI-IPCC) to assess and compare the vulnerability of two types of livestock farming systems. A household survey among 200 farm families practicing livestock alone and as a component of crop-livestock integrated systems was carried out in four divisional secretariats (Nintavur, Sammanthura, Irakamam, and Ampara) in Ampara District. Eight major components were considered under LVI assessment: Socio-Demographics, Livelihood Strategies, Social Network, Health, Food, Water, Natural Disasters, and Climate Variability. Each major component made up of several sub-component variables that were averaged to calculate the weighted value of major components for each division. Assessment based on the IPCC framework considered exposure, adaptive capacity, and sensitivity. Goat farmers showed a higher vulnerability score for livelihood strategies (0.620) major component. Poultry farmers reported a higher vulnerability score for water (0.083) major component. Buffalo farmers gave a higher vulnerability score for social networks (0.576). Integrated farmers recorded a higher vulnerability score for socio-demographics (0.255), health (0.418), food (0.451) and natural disasters (0.559) major components. For the VI-IPCC, Goat farmers reported a higher adaptive capacity score (0.597). Integrated farmers have a higher exposure score (0.460) and a sensitivity score (0.291). Irakamam division and Poultry farmers were identified as the most vulnerable, while Ampara division and goat farmers were the least vulnerable. Compared to crop-livestock integrated systems, livestock alone systems are concluded to be more vulnerable to climate change.

Keywords: Climate change, Livestock farming systems, Vulnerability, Vulnerability index

Effect of Bread Fruit (*Artocarpus altilis*) Flour on Growth Performance and Meat Quality Parameters of Broiler Chickens

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Breadfruit flour (BFF) is considered as an energy rich food ingredient which provides an excellent source of calories for the diet. The study reported herein was conducted to determine the effect of breadfruit (*Artocarpus altilis*) flour on growth performance and meat quality parameters of broiler chickens. Ninety-day old Cobb 500 broiler chicks were randomly assigned into three dietary treatments as control (0% BFF), treatment 1 (5% BFF), and treatment 2 (10% BFF) in a booster, starter and finisher diets, respectively. Each treatment replicated three times with 10 birds per replicate. Body weight, feed intake and feed conversion ratio (FCR) were recorded for 5-weeks. On day-36, two birds from each replicate were randomly selected and were slaughtered for carcass analysis. Data were analysed using a one-way analysis for a variance by using Minitab 17 software. Tukey multiple range test was used to determine the significant differences between experimented groups at $p < 0.05$. There was no significant difference ($p > 0.05$) on feed intake of broilers fed different dietary treatments. Birds fed 10% BFF achieved the highest ($p < 0.05$) weight gain and the lowest FCR compared to other treatments. The highest ($p < 0.05$) dressing percentage and the relative weights ($p < 0.05$) of heart, liver, and intestines were recorded from the birds fed the diet having 10% BFF. No significant effect ($p > 0.05$) was observed in proximate composition and meat quality parameters tested. Sensory attributes were higher in birds fed treatment 2 and the highest ($p < 0.05$) overall acceptability was recorded by the birds fed with 10% BFF. In conclusion, breadfruit flour can be incorporated into broiler diets at a 10% level to enhance body weight, good carcass yield, and to improve meat quality parameters of broiler chickens without any negative effects.

Keywords: Breadfruit flour, Broiler chickens, Growth performance, Meat quality

Effect of Non-Tariff Measures on Sri Lankan Tea Trade: A Bayesian Inference

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Non-tariff measures such as food safety standards on agricultural trade have become an emerging barrier throughout the world. The objective of this paper is to assess the impact of Sanitary and Phytosanitary measures for Sri Lankan tea exports by stipulating Maximum Residual Levels (MRLs) for the pesticide Endosulfan that is mostly used for tea production all over the world. Bayesian analysis was used in this study to estimate the gravity equation for the tea exports from Sri Lanka using a Multilevel Mixed Model. Panel data from 2003 to 2017 for fourteen prime destinations of Ceylon tea were considered for this study. The results show that the MRL of pesticide imposed by importing countries has significantly affected Sri Lanka's tea exports. One percent decrease in the MRL on Endosulfan can result in a 0.67% (approximately USD 10,138,488.77 in 2017) decrease in Sri Lanka's tea exports and one percent increase in the tariff rate leads to a 0.03% percent decrease in the value of Sri Lankan tea exports. By comparison with the tariff effect, the MRL is associated with a bit higher trade effect for Sri Lankan tea exports. Policy implication such as large variations among countries and increasingly tighter restrictions from developed countries on food safety standards leads to great challenges in exporting food products like tea. Thus, these outcomes recommend that the negative impact of MRLs is found to outweigh the impact of import tariffs, highlighting the greater role that non-tariff measures play on Sri Lankan tea exports. Therefore, there is an urgent need for regulatory policies to uplift Sri Lankan tea exports.

Keywords: Bayesian analysis, Gravity model, Maximum residual level, Non-tariff measures, Tea exports

A Model for a Mobile Application to Support Agro-ecological Zones based Crop Selection in Sri Lanka

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Agriculture is the key source of livelihood and economic support for the Sri Lankan population. The farmer is the salient stakeholder in agriculture and he has to decide the appropriate crops for cultivation in every season. This decision should be primarily based on market conditions including pricing but several other factors such as climatic conditions of the area, land suitability, irrigation facilities, etc. should also take into consideration. Thus, crop selection is a vital and critical decision that farmer has to get in the farming lifecycle and many farmers face problems in selecting the right crops at the right time to grow. Therefore, in this study, a digital platform has been created to provide crop suitability information based on the agro-ecological zones in Sri Lanka. Providing information regarding suitable crops according to agro-ecological zones in Sri Lanka is the correct intervention to facilitate farmers during the crop selection stage. Contextual data for crop selection were mainly gathered through primary and secondary sources. The study learned that the agro-ecological zones have been classified based on different climatic zones, annual rainfall, terrain characteristics, available major soil groups, and recommended crops for all agro-ecological zones. A crop selection model was designed and listed out suitable crops based on 46 agro-ecological zones in Sri Lanka. Further, this decision is depended on the influence factors such as major cultivation seasons, irrigation types, and farmer preferences, etc. The designed model has been provided through a mobile-based platform to the farmers. Then, they could easily find recommended crops and varieties suitable to their farms by asking users to add their Province, District, Divisional Secretariat, and Grama Niladhari, division. Thus, the model will be promised in supporting farmers to increase the profit and social status of the farmers in Sri Lanka.

Keywords: Agriculture, Agro-ecological zones, Crop selection, Farmers, Mobile application

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Economic Efficiency in the Tea Estate Sector: A Case Study from Dimbula Tea Region

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Being the main agricultural export crop for around 150 years, tea contributes to the Sri Lankan economy in a significant manner. In the recent past, Sri Lanka's tea production and exports show a declining trend. Making matters worse, the average price has fallen below the average cost of production causing low profits. Amidst these, the tea estate sector faces many additional challenges in the form of the high cost of production, scarcity of labor, and maintenance issues. However, despite having the aforementioned constraints, some estates perform well while others are not. Hence, this study aims to analyse variability in the economic efficiency and determinants of revenue using a stochastic revenue frontier. To estimate the revenue function, panel data were collected from seven tea estates in the Dimbula region, which were selected by the purposively based on the availability of data and the access for the required data. Green leaf amount, Net Sale Average (NSA), labor days, chemical cost, and fertilizer cost were extracted from estate monthly accounts from 2005 to 2018. To estimate the stochastic revenue frontier, Battese, and Coelli model (1988) was used to capture the firm specific time invariant inefficiency. Results showed a mature area extent, NSA and labor days has a positive significant impact on revenue. The largest impact on revenue is given by the increase in extent as expected. A 1% increase in extent increases revenue by 1.4%. Similarly, a 1% increase in NSA can increase the revenue by 0.76% and a similar increase in labor can increase the revenue by 0.07%. Selected tea estates in the Dimbula region have a mean efficiency of 84%, which implies that still efficiency can be improved by 16% on average. Even though the mean is 84%, the maximum is 96.92% and the minimum is 68% showing that the inefficiency range is 31.97% to 3.08%. Therefore, it is clear that some estates have not achieved even the mean level of efficiency and a considerable amount of potential revenue is lost due to inefficiency.

Keywords: Economic efficiency, Revenue function, Stochastic frontier, Tea estate sector

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Determination of Nutrient Composition in Locally Available Feed Ingredients in Anuradhapura

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The objective of this experiment was to assess the nutrient quality of locally available feed ingredients for feeding ruminants in Anuradhapura district, Sri Lanka. Agro-industrial by-products such as rice (*Oryza sativa*) bran, maize (*Zea mays* L.) meal, coconut (*Cocos nucifera*) poonac and soya bean (*Glycine max*) meal and different fodder species such as maize (*Zea mays*), sorghum (*Sorghum bicolor*), CO3 (*Pennisetum purpureum*), guinea grass (*Panicum maximum*) and Gliricidia (*Gliricidia sepium*) were used. The chemical composition of the above ingredients was determined according to the association of official analytical chemists. The ingredients were analysed for dry matter content, crude protein, crude fiber, ash, ether extract, and gross energy content. From the tested ingredients, soya bean meal ($50.56 \pm 0.25\%$), coconut poonac ($19.39 \pm 0.25\%$), and Gliricidia ($23.78 \pm 0.79\%$) had comparatively higher crude protein contents. Rice bran (4219 ± 209.30 kcal/g), Gliricidia (4066.50 ± 0.71 kcal/g), sorghum (3882 ± 39.60 kcal/g), coconut poonac (3877 ± 66.47 kcal/g), and soya bean meal (3714 ± 33.94 kcal/g) had higher gross energy contents compared to the other feed sources. The highest ash ($10.70 \pm 2.02\%$) and crude fiber ($38.72 \pm 1.48\%$) contents were reported in sorghum. Relatively higher ether extract content was observed in rice bran ($11.48 \pm 1.48\%$), coconut poonac ($7.16 \pm 0.40\%$), Gliricidia ($4.64 \pm 0.04\%$), and maize meal ($3.12 \pm 0.99\%$). The present results show that industrial by-products and different fodder species vary in chemical composition. According to the available nutrient composition, these feed ingredients can be used for feeding ruminants. Therefore, there is a possibility of preparing a total mixed ration using these ingredients.

Keywords: Agro-industrial by-products, Chemical composition, Feeding ruminants, Fodder species

Constraints Faced by Potato Farmers in Major Potato Growing Areas in Sri Lanka: An ICT based Intervention

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Potato is one of the most attractive crops and plays an important role in human nutrition. However, the average yield of the potato is less than its yield potential and local production is insufficient to meet the demand in Sri Lanka. Therefore, a field survey was conducted in major potato growing districts such as Badulla, Nuwara-Eliya, and Jaffna to examine key challenges faced by potato farmers. One hundred potato farmers were selected through a purposive sampling technique and interviewed using a structured questionnaire. The collected data were analyzed using SPSS. The majority of farmers from study areas cultivate potato for consumption other than seed purpose and enriched with smallholdings. Results revealed that low farmgate prices (37%), pest and disease attacks (32%), and high cost of farm inputs (20%) are the major challenges faced by the majority of farmers. Low farmgate price for potatoes is mainly due to the involvement of a higher number of middlemen, the majority of farmers cultivate potato at the same time and low quality. Potato early blight, late blight, and bacterial wilt were common diseases; mite and whitefly attacks were the common pest attacks faced by the majority of farmers. Furthermore, high input price constituted the cost of seed potato (63%), fertilizer and chemical cost (18%), machinery and labor cost (12%), and cost for irrigation (7%). Thus, the importation of seed potatoes was the key influential factor for the increase of input price. The study recommends improving better coordination among stakeholders in the industry and it is crucial to direct farmers to follow proper cultivation and harvesting techniques. Further, the study suggested that it is important to come up with a mobile-based solution mainly among farmers to access context-specific information promptly and easily; that could be resolved major challenges faced by potato farmers in Sri Lanka.

Keywords: Key challenges, Potato farmers, Yield

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Evaluation of Different Moisture Conservation Methods to Reduce Fruit Cracking in Pomegranate (*Punica granatum*) in Fruiting Stage

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Fruit cracking caused by irregular watering and moisture stress is a common problem in pomegranate that accounts for 20-40% yield loss. However, less scientific information is available on preventing fruit cracking. Therefore, this study was conducted to evaluate the different moisture conservation methods to reduce fruit cracking in the fruiting stage of pomegranate at 4-year old cultivation in Dankotuwa. Treatments were laid out in two-factor factorial RCBD with 3 blocks. Factor 01 was moisture conservation method (T1-2 kg coconut husk chips with 25 g super absorbent polymer, T2-4 kg compost, T3-2 kg coconut husk chips, T4-covering fruits with poly bags treated with 0.5 g super absorbent polymer and T5-control) and factor 02 was the mulching effect (Mulch with grass straw and No mulch). T1-T3 was buried in a trench as a 15 cm layer (in 1/3rd of canopy circle; 45 cm depth and 30 cm wide trenches). Super absorbent polymer material was analysed separately for its physical and chemical properties. Yield and quality parameters were tested through field evaluations. pH (7.46) and EC values (2.5 $\mu\text{S cm}^{-1}$) of the polymer were not at a hazardous level to the plant growth or soil and its absorption capacity was 329.66 ml g⁻¹. However, it failed to return to dry form after saturation at a considerable time by making it less practicable for repeated use. No significant interaction effect was observed in the number of flowers, healthy fruits, cracked fruits, flowers, and fruit drops ($p \geq 0.05$). Further, no significant difference was observed in any quality parameter. The number of cracked fruits was significantly affected by the moisture conservation method. Fruit cracks were reduced by 33% in the fruiting stage by burying 2 kg of dried coconut husk chips (T1) as a 15 cm thickened layer around the 1/3 of the canopy circle of pomegranate in 45 cm depth and 30 cm wide trenches. Hence, the coconut husk chip application can be recommended as an effective remedy to reduce fruit cracking in pomegranate.

Keywords: Fruit cracking, Moisture conservation, Mulching, Super absorbent polymer, Moisture stress

Amelioration of Cadmium (Cd) Stress in Rice (*Oryza sativa* L.) by using Selected Soil Amendments and Aquatic Plants

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Heavy metal contamination in paddy soil, particularly Cadmium (Cd) has become a serious issue with the potential risk of transferring Cd to the human food chain. Rice plants exposed to high Cd, encounter deleterious effects on growth and yield. This necessitates the need to identify effective and feasible remediation measures to ameliorate Cd stress in rice. Therefore, the efficacy of using selected soil amendments and floating aquatic plants to ameliorate Cd stress in rice was evaluated in this study under controlled environmental conditions using rice variety Bg 250. The experiment was laid out in a Complete Randomized Design with six treatments replicated thrice. Water lettuce (*Pistia stratiotes*), duckweed (*Lemna minor*), partially burnt rice husk (RH), and rice straw (RS) were evaluated as the amelioration treatments under two soil Cd contamination levels (5 and 8 ppm). The control was maintained with the only Cd without any amelioration. RH and RS were separately incorporated to Cd treated soil and mixed well at two levels (soil: RH or soil: RS, 1:1 and 2:1 v/v). Upon transplanting of rice, the aquatic plants were introduced to Cd treated pots. Growth and yield parameters were measured at 45 and 75 days after transplanting. Rice grown in the soil medium amended with RH (1:1 v/v) showed significantly higher values for plant height (43 ± 0.2 cm), the number of tillers (3.67 ± 0.03), root length (24.33 ± 1.2 cm), root volume (13.33 ± 0.7 cm³), root dry weight (3.17 ± 0.2 g plant⁻¹), shoot dry weight (7.44 ± 0.07 g plant⁻¹) and seed dry weight (3.12 ± 0.15 g plant⁻¹) compared to the control under 5 ppm Cd level. A similar pattern was observed in the other Cd level as well. Interestingly, the aquatic plants reduced the growth and yield of rice possibly due to competition for resources. In conclusion, RH has the potential to be used as an effective soil amendment to ameliorate Cd stress in rice. Field investigations are suggested for making a general recommendation.

Keywords: Aquatic plants, Cd stress, Growth and yield, Rice, Soil amendments

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Antifeedant Activity and Contact Toxicity of the Two Peptaibols, Trichocellin A-I and B-II Isolated from the Endophytic Fungus *Trichoderma reesei*

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Plutella xylostella is a destructive cabbage pest responsible for massive economic losses worldwide. The use of synthetic pesticides in huge amounts for its control has resulted in pesticide-resistant strains, detrimental human health impacts, and environmental problems. Consequently, the development of alternatives with minimal such undesirable side-effects becomes crucial. Biopesticides derived from microbes are one such alternative. In a preliminary study, the crude extract of the endophytic fungus *Trichoderma reesei* isolated from *Cyperus iria* exhibited prominent antifeedant activities against *P. xylostella* larvae. The main aim of the current study was to isolate the bioactive compounds of *T. reesei* and investigate their antifeedant activities and contact toxicities against *P. xylostella* 2nd instar larvae. Two bioactive peptaibols, trichocellin A-I and trichocellin B-II, were isolated from the ethyl acetate extract of *T. reesei* using a bioassay guided purification method and their structures were elucidated using nuclear magnetic resonance and mass spectral data. To investigate the antifeedant activities choice leaf disc assay was conducted at an initial concentration of 50µg/cm² using commercial neem (100%) and methanol as positive and negative controls respectively. For contact toxicity assay larval mortality was calculated after 24 h of applying 17.5µg of compounds/larvae. Trichocellin-A-I resulted in a 100% feeding deterrence while the DC50 value was 2.38µg/cm². Trichocellin B-II also gave a feeding deterrence index of 100% for choice leaf disc assay. For the contact toxicity assay, Trichocellin A-I and B-II showed 40% and 50% mean motility percentages respectively while the respective values for positive and negative controls were 100% and zero. This study revealed that the endophytic *T. reesei* produces two biopesticides, trichocellin A-I and trichocellin B-II, that exhibit potent antifeedant activity and moderate contact toxicity against *P. xylostella* larvae.

Keywords: *Plutella xylostella*, *Trichoderma reesei*, Choice leaf disc assay, Contact toxicity

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Households Demand for Selected Food Commodities in Uva Province of Sri Lanka

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The pattern of food consumption in Sri Lanka has been undergoing dramatic changes over the last decades. The changes in food prices and income have a greater effect on the food consumption pattern of households, especially among the poorer households. This study investigates the effects of food price and income variation on households' food consumption patterns in the Uva province using Household Income and Expenditure Survey 2016 conducted by the Department of Census and Statistics. The study estimated the demand for selected food items namely rice (white kekulu – normal), bread, dhal, chicken, coconut, milk powder, and sugar applying the Linear Approximation of the strict Almost Ideal Demand System model using the Seemingly Unrelated Regression procedure. Descriptive analysis show households in Uva province spend mainly on cereals and vegetables while the lowest amount spends on sugar, meat, and pulses compared to other provinces. Especially, liquor consumption is remarkably high in Uva province. The result shows that all food items are normal goods because all items have positive expenditure elasticity. Expenditure elasticity for rice, milk powder, and coconuts are greater than one implies these food items are luxury goods. The own-price elasticities are negative for all food items and less than one in absolute value, indicating price inelastic demand in these goods. Besides, almost all cross-price elasticities show negative values imply that they are complementary goods. This study concludes that households in Uva province are highly sensitive for price changes of some necessary foods including rice. Finally, this analysis suggests formulating targeted food policies to increase local production of luxury food items such as milk and rice to assist the poor families in the Uva province.

Keywords: Almost ideal demand system, Elasticity, Food consumption pattern, Household, Uva province

Examining the Market Orientation of Vegetable Farmers in Uva Province, Sri Lanka

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Sri Lanka has a long history of cultivating vegetables. There are two types of vegetables cultivating in Sri Lanka namely upcountry vegetables and low country vegetables which are varied according to agro-ecological adaptability. In the country, most of the small scale and medium scale farmers are involved in vegetable cultivation. The market orientation is the understanding of customers' wants and needs and meeting them profitably. To become market-oriented, the vegetable farmers have to meet the customers and to be educated about their requirements. But practically there is less possibility for vegetable farmers to meet the buyers due to the number of intermediaries in the vegetable supply chain and farmers are rarely practicing direct marketing. In this context, there is a suspicion that whether the vegetable farmers have a proper understanding of customer requirements. Accordingly, this research was designed to identify the factors affecting the market orientation where the market orientation of vegetable farmers was measured using the MKTOR scale. A pre-tested structured questionnaire was used in the study and 123 farmers from the upcountry and 141 farmers from the low country were randomly interviewed in their fields. Multiple linear regression was employed in data analysis. According to regression results, machinery availability, financial availability, attitudes towards market orientation, subjective norms about market orientation and the perceived behavioural control for market orientation significantly affected on the market orientation of upcountry vegetable farmers and land size of cultivation, attitude towards market orientation, subjective norms about market orientation and the perceived behavioural controls for market orientation significantly identified as factors affecting the market orientation of low country vegetable farmers in the Uva province.

Keywords: Market orientation, Vegetable farmers, Attitudes, Subjective norms, Perceived behavioural controls, MKTOR scale

Impact of Drought on Households in the Dry Zone of Sri Lanka

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When the environment is exposed to a period of aridness, it refers to the drought condition, which can alter the continuity of existence that is not able to adapt to certain conditions. Consequently, the objectives of this study were to recognize the social impacts of drought and the perception of farmers on its aspects in the Dry Zone of Sri Lanka. Since drought condition is prevailing severely in North Central Province, 533 farmers were selected randomly from eight divisional secretariat divisions to collect data through self-administrated questionnaire. The tool consisted of questions using a 5-point Likert scale to find the experience of the households regarding the perception of the drought on social aspects. The preliminary task was to find the social impacts of drought worldwide to a certain extent through the subsequent series of literature review, which was performed as a desk review of the research. It was able to excel six social impacts of drought matched with the perspective of Sri Lanka from 18 impacts that were obtained by the review. Health issues, changing the food pattern, scarcity of food, inadequate drinking water, arising conflicts among people for water resources, and migration are the six impacts. A Non-parametric analysis: Sign test with the normal approximation was performed as data were distributed freely. Correspondingly, health issues, changing the food pattern, scarcity of food, inadequate drinking water, and arising conflicts are significantly affected by drought ($Z > 1.96$) but not the migration. Heat and dust-related illnesses, low air quality, low nutritious food, low income, inadequate water supply, limited resources, and distribution of limited resources to a variety of activities are the rationales for the above results; people may not tend migration, as they cannot have any alternative. Early warning systems, awareness of drought resilience methods can be recommended to overcome the negative impacts.

Keywords: Drought, Dry zone, North Central Province, Social Impacts, Sri Lanka

Variability of Technical Efficiency in High Grown Tea Estates – A Bayesian Approach

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This study was carried out to identify the technical efficiency levels of the high grown tea estates in Sri Lanka. Data were collected from tea estates in the Nanuoya region in Dimbula planting District covering seven tea estates. Monthly data on green leaf production, revenue extent of the estate, labour costs, agrochemical costs, and fertilizer costs were extracted from monthly accounts and progress reports from the year 2005 to 2018 to form a panel data set. To estimate efficiency, stochastic frontier production functions of Cobb Douglas and Translog forms employed. Two distributional assumptions were made on the distribution of the firm specific inefficiency term as exponential and half-normal. Econometric estimation used a Bayesian framework with a non-informative Jeffrey's before estimate the posterior distribution. Results indicated that the Cobb-Douglas stochastic frontier with an exponentially distributed inefficiency term with random effect was the best fit. Technical efficiency was estimated for each tea estate assuming the time variation of efficiency cannot be seen in the sample estates. Results further indicated that there is a positive and significant impact on the monthly green leaf production by the revenue extent, labour, agrochemical, and fertilizer costs. The average technical efficiency level estimated was 86.9% and the minimum level is 66.2%. This shows that on average, in the high grown tea estates, a 13.1% increase in the production can be obtained without increasing the cost of production. Further, the highest impact on the green leaf production comes from the extent and therefore, estates should consider utilizing the abandoned tea lands to increase the production. Besides, it is prudent for the estates to look into the reasons for inefficiency and correct them so that they can increase their profitability in these hard times that most estates are running at a loss.

Keywords: Bayesian analysis, Stochastic frontier analysis, Tea estates, Technical efficiency

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Isolation and Identification of Vesicular Arbuscular Mycorrhiza in Maize Plant as Bio Control Agent

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The raising claim for more environmental and healthy agriculture is a strong intensive to find an alternative strategy to replace the use of mineral fertilizer and pesticides. Vesicular Arbuscular Mycorrhiza (VAM) a main soil microbiota represents a promising tool as a provider of key ecological services symbiotically associated with higher plant roots. It enhances nutrient uptake, tolerant to drought, toxic heavy metal, and nematode infection. Maize as host plant tested for root infection and spore count. This study was undertaken to find the occurrence and distribution of VAM colonization in rhizosphere soil and roots of maize (*Zea mays*). The fungi propagules were observed from root cortex cells by staining with a cotton blue stain. Also, spores of *Glomus*, *Gigaspora*, and *Acaulospora* species were isolated from rhizosphere soil by wet sieving with sucrose centrifuge technique. Sample soil characteristics such as electric conductivity (EC), pH, soil moisture, and texture were analysed. All tested plants are associated with VAM fungi and the number of VAM fungal spores from soils ranged from 09 to 119 per 100g of soil and infection varied from 20% to 93% there were significant differences in VAM colonization between plants sample. Spore number and root infection were negatively correlated in plants indicating that a low level of spore density is associated with high root colonization. In soil properties, EC and sand have a positive correlation whereas clay shows a negative correlation.

Keywords: Vesicular arbuscular mycorrhiza, Isolation, Spores, Morphological identification, Maize

Implementation of low cost, automated, mobile monitoring module by means of AI for container gardening in urban areas

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The limited amount of space and climate variability have led to the emergence of urban agriculture mainly in agricultural countries. This has turned urban gardens to be smart, autonomous, and efficient with the trend towards interconnected devices. The main objective of this study is to build an IoT based low cost, automated, mobile monitoring module for container gardening in urban areas. This system built with NodeMCU ESP-32 has been designed and successfully examined during the study. In constructing of the device, several sensors such as environmental humidity and temperature, light, Passive Infrared Sensor (PIR), soil temperature, soil moisture sensors and a base station connecting the cloud to the whole network were used. The system will track plants on a mobile device which has the capability of providing real-time updates on crop conditions through the internet (Thingspeak). The device is capable of measuring five parameters (soil moisture, temperature of soil & air, air humidity and light intensity) at once and show all the parameters on the ThingSpeak site for user to get the idea and also this controls the light level and soil moisture levels of the pot automatically. The acquired results have shown the performance of the device is precise. Such as collecting, logging and analyzing the irregular data from the sensors. Consequently the system is beneficial and cost effective for the commercial scale farmers as well. Farmers can be monitor their field without wasting time and resources with the help of several sensors and the alert system. With the automatic irrigation system help to reduce water wastage and it allows to use water efficiently. Therefore, the device is efficient both the farmer's as well as environment in concentration.

Keywords: Artificial intelligence, NodeMCU ESP-32, Smart gardening, Sustainability, Urban agriculture

Consumer Willingness to Pay for Underutilized Vegetables in the Badulla District

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Sri Lanka is one of the countries that consist of a wide range of plant species and they can be categorized as wild and domesticated plant species. Underutilized crops can be described as the domesticated plant species which have been eventually declined their importance for the society. The vegetable crops which are neither grown commercially in large scale nor traded widely termed as “underutilized” vegetable crops. Nowadays, consumers exhibit increased concern on the underutilized crops due to their medicinal properties, other health benefits, and nutritional values. However, prices of these underutilized vegetables at farmers’ markets and village fairs are low and unstable so that the sellers cannot maintain competitive prices and profit margin for underutilized vegetables. Therefore, this research was carried out to identify the consumer and marketing mix factors that may be influential on consumers’ willingness to pay for underutilized vegetables. To accomplish the objectives, a self-administered questionnaire was prepared and a survey was conducted with 200 customers who visited the village fair for purchasing vegetables in Badulla, Bandarawela, and Hali Ela divisional secretariat area in Badulla district. For data analysis, the ordered logit model was applied. The results of regression analysis revealed that consumer age, income, suffering from non-communicable diseases by family members, number of children present in the family, attitude towards health benefits of foods, knowledge on health foods, and marketing mix factors were significantly associated with the consumer willingness to pay for underutilized vegetables. Furthermore, the marginal effects were calculated to reveal the probable impact of each significant independent variable on consumers’ levels of willingness to pay for underutilized vegetables.

Keywords: Underutilized vegetables, Willingness to pay, Consumer factors, Marketing mix factors, Ordered logit model

The Effect of Pre-incubation Storage Duration on the Embryonic Development and Hatch Weight in Cobb 500 Broiler Hatching Eggs

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It is a common practice of storing hatching eggs until they are finally placed in an incubator. The effect of pre-incubation storage duration on embryonic development and hatch weight has not been fully investigated. This study was conducted to identify the effect of pre-incubation storage duration on embryonic development, hatch weight, and to determine the best pre-incubation storage duration that gives the highest embryonic development, hatch weight in broiler hatching eggs. Broiler hatching egg samples with the weight range of 64-67g and approximately similar colour and shape index from the Cobb 500 strain were randomly selected from 8 a.m. to 9.30 a.m. for the experiment and stored under 16-18°C and 75% relative humidity. Six experiments were carried out and each experiment consisted of the 15 treatments and 3 replicates. Day 1 storage of the egg samples was considered as the control and day 2 to day 15 of the storage were the rest of the treatments. The embryonic development was measured by the diameter of the blastoderms, the diameter of the blood rings, the highest distance between air sac, and the area of blood vessels spread and the weight of 15 days old embryos. The hatch weight was measured at the initial and the post stages of the hatching. Collected data were subjected to the One-way ANOVA technique independently for each experiment. The embryonic development was decreased ($p < 0.05$) from day 8 of the storage and the hatching weight was decreased ($p < 0.05$) from day 9 of the storage. The maximum embryonic development and the hatching weight were observed on day 3 of the storage. The reason for delay the development after 3rd day of storage can be the delay of initial embryonic development due to cold storage. In conclusion, broiler hatching eggs can be stored up to 7 days without reducing embryonic development ($p < 0.05$) and up to 8 days without reducing hatch weight ($p < 0.05$). The maximum embryonic development and the hatching weight were obtained on day 3 of the storage.

Keywords: Broiler, Cobb 500, Hatching eggs, Embryonic development, Hatch weight

A Study on Gastrointestinal Strongyle Parasitism of Free Grazing Jaffna Local Sheep

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Gastrointestinal (GI) parasitism is a major health problem that limits the maximum production of sheep. *Ad hoc* use of anthelmintics has been led to anthelmintic resistance in parasites. Hence, strategic deworming of parasite susceptible risk groups will be a suitable option to reduce the anthelmintic usage and further development of anthelmintic resistance in parasites. Therefore, this study was aimed to identify the differences of parasite susceptibility for GI strongyle parasitism between males & females and adults & kids of Jaffna Local Sheep (JLS). Five large-scale farms in the Jaffna Peninsula, which are managed similarly were selected for the study. Direct rectal, faecal samples were collected from a total of 214 {Male-Adult (MA)-50; Male-Kid (MK)-49; Female-Adult (FA)-62; Female-Kid (FK)-53} JLS who have not dewormed. Faecal Egg Count (FEC) of each sample was determined by the modified McMaster counting technique and log-transformed FEC { $\text{LnFEC} = \text{Ln}(\text{FEC} + 100)$ } were analysed by PROC-MIXED procedure of SAS 9.2 software. The FEC in females (705.21 ± 70.74) were significantly higher than males (623.93 ± 62.70), ($p < 0.05$). The age effect on FEC was not significant ($p > 0.05$) reflecting the presence of similar infections in adults (649.42 ± 65.14) and kids (677.75 ± 68.11). The interaction effect of sex \times age on FEC was significant. Further, female kids (749.29 ± 78.30) have significantly higher FEC compared to MK, FA, and MA ($p < 0.05$). The fact that high parasitic susceptibility in female kids may be due to high stress in females may have contributed to the high reproductive events and insufficient or unbalanced diets against their high needs. In conclusion, sheep female kids are the high-risk group for GI strongyle parasitism. Strategic deworming of female sheep, especially kids will be useful in the prevention of GI strongyle parasitism in sheep.

Keywords: Gastrointestinal parasitism, Jaffna Local Sheep, Faecal egg count

Determining the Willingness to Adopt Sustainable Rice Supply Chain Approach in Sri Lanka

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Rice is the major staple diet of people in Sri Lanka and is the single most important crop occupying in Sri Lanka. Although it represented a major supply chain in the country there are many issues regarding the durability of the rice supply chain. Achieving sustainability supply chain practices is the best way to address those issues. For that, it is important to consider the willingness of each member in the supply chain. The main purpose of this study is to determine the willingness to adopt the sustainable rice supply chain approach in Sri Lanka. To accomplish the objective, a structured questionnaire was constructed and direct interviews were conducted with 100 farmers and 37 rice mills in Pollonaruwa and Hambanthota districts. For data analysis ordered logistic regression model was used and the marginal effects were calculated. The regression results revealed that the potential, subjective norms, perceived behavioural control, and technology acceptance have a significant relationship with the sustainability approach for the farmers' practices. The regression-based on rice mills revealed that attitudes and perceived behavioural control are the most influencing factors that affect the willingness to adopt a sustainability approach.

Keywords: Sustainability, Willingness, Rice Supply Chain

Effect of DMX-7 Mold Inhibitor on Mold Inhibition and Nutritional Composition of Commercial Layer Feed Stored under Room Temperature

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DMX-7 is a mold inhibitor used in the animal feed industry. The objectives of this study were to determine the effect of DMX-7 on layer feed, the effective dosage which could be used under Sri Lankan condition, and to analyse the proximate composition of the prepared layer feed. Four different inclusion levels of DMX-7 were used as treatments such as 1 kg^t⁻¹, 1.5 kg^t⁻¹, 1.75 kg^t⁻¹, and zero levels as the control of the experiment. The treatments were stored under room temperature. Proximate composition, mold colony count, and aflatoxin detection during 60 days of storage duration were measured in triplicate at biweekly intervals. Statistical data were analysed using one-way ANOVA and Tukey's multiple range test at $p < 0.05$. Proximate analysis was done to determine the moisture, crude protein, crude fat, crude fiber, and total ash. Feed samples were inoculated on Sabouraud Dextrose Agar and mold colonies were counted after 7 days incubation period at 25° C. Isolated colonies were inoculated on Coconut Agar Media (CAM) and were incubated at 25° C for 7 days. Aflatoxin analysis was performed in the presence of fluorescence ring on CMA under UV light. During the storage period except for moisture, the proximate composition of all the treatment was not shown a significant difference. The mold colony count was increased in all treatment with storage duration. The highest mold count was recorded in the control. DMX-7 added treatments were not shown a significant difference in the mold count with each other. The presence of the fluorescence ring firstly appeared at 45th day of storage on the control and others were not present the fluorescence ring at the rest of storage duration. In conclusion, DMX-7 can be used to control the growth of mold in layer feed. Based on microbial, nutritional, and cost basis the effective dosage of DMX-7 is 1 kg^t⁻¹ of feed. The aflatoxin contamination has reduced by the effect of DMX-7 and the nutritional composition of prepared layer feed was not altered by DMX-7.

Keywords: DMX-7 Mold inhibitor, Layer feed, Proximate analysis

The Effect of Canopy Thermal Changes on Growth, Yield and Grain Sterility of Three Ultra-short age Rice Varieties under Aerobic and Flooded Conditions

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Canopy Temperature (CT) represents the temperature experienced by the uppermost portion of the crop canopy. CT may better explain the grain sterility associated with high temperatures than the air temperature. Most of the CT related experiments were conducted on wheat. Therefore, Sri Lankan rice varieties were evaluated at the Rice Research and Development Institute, Bathalagoda under two soil moisture conditions to realize the canopy thermal changes and its impact on growth, yield, and grain sterility. This Experiment was arranged in a two-factor factorial in Completely Randomized Design with eight replicates. Factor one was soil moisture conditions, aerobic, and flooded. Factor two was rice varieties; Bg 250, Bg 252, and Ld 253. CT, growth, and yield parameters were recorded. CT at 10:00 h had a positive impact ($r=0.76$) on grain yield in flooded condition and CT at 9:00 h had a positive impact ($r=0.77$) on yield in aerobic conditions. Grain sterility increased with increasing CT in both moisture conditions. The number of tillers was negatively correlated with maximum CT, while plant height was positively correlated with minimum CT in both conditions. CT at spikelets opening had a negative impact ($r=0.76, 0.80$) on pollen fertility at heading and positive impact ($r=0.95, 0.85$) on grain sterility in both conditions. Moreover, growth and yield performances were superior under flooded conditions compared to aerobic conditions. Interaction between soil moisture and variety was significant for thousand-grain weight and pollen fertility % where highest values were recorded by Bg 250 (29.33 g) and Bg 252 (96.4%) in flooded conditions, respectively. In conclusion, monitoring CT dynamics can be considered as a useful tool to assess the growth and yield performances of rice under varying environmental conditions.

Keywords: Rice (*Oryza sativa*), Canopy temperature, Aerobic & flooded conditions, Grain sterility, Pollen fertility

Effect of Root Pruning on Growth and Yield Performance of Potatoes Grown in Aeroponic System

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Production of potato mini-tubers through aeroponics is gaining popularity with the increased demand for more efficient, high-quality seed production methods. Root zone with mini-tubers of potatoes is always wetting with a nutrient solution in the aeroponic system making roots more vulnerable to fungal infections. Disease infected roots can be removed by practicing root pruning. However, proper assessment is needed to identify the effect of root pruning on tuber production. Therefore, the effect of root pruning on growth, mini-tuber yield and, quality of aeroponically grown different potato varieties were evaluated at the Agricultural Research Station, Seetha-Eliya during *Maha* season 2019-2020. Four levels of root pruning (no pruning and pruning $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$ of the potato roots, respectively) and three potato varieties (Granola, Red La Soda, and Arnova) were tested using two-factor factorial design of CRD with four replicates. Growth, yield, and quality parameters such as specific gravity, starch, and dry matter content were recorded. Data were analysed using SAS statistical software. Plant height, compound leaf width, terminal leaf length & width, and stolon number were not significantly affected by root pruning or variety ($p \geq 0.05$). The interaction effect between pruning level and variety was significant for mini-tuber yield where the highest value was recorded by Granola with no root pruning (235.98 g) which was statistically similar to the value recorded by $\frac{1}{4}$ level of root pruning (235.72 g). The highest starch (8.06%) and dry matter (13.53%) contents of mini-tubers were found in Granola at $\frac{1}{4}$ level of root pruning and no pruning, respectively. The specific gravity of mini-tubers was not affected by root pruning or variety. In conclusion, pruning at a level of $\frac{1}{4}$ of the total root length can be recommended for aeroponically grown potato with root infections as it does not cause any yield or quality reduction.

Keywords: Aeroponics, Growth, Yield, Potato mini-tubers, Quality, Root pruning

Investigating the Association of Vesicular Arbuscular Mycorrhiza (VAM) with *Commelina benghalensis* Weed Species in Tea Lands

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A study was conducted to investigate the association of Vesicular Arbuscular Mycorrhiza (VAM) with *Commelina benghalensis* (Girapala), which is an aggressive weed infesting in tea cultivations. A field experiment was carried out at Wewessa estate, Badulla from September to December 2019. Four treatments i.e. Tea infested with *C. benghalensis* slashed at 3 weeks interval, Tea infested with *C. benghalensis* slashed at 6 weeks interval and Tea with no weeding for 3 months and tea alone (weed-free), were included. VAM spore count and root colonization percentages were calculated at 6-week intervals. Soil Phosphorus was analyzed and tea yield was measured. VAM spore count and root colonization percentage were significantly ($p < 0.05$) higher in two treatments with *C. benghalensis* compared to those of no weeding treatment. Spore counts were recorded as 190, 200 spores/100g of soil in the treatments of which *C. benghalensis* was slashed at 3 and 6 weeks interval, against 120 in no weeding treatment. Root colonization was also reported as 56.7%, 60%, 39.4% in tea infested with *C. benghalensis* slashed at 3 and 6 weeks interval, and no weeding treatments, respectively. Significantly higher levels of soil Phosphorus (241 ppm and 237 ppm) were also reported from two treatments of *C. benghalensis* slashed at 6 and 3 weeks intervals compared to no weeding (230 ppm) treatment at the end of 3 months. There was no significant difference in tea yield between treatments. The study concluded that there is an association of VAM with *C. benghalensis* and P solubilization is taken place with VAM colonization in the rhizosphere of *C. benghalensis*. VAM association with *C. benghalensis* weed has thus been favorably affected on tea growth.

Keywords: Aeroponics, Growth, Yield, Potato mini-tubers, Quality, Root pruning

The Effect of Selected Sri Lankan Herbal Plant Crude Extracts Against *Spodoptera frugiperda* (Fall Armyworm)

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The fall armyworm (FAW), *Spodoptera frugiperda* is a recent invasive pest that has successfully established in Sri Lanka where it continues to disrupt agriculture, particularly corn production. Management of fall armyworm using agrochemicals has led to the development of resistance against many insecticides and the accumulation of toxic residues on agricultural products. Therefore, the utilization of plant extracts which are wealthy in bioactive compounds for the control fall armyworm has become a developing pattern. This study was undertaken to screen the effectiveness of *Adathoda vassica*, *Dathura metel*, and *Tagetes erecta* crude extracts against fall armyworm. Shade dried leaves were used for the extraction which was done by the Soxhlet method using methanol and ethyl acetate as solvents. Bioefficacy of crude extracts was studied against third instar larvae of *S. frugiperda* using 4000, 2000 and 1000 ppm concentrations to test the contact toxicity by topical application method, antifeedant activity by leaf disc no choice assay and repellency effect from the dual choice method. Commercially available insecticide, collagen was used as a positive control. The crude extracts from *T. erecta* (LD₅₀ - 186.63µg/g) and *D. metel* (LD₅₀ - 256.44µg/g) showed significantly ($p < 0.05$) high mortality (100%) rate within twelve hours even compared with the positive control. The results revealed that the methanolic extract of *T. erecta* showed the highest significant ($p < 0.05$) antifeedant activity (92.09%) at 4000 ppm compared with other plant extracts. All plant extracts provoked a notable decrease in feeding with the increment of their concentration. Methanolic extract of *T. erecta* showed the highest significant repellency (66.65%). Therefore, it can be concluded that methanolic extracts of *D. metel* and *T. erecta* have the power of damaging fall armyworm and are suitable candidates for the development of bio-insecticide for the local use.

Keywords: Fall armyworm, *Adathoda vassica*, *Dathura metel*, *Tagetes erecta*

Acknowledgment: This research was funded by Uva Wellassa University of Sri Lanka (UWU/RG/ST/2019/010)

Potential of Biofilm Biofertilizer Application in Paddy Soil Carbon Sequestration in Sri Lanka: An Economic Feasibility Analysis

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Anthropogenic emissions of carbon (C) to the atmosphere at higher rates have led to global warming and climate change. Soil carbon sequestration (SCS) has been recognized as the process that stores atmospheric C for a long period without escaping back to the atmosphere. Globally, expanding agricultural lands has come to play a major role in SCS in the phase of degradation of natural ecosystems like forests by deforestation, fire, etc. The objective of this study was to evaluate the potential of Biofilm biofertilizer (BFBF) application in SCS under rice cultivation. Soil stable C was estimated as sequestered soil C by using organic carbon (Walkley-Black) and oxidizable carbon in the BFBF application and the farmers' chemical fertilizer (CF) alone application. Soil samples were collected from paddy fields in 25 representative locations in several districts of Sri Lanka in three consecutive seasons: *Yala* 2018, *Maha* 2018/19, and *Yala* 2019. The results showed that the SCS was significantly ($p < 0.05$) higher in the BFBF practice in every season. This is due to increased microbial C assimilation in the root zone of soil. The BFBF practice sequestered 19 t C ha⁻¹ year⁻¹ over farmers' CF practice, showing an enormous potential to gain income through soil C trading. There was also an increasing trend in the paddy grain yield up to ca. 30% under the same practice. Thus, during the next five years, if the BFBF practice would be implemented island wide, the potential income from trading C will be ca. 190 billion rupees. In conclusion, the BFBF practice can be considered as an eco-friendly and economically viable method to replace the farmers' current practice of CF alone application.

Keywords: Biofilm biofertilizer, Carbon trading, Rice cultivation, Soil carbon sequestration

Comparison of Morphological Characters of High Performing Seedlings and Extensively Used Vegetatively Propagated (VP) Tea Cultivars in Selected Tea Estates in Passara Region

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Total tea production in Sri Lanka has been declining due to yield reduction. Vegetatively propagated tea cultivars that have a narrower genetic diversity compared to seedling tea are extensively cultivated in the Passara region where prolonged drought conditions were experienced over the past few decades. Further, there is a scarcity of suitable planting materials and well-adapted teas in this area. However, there is high performing seedling tea in the Passara region which is a good source to increase genetic diversity and gives a comparatively high yield. This study was conducted to compare twenty-one of selected high performing seedlings and extensively used vegetatively propagated cultivars in selected tea estates, Passara for ten morphological traits. According to the analysis of variance results, there was a significant difference between selected tea bushes from each estate in consideration of the given quantitative morphological traits. Cluster analysis was performed for all the considered characters to identify whether they are genetically overlapped. A seedling labelled as *GS4* from Gonakale estate has been clustered with *TRI 2025* while *GS2* and *GS3* seedlings have been clustered together with *TRI 2043*. Seedling *VS1* from Varellapathna estate has been clustered together with *TRI 2023* while seedling *VS3* has been clustered with *CY9*. None of the selected seedlings from Hopton estate were clustered together with selected vegetatively propagated cultivars in the same estate. Therefore, *GS2*, *GS3*, and *GS4* seedlings from Gonakale estate and *VS1*, *VS3* seedlings from Varellapathna estate can be recommended to maintain as mother bushes to obtain cuttings for nurseries and they can be used to increase the genetic diversity of tea in Passara region.

Keywords: Genetic diversity, Morphological characters, Seedlings, Vegetatively propagated tea cultivars

Evaluation of the Efficiency of Weed Seed Separation from Crop Seeds Using the Seed Color Sorter

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Seed color sorter machine has the potential to help quarantine purposes by facilitating the separation of weed seeds from crop seeds. It separates weed seeds from crop seeds based on color differences with the help of Near Infra-Red cameras. The current study was conducted to evaluate the separation efficiency of 'Sinvec' seed color sorter with the appropriate speed level. This study was conducted at the National Plant Quarantine Service, Katunayake, during the period from September to December 2019. Three random samples of 500 g were taken from onion, radish, coriander, leeks, and carrot separately. Each sample was mixed with quarantine important weed seed mixture which was prepared using 5 quarantine weed seed species. 10 seeds from each weed species were used. Prepared samples were tested under 3-speed levels viz., 55, kg hr⁻¹, 45 kg hr⁻¹ and 35 kg hr⁻¹. The manual separation was followed to clarify the obtained results. Average separation efficiency was calculated using 3 replicates. The time taken for the machine to finish the sorting process was measured and the weight of rejected crop seeds of each machine test was also weighed. Data were analysed using the SAS university edition. Speed 45 kg hr⁻¹ showed better performances compared to the other two speed levels. Under 45 kg hr⁻¹ speed, the weed seed separation efficiency for coriander was 80-100%. Separation efficiency for leeks, carrot, onion, and radish was 73-100%, 76-100%, 50-86% and 46.7-90%, respectively. Always, the machine method consumed less time compared to the manual method. Drawbacks of seed color sorter were found during the study as it was unable to achieve 100% separation efficiency, Improper data feeding procedure, Malfunctioning with crop seeds treated with colored fungicides, highly sensitive to voltage variations, the higher weight of rejection, needs of proper technical knowledge to operate the machine. These findings will be useful in the future for the proper functioning of the new Seed Color Sorter in handling large seed lots.

Keywords: Seed colour sorting, Separation efficiency, Weed seeds, Quarantine

Investigation on Durable Plant Materials as Alternative Sources of Mulch in Tea New Clearings in the Upcountry Intermediate Zone

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Mulching as a cultural technique is an eco-friendly practice to manage weeds. Hence, a field experiment was conducted to investigate the potential use of different plant materials as mulches in a tea new clearing at Ury estate, Passara, from September to December 2019. Tertiary branches of *Acacia mangium* (Acacia), *Cassia spectabilis* (Kahakona), *Grevillea robusta* (Sabukku) with leaves, and *Megathyrsus maximus* (Guinea grass) were used as treatments and *Cymbopogon confertiflorus* (Mana grass) was used as the 'Control'. Each mulch was spread on randomly selected tea plots each sized 14.4 m² at a rate of 1 kg dry matter m⁻² and replicated three times. The rate of decomposition of each material was assessed in terms of ground exposure percentage and weight reduction in litter bags filled with each mulch material at fortnight intervals. Weed density and weed dry weight were measured at 2 and 4 weeks intervals, respectively. Plant growth parameters were measured before and after 12 weeks mulching. Soil moisture and soil carbon content were measured. A bioassay was also conducted for any allelopathic effect of mulch materials. Half-life (time taken for 50% ground exposure) as 8.1, 9.2, 10.0, 10.3, 12.0 weeks was recorded for Kahakona, Acacia, Guinea grass, Mana grass, and Sabukku respectively. Whilst, the same was recorded as 100%, 98%, 88%, 68%, and 50% respectively 12 weeks after mulching. The weight of Sabukku mulch was significantly higher ($p < 0.05$) than other materials. Weed density and weed dry weight were significantly lower with Sabukku. Tea growth was not significantly affected by any treatment. Guinea grass and Sabukku were found to be increased the soil carbon level while high moisture content was recorded underneath the mulch of Mana and Sabukku. Sabukku was found to be more durable and could effectively suppress weed growth. Guinea grass and Mana grass showed some comparable performances. Sabukku and Guinea grass can be used as alternatives mulches for Mana grass

Keywords: Allelopathic effect, Decomposition of mulch materials, Suppression, Tea, Weed growth.

Present Situation of Intercropping in Potato Cultivation in Nuwara Eliya and Badulla Areas

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Intercropping is one of the methods of increasing crop productivity. It has proved to achieve many advantages. However, with the increasing demand for local potatoes, intercropping with potato cultivation in Sri Lanka is still an open research challenge which is needed to be addressed. On the other hand, Potato is extensively cultivated in Nuwara Eliya and Badulla districts in Sri Lanka. Therefore, this study examined the present status of intercropping in potato cultivation in Nuwara Eliya and Badulla areas to determine the farmer's knowledge and awareness on intercropping in potato cultivation. The study was based on primary data gathered through questionnaires from 100 potato farmers selected through the snowball technique. Out of 100 farmers, 48 farmers were selected in Nuwara Eliya district and others were selected in the Badulla district. The results obtained were analysed using descriptive statistics. Results indicated that 58% of farmers were aware of the intercropping. However, among them, due to the lack of knowledge and ignorance of the benefits of intercropping 30% of farmers were not practicing it. The other 28% of farmers did practice intercropping with short term vegetable crops such as beans, radish, and leaks, etc. They gained extra income from intercropping at a low cost of production by proper land use and maximum utilization of natural resources such as water and nutrient. The rest of the farmers (42%) were not aware of intercropping with potato and its benefits. Meanwhile, 54% of farmers claimed that they did not have vital information such as crop choices, cropping patterns, and amount of potential harvest, etc. Therefore, the study has brought out the urgency of the appropriate knowledge delivery method to disseminate the right knowledge on intercropping with potato and to create the awareness to encourage intercropping in potato cultivation which ensures food security, poverty reduction, and sustainable utilization of natural resources.

Keywords: Intercropping, Food security, Potato cultivation

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Comparative Study on the Phytochemical Composition of Medicinally Important Three *Ocimum* Species Available in Sri Lanka.

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Ocimum species have been used as an important medicinal herb, since ancient times but no recorded scientific evidence on morphological variations and phytochemical composition in Sri Lanka. Hence this study was conducted to determine the variation of morphological characteristics, total polyphenol content, antioxidant activity, and essential oil composition of three different *Ocimum* species namely; *Ocimum sanctum*, *Ocimum gratissimum* and *Ocimum americanum*. Healthy and fresh leaves of *Ocimum* plants were collected from Badulla and Welimada area. Morphological differences in leaves, flowers, roots, stem, and seeds of three *Ocimum* species were compared visually and recorded. Methanol extraction was performed using dried and powdered leaf samples and analysed total polyphenol content and antioxidant activity for three species using the Folin Ciocalteu reagent method and standard 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity respectively. Hydro distillation was done to extract essential oils from *Ocimum sanctum* and *Ocimum gratissimum* and analysed by using Gas Chromatography – Mass Spectrometry method. There were differences and similarities between morphological characteristics among three species. The maximum polyphenol content was recorded in *Ocimum americanum* and the minimum was recorded in *Ocimum sanctum*. In determination of antioxidant activity, the highest half maximal inhibitory concentration was recorded in *Ocimum americanum* and the lowest was recorded in *Ocimum gratissimum*. There were differences in essential oil composition between *Ocimum sanctum* and *Ocimum gratissimum*. It can be concluded that there is a significant variation in morphological characteristics and phytochemical composition of three different *Ocimum* species available in Sri Lanka.

Keywords: Antioxidant, Chromatography, Polyphenol, Scavenging, Spectrometry.

Real-time Data Base Management System for Efficient Data Recording and Management in Regional Dairy Cattle Farming

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Real-time data are an essential part of successful dairy cattle farming. Hence, the objective of the present study was to develop a real-time database management system (DBMS) for Badulla Veterinary Division. This aims to enhance the efficiency of data recording and data retrieval by field officers engaged in routine field work related to animal husbandry. Initially, information on currently used DBMS was gathered using key informant interviews held with veterinarians and LDIs in Badulla Veterinary Division. A need analysis was conducted and the most vital data required to be recorded and retrieved (i.e. farm registration, disease management, breeding, and artificial insemination, vaccinations, and individual animal health status) through real-time DBMS were identified using a questionnaire. Based on the above information, a real-time database management mobile application was developed using Android Studio® 3.5.0.0, which consists of optimized user interfaces and an online database. Afterward, the mobile application was tested for its usability, conformance, and performance using identified end-users (Field Officers, n=10) of the application, and the data were collected using a structured questionnaire. Results had shown that 100% agreement with quality of information (exactness, reliability, completeness, usefulness, actuality, format, clarity, and complexity) and quality of the system (accessibility, integration, flexibility, timeliness, perceived, usefulness, user-friendly and user satisfaction level) and 80% overall satisfaction on the application. Hence, the real-time Android database management application has the potential to be used as an efficient DBMS in the dairy farming sector of Sri Lanka. A field trial is suggested in the future to assess the long-term usability of the developed DBMS at the field level.

Keywords: Android, Field officers, Mobile application, Veterinarian, Database

Antioxidant Properties and α -Amylase Inhibition Activities of Four Different *Curcuma* Species in Sri Lanka

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The genus *Curcuma* belongs to the family Zingiberaceae comprises rhizomatous annual or perennial herbs. *Curcuma* has a long history of traditional uses ranging from folk medicine to its culinary uses. This study was undertaken to study the biological activities of rhizomes and leaves of four *Curcuma* species available in Sri Lanka namely, *Curcuma albiflora*, *Curcuma aromatica*, *Curcuma longa*, and *Curcuma zedoaria*. Fresh rhizomes and leaves of four *Curcuma* species were collected from their natural habitats in Wet and Dry Zones of Sri Lanka. Rhizomes and leaves were cleaned and cut into small pieces and oven-dried at 45 °C and 40 °C respectively for 12 hrs. Dried samples were ground into a fine powder. Methanol extracts from rhizomes and leaves were screened for total polyphenol content (TPC), antioxidant activity, and α -amylase inhibition activities. The TPC of dried rhizomes of *Curcuma longa* was the highest of all tested as 5.530 ± 0.012 g of GA equivalents per 1 g of the dried rhizome. The Methanol extracts of the rhizome and leaf samples of four species showed moderate antioxidant activity in the DPPH radical scavenging assay with IC₅₀ values ranging from 150.253 ± 0.273 ppm to 389.051 ± 0.426 ppm. Interestingly the rhizome extracts of *Curcuma aromatica*, *Curcuma longa*, and *Curcuma zedoaria* exhibited higher α -amylase inhibitory activities (13.915 ± 0.023 , 6.455 ± 0.117 and 9.492 ± 0.024 respectively) than the Acarbose drug which is an anti-diabetic drug (28.273 ± 0.615 ppm). The results revealed that the Sri Lankan *Curcuma* species have a potency to be used as a source of antioxidant and anti-diabetic agents and it is important to increase the value of the unexplored medicinal herbs available in Sri Lanka.

Keywords: Antioxidant, Anti-diabetic, Biological Activities, *Curcuma*

Quantification of L-theanine Content of Two Selected Tea Cultivars [*Camellia sinensis* (L.) O. Kuntze] Grown in Sri Lanka

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L-theanine is an abundant non-protein amino acid that accounts for more than 50% of the total free amino acid in the green tea leaves, having various pharmaceutical importance. The study was conducted to determine the variation of L-theanine content of commonly growing tea cultivars, TRI 2025, and TRI 4053 among all tea-growing agro-ecological regions in Up, Mid, and Low Country of Sri Lanka, concerning one month before and after the onset of rainfall periods. Fresh tea leaves were collected from same-aged plants by using stratified sampling techniques and samples from each stratum were selected randomly from different tea estates of each agro-ecological region in all three elevations of Sri Lanka. Collected samples were oven-dried at 50°C for 12 hours and hot water (85°C) was used to extract L-theanine from fresh tea leaves. The High-Performance Liquid Chromatographic technique with ultraviolet detection (RP-HPLC-DAD-UV) was optimized and validated to quantify L-theanine content according to conditions of Csutor's method with slight modifications. Data acquisition and evaluation were performed using Chromeleon software. The findings of this study showed that the total L-theanine contents (gg⁻¹%) were significantly different ($p < 0.05$) among the tea growing agro-ecological regions in both TRI 2025 and TRI 4053 in Up, Mid and Low Country of Sri Lanka. The highest total L-theanine contents were recorded in IU3d, WU2b, and WL1b-E1 of TRI 2025 and IU3a, IM3a, and WL2a-E3 of TRI 4053 in Up, Mid and Low Country respectively. Significant variation in total L-theanine content in TRI 2025 and TRI 4053 in all three major elevations one month before and after the onset of rainfall was observed. Total L-theanine content (gg⁻¹ %) was ranged from 0.04 - 7.96% in all three elevations in Sri Lanka and it was higher than reported values from Kenya. This study evident that Ceylon tea is having higher quality in terms of L-theanine content.

Keywords: Agro-ecological regions, Low country, Mid Country, Total L-theanine, Up Country

Status of Bovine Mastitis and Risk Factors Associated with Mastitis in Kilinochchi District

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Kilinochchi district is situated in the Northern part of Sri Lanka. Livestock is an important traditional economic contributor in this district. Milk production often does not satisfy the country's milk requirements. Mastitis, common disease of dairy cows, which can change the milk production and its quality negatively. The present study was conducted to study the status of bovine mastitis and risk factors associated with it in the Kilinochchi district from November 2018 to March 2019. A total of 136 lactating cows were randomly selected to identify mastitis from four veterinary ranges of Kilinochchi district and a cross-sectional study was carried out among 136 smallholder dairy farms randomly using questionnaires to collect data from Karachi, Kandawalai, Poonakari, and Pachchilaipalli. Milk samples were screened for mastitis by California Mastitis Test (CMT). Results showed that 14.7% (n=20) lactating cows were positive to CMT. The prevalence of mastitis was significantly high in Jersey cross (23%) compared to local breed (8.7%). Only 4.4% (n=6) farmers were using gloves during milking and handling of cattle. The highest prevalence (20.9%, n=14) of mastitis was observed when the cows were kept with other animals during the parturition. Prevalence of mastitis was 13.4 % (n=18) when hand milking and it was higher than the machine milking (10%). The highest prevalence of mastitis was observed in a semi-intensive farming system (20.5%) and in crop and livestock integrated farm it was 34.6% (n=47). More cases of mastitis were found during six to nine months of lactation period (50%). Only 2.9% (n=4) of farmers were practicing the post milking teat dipping while milking. Among them, 85% (n=17) of affected farms did not practice post milking teat dipping. Most of the common symptoms of mastitis reported in this study were, the swelling of the udder, warm, rough, and redness in the udder and, presence of clots, blood, and colour change in milk.

Keywords: Mastitis, Jersey cross, Lactation period

Effect of farming system on energy balance of temperate crossbred dairy cows in early lactation: A case study conducted at Welimada Veterinary Division

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The early lactation period of dairy cows in Sri Lanka has been identified with negative energy balance (NEB) due to improper feeding strategies. Hence, the objective of the current study was to evaluate the energy balance of temperate crossbred dairy cows in early lactation reared under two management systems (stallfed and tethered) at Welimada Veterinary Division. Forty dairy cows in early lactation were selected for the study (stallfed, n=20, and tethered, n=20). The energy balance was evaluated using a serum metabolic profile. Blood samples collected (between 0900 to 1030 hrs.) from each cow were analysed for serum Non-esterified fatty acids (NEFA) and Beta-hydroxybutyrate (BHBA) contents and values were compared with reference ranges. Milk production, parity, days in milk (DIM), and amount of concentrate fed were recorded. The average DIM was recorded as 30.75 days. The NEFA content of cows in both systems (0.30 ± 0.05 vs. 0.39 ± 0.07 mmol L⁻¹) was below the upper critical limit of the reference range and no significant difference ($p > 0.05$) was observed between systems. Yet, the BHBA content of cows in the tethered system was significantly higher ($p < 0.05$) than its counterpart (0.81 ± 0.22 vs. 0.35 ± 0.06 mmol L⁻¹) and it was close to the upper critical limit (0.854 mmol L⁻¹). Higher BHBA contents indicate NEB conditions during early lactation. The number of concentrates fed to stall-fed cows was observed to be significantly higher ($p < 0.05$) than its counterpart (13.64 ± 0.42 vs. 4.46 ± 0.29 kg/cow/d). Similarly, stallfed cows indicated higher ($p < 0.05$) milk production (19.88 ± 0.26 vs. 6.93 ± 0.40 L/cow/d). Results revealed that only the tethered cows were affected with NEB status. The reasons for low milk production and NEB in tethered cows could be due to lack of energy intake which was indicated by the low amount of concentrate fed. Further research is warranted to identify methods for increasing the energy intake of tethered dairy cows at early lactation while considering the socioeconomics of the farming system.

Keywords: Beta-hydroxybutyrate, Milk production, Non-esterified fatty acids, Stallfed, tethered

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Development of a Protocol for Effective Acclimatization of *In-Vitro* Propagated *Dendrobium* Orchids

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Dendrobium orchids are popular flowering potted and cut flowers around the world. The success of *in vitro* propagation of *Dendrobium* is high, but when transplanted into the natural environmental condition (acclimatization), their survival is minimal. Therefore, this study was aimed to develop a protocol to evaluate the effect of acclimatization of *Dendrobium* after ten weeks of transplanting under the protected environment conditions. As the first experiment, the success of the acclimatization was evaluated with different root numbers. In the second experiment, two acclimatization media were tested with different media compositions, common acclimatization media (M1) - sand: coir dust: charcoal: tile pieces, alternative media (M2) - granite chips: coir dust: charcoal: tile pieces (1:1:1:1). The direct transplanting method and non-direct transplanting method were followed in the third experiment. Under experiment four, the number of plantlets was changed including in a community pot and single propagators were done just after transplanting. Four and 3.5-inch diameter clay/plastic community pots were applied to the same plant numbers (25 plantlets per pot) in experiment five. Survival percentage and visual appearances at weekly and height of the plantlets at two weeks intervals were recorded in each replicate. The highest survival and height were recorded in well-rooted plantlets (10 roots). M1, M2 both showed the same performances. The direct planting method showed the best performances. Four-inch diameter/clay community pots with higher amounts of plant numbers (30, 35) showed the highest survival and growth. The propagator application was positively contributed to the height of the plantlets. Community pots in 3.5-inch diameter were recorded the best survival and height. Plastic community pots were the possible alternative for clay pots. In conclusion, applying the complete protocol can be considered as a clear solution to increase the survival of tissue cultured *Dendrobium* orchids at acclimatization.

Keywords: Acclimatization, *Dendrobium* orchids, *In-vitro* propagation, Survival percentage

Investigating the Existence of *Candidatus Liberibacter asiaticus* in *Murraya koenigii*

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In 2015 the European Union banned importing fresh curry leaves from Sri Lanka due to Citrus greening disease reported in Sri Lanka. Citrus greening is the most dangerous disease in citrus cultivation. The disease is caused by the infection of non-culturable bacteria named *Candidatus Liberibacter* (CLas). This bacterium transferred by a vector named Asian citrus psyllid (*Diaphorina citri*). Asian citrus psyllid is one of the major pests in Curry leaves. This study was conducted to confirm the existence of *Candidatus Liberibacter* in Curry leaves by conducting a pathogenicity test to test the ability of CLas to cause the disease. 11 Citrus plants and 11 Curry leaves plants were tested for *Candidatus Liberibacter*. The presence of CLas in leaf samples were identified by amplification of 1160 bp fragment of 16s rRNA. 10 Curry leaves and 10 Citrus plants were placed inside of a rearing cage in the protected house. One curry leaf and one citrus plant kept outside of the cage but inside the protected house as controls. Approximately, 500 *Diaphorina citri* insects were collected from several Districts in Sri Lanka and kept in a secondary cage to facilitate the mating process for a week with one feeding plant. Insects were inserted into the main cage. After a month, all plants and some random insect samples were tested for the presence of *Candidatus Liberibacter*. Initially, all the curry leaves plants and citrus plants give negative results confirming the absence of CLas. After a month, one citrus plant was positive for the presence of CLas and other 9 citrus plants and curry plants produce negative results confirming the absence of CLas. Two random *Diaphorina citri* samples were checked. One sample was positive and the other one is negative for the presence of CLas. Results indicate that CLas is unable to survive in curry leaves plants, but further studies should be conducted. There is a potential to export fresh curry leaves, due to the absence of CLas in curry leaves.

Keywords: Citrus Greening, *Candidatus Liberibacter asiaticus*, *Murraya koenigii*

Bark, Leaf and Stem Yield of Cinnamon as Affected by Spacing and Type of Planting Material: At the Stage of First Harvest

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Cinnamomum verum J. Presl (cinnamon), is an evergreen aromatic plant with several uses and considered as a prominent spice throughout the world. Though, quills produced from bark are the most familiar product of cinnamon, leaves and stems also yield some economically valuable products. Therefore, this study was aimed at identifying the effect of spacing and type of planting material on the yield of leaves, bark, and stems of cinnamon at the stage of the first harvest. Seedlings and vegetatively propagated plants of cinnamon variety Sri Gemunu were planted under three different spacing as 1.2×0.6 m with three plants per hill, 1.2×0.4 m with two plants per hill and 1.2×0.2 m with one plant per hill as two-factor factorial RCBD at the Agriculture Faculty premises of University of Ruhuna, Sri Lanka. Seedlings in 1.2×0.6 m spacing with three plants per hill were used as the control. The first harvest was collected after two years from the establishment and the measurements were taken. According to the results highest mean dry weight of bark (59.68 g), leaves (267.9 g), and stems (600.1 g) were recorded in control. But it was not significantly different ($p<0.05$) from seedlings in 1.2×0.2 m spacing with one plant per hill. The highest yield of quills per plant (55.58 g) and the highest mean weight of bark per centimeter of the harvested shoot (215.41 mg cm⁻¹) were also recorded in the control. But it was significantly different ($p<0.05$) only from vegetatively propagated plants in 1.2×0.2 m spacing with one plant per hill. The type of planting material and spacing does not have any significant influence ($p<0.05$) on the bark stem ratio of cinnamon plants at the stage of the first harvest. When considering the results of the study, seedlings tend to produce more bark, leaf, and stem yield when compared with vegetatively propagated plants at the stage of the first harvest. Though vegetatively propagated plants have higher yield potential, it appears to require more time to develop a better structure which can give a higher yield.

Keywords: *Cinnamomum verum* J. Presl, Spacing, Planting material, Yield

Phytochemical Comparison of Imported and Locally Available Species of *Rubia cordifolia* (Walmadata)

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At the commercial level, it is difficult to find quality medicinal plant material though it is important in Ayurvedic preparations. *R. cordifolia* is a common and important medicinal plant belongs to the Rubacea family. It imports from India through favourable growing conditions that exist in Sri Lanka. Therefore, this study was conducted to investigate the important phytochemical properties of imported and locally available materials of *Rubia cordifolia*. The imported market sample was collected from the Uva Provincial Department of Ayurveda, Diyathalawa, and the fresh locally available sample was collected from *Maspenna* (IM1a) forest area in *Welimada*. Those samples were washed and dried under the shade, oven-dried at 40°C and sonication proceeded for phytochemical extraction using 70% methanol. Before the extraction, samples were observed for macroscopic and microscopic features of the root and stem. Phytochemical properties such as total polyphenols, antioxidant activity, flavonoid, and anthocyanin were quantitatively analysed by using standard protocols available in the literature with slight modifications. There was no significant difference between morphological characteristics of locally available *Rubia cordifolia* and Indian species according to the literature except the colour of the stem and roots. However physicochemical properties of the locally available sample are in better comparison to the imported market available sample. The 7.412 ± 0.45 mg gallic acid/1 g dry weight of polyphenol was received from the local sample and it was significantly higher amount compare to the imported sample (4.182 ± 0.399 mg gallic acid/1 g dry weight, $p < 0.05$). A significantly high antioxidant activity was observed in the locally available sample 239.08 µg/ml compare to the imported sample 228.48 µg/ml. Flavonoid content and monomeric anthocyanin in local available *R. cordifolia* is significantly lower than the imported sample of *R. cordifolia*. This implies the potential of using locally available materials for drug manufacturing and different Ayurveda preparations.

Keywords: Antioxidants, Polyphenols, Flavonoids

Standardization of Callus Induction Protocol for Extraction of Secondary Metabolites from *Andrographis paniculata* (Kiratha)

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Andrographis paniculata, known as *Kiratha* or *Heen binkohomba* in Sri Lanka is an important medicinal plant with some valuable secondary metabolites. Cultivation and extraction of secondary metabolites from this plant are constricted due to limitations in conventional propagation methods. Therefore, this study aimed to standardize a callus induction protocol for this plant to extract secondary metabolites. Nodal cuttings, leaves, and seeds were tested for surface sterilization with two Clorox concentrations (10%, 15 %) and three exposure periods (5 min, 10 min, 15 min). For callus induction and multiplication, the established cultures were transferred to Murashige and Skoog (MS) medium supplemented with various combinations and concentrations of Naphthalene Acetic Acid (NAA) (1.0, 2.0 mgL⁻¹) and 2,4-Dichlorophenoxy acetic acid (2, 4 D) (0.5, 1.0, 1.5, 2.0 mgL⁻¹). All experiments were arranged according to a completely randomized design with 25 replicates. Non-contamination percentage, amount of calli formed, and appearance of callus by its colour and growth were recorded and subjected to analyse variance and Kruskal-Wallis test as required. Seeds were the most suitable explant for callus induction because of 100% non-contamination in all treatments. However, 0% of non-contamination was observed ($p \leq 0.05$) for nodes and leaves. When considering minimum resources allocation, 10% Clorox for 5 minutes exposure time period was selected as the best surface sterilization method. The highest calli formation (91.8%) was observed in MS medium supplemented with 2.0 mgL⁻¹ 2, 4 D + 1.0 mgL⁻¹ NAA ($p \leq 0.05$). Result was significantly different only from the treatments with 1.0 mgL⁻¹ 2, 4 D + 1.0 mgL⁻¹ NAA and 1.5 mgL⁻¹ 2, 4 D + 2.0 mgL⁻¹ NAA. Excellent callus with non-brownish colour (83%) and callus with excellent growth (67%) were observed in the same treatment. Secondary metabolites will be extracted and compared with mother plants in future studies.

Keywords: Callus, Induction, Extraction, *Andrographis paniculata*

Effect of Hydro and Chemical Priming on Seed Germination and Seedling Growth of Rubber (*Hevea brasiliensis*)

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Rubber (*Hevea brasiliensis*) is propagated through grafting buds of selected clones onto vigorous seedling rootstocks using a green budding technique. Both rootstock and budwood should be of high quality for producing high quality budded rubber plants. Seeds are used in raising rootstock plants of rubber. Being recalcitrant, rubber seeds deteriorate within a few days after falling from trees. The use of old seeds has resulted in low germination and extended germination period in commercial rubber nurseries. The main objective of this study was to investigate the effects of hydro- and chemical-priming on seed germination and seedling growth of *Hevea*. The experiment was conducted in a nursery at the Rubber Research Institute of Sri Lanka, Dartonfield, Agalawatta. Seeds were soaked in solutions of ZnSO₄ (1% & 2%) Urea (0.05%, 0.10%, & 0.15%) and in water (mock treatment) for 24 hours followed by sown in a germination bed according to a randomized complete block design. Un-primed seeds were used as control. Germination percentage was recorded at 7, 9, 11, 13, and 17 days after sowing. Growth parameters of seedlings were recorded at monthly intervals for up to three months after transplanting in polybags. Significantly higher germination percentages were recorded in seeds primed with water (hydro priming), urea, and ZnSO₄ after 17 days of sowing when compared to control. However, the highest germination percentage was recorded from the seeds primed with water (mock treatment). No significant differences were recorded in growth parameters of seedlings raised from seeds primed with chemicals or water when compared to those derived from un-primed seeds (control). Therefore, hydro priming may be the simplest and cost-effective priming treatment to improve the germination of rubber seeds.

Keywords: Germination, Growth, Seed Priming, Urea, Zinc Sulphate

Study of Mechanical and Physical Properties of Nitrile Butadiene Rubber Glove with Sulfur, Accelerator and Particle Size of the Dispersion

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Sludge formation in the latex dipping tanks is the most destructive matter in the glove industry. This problem can cause quality defects of the glove and hence, high cost of production. This study was carried out to reduce the sludge quantity while the physical properties of the nitrile butadiene rubber glove by reducing the particle size of the dispersion. The particle size of the dispersion was reduced by increasing milling cycles in the pearl mill. Two milling cycles were considered in this study. Particle sizes of two samples were 2.5 μ m and 1 μ m according to the Dynamic Light Scattering test. Those dispersion samples were used to prepare compounds to measure the sludge quantity and gloves were prepared to investigate the physical properties. Particle size with the milling cycles was studied as a preliminary study. Further improvements of the physical properties of the glove were investigated using different sulfur/accelerator ratios within three sulfur vulcanizing systems. Two levels of sulfur/accelerator ratios in each system were used to determine the best ratio with better properties. Dispersion with 1 μ m particle size was given at least sludge quantity than the dispersion with 2.5 μ m particle size while improving the properties. Standard property levels in nitrile butadiene glove were considered as the control in this study. 3.5/1 sulfur/accelerator ratio was given better properties than the 2.5/0.5, 0.4/0.5, 0.8/3, 1/1, 1.5/1.5 ratios. This is because vulcanizate with a high proportion of polysulfidic bonds obtained high mechanical strength. Therefore, it is effective to use dispersions made from 1 μ m particle size with 3.5/1 sulfur/accelerator ratio in the production of a nitrile glove.

Keywords: Particle size, Physical properties, Sludge, Sulfur/accelerator ratio

Morphological Characterization of the Ecotypes of *Murraya koenigii* (Curry Leaves) in Sri Lanka

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Curry leaves (*Murraya koenigii*) are significantly used as a medicinal spice; highly valued as an ingredient that promotes appetite for its unique, inherent; odor and flavor. Its nutrient property is used for cosmetic products, functional goods, and considered a valued export commodity. Being a native wild species, domestication cannot be seen. Thus, high morphological differences could be observed making high diversity. The ecotypes of *Murraya koenigii* were proved to be available at *Dambulla*, *Matale*, and *Ritigala* sites but morphological studies have not been conducted to find whether the morphological characters are diversifying geographically. This study was carried out to identify the morphological characters of the ecotypes of *Murraya koenigii*. Thus, the plant descriptor was developed. From the above selected ecoregions including *Mahiyanganaya* district, samples (12) with replicates (3) were collected randomly. Cluster analysis was conducted for all the sixteen characters including nine quantitative and seven qualitative parameters, to identify whether they are genetically overlapped. There was a significant difference between selected ecotypes from each selected eco-regions with consideration to the given quantitative morphological traits based on the analysis of variance. *Dambulla* type1 clustered with *Matale* type2. As the second cluster, all other types were clustered together. *Dambulla* type3 was clustered as a separate group. For the *Mahiyanganaya* (MH) samples, though the comparative results could not be obtained from the mean comparison data analysis; MH type2 and MH type3 were clustered together. This cluster reflected only the qualitative traits but not the quantitative characters. Ecotypes were clustered together with each other thus proving that there is a significant morphological variation among the ecotypes of *Murraya koenigii*.

Keywords: Descriptor, Ecotype, Morphological Characterization, Native, Wild Species

Determination of Optimum Water Application Interval for Young Tea Plants

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Tea productivity is highly vulnerable to changes in precipitation. With limited availability of water for irrigation, identification of optimum irrigation interval is necessary to increase water use efficiency. Therefore, a pot experiment was conducted at the Tea Research Institute, Rathnapura to determine the optimum water application interval for young tea plants using one year old uniform tea plants of cultivar, TRI 2027 under controlled environmental conditions (Max and Min temperatures, 32.1 °C and 23.1 °C, respectively; Average sunshine hours, 3.15 h day⁻¹). The experiment was laid out according to Complete Randomized Design with four replicates. Four irrigation treatments were applied as daily watering (175 ml plant⁻¹), watering at a 4-day interval (750 ml plant⁻¹), watering at a 7-day interval (1150 ml plant⁻¹), and none watering (control). Plant growth performance was evaluated during the experimental period. The highest evapotranspiration rate (3.02 mm day⁻¹) was recorded at daily watering followed by watering at a 4-day interval (2.33 mm day⁻¹). Plants watered daily showed significantly higher ($p < 0.05$) plant height (51.4 cm), girth (6.1 mm), leaf dry weight (5.7 g), leaf area (550.5 cm²), stem dry weight (3.1 g) and leaf nitrogen percentage (3.15%) compared to control (35.3 cm, 4.1 mm, 1.33 g, 119 cm², 1.3 g, 2.14%, respectively). Interestingly, growth performances of plants that watered daily were not significantly deviated ($p > 0.05$) from plants that watered at the 4-day interval. There was no significant difference ($p > 0.05$) in root volume and dry weight among different treatments. The results of this experiment suggest that frequent irrigation at least once in four days is important for better establishment of young tea plants. However, before drawing any firm conclusion it is suggested to continue such trials for at least three dry spells.

Keywords: Evapotranspiration, Growth performance, Irrigation interval, Young tea plants, Water availability

Optimization of a Somatic Embryogenesis Protocol from Nodal Cuttings and Leaf Explants of *Camellia sinensis* (L.) O. Kuntze

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Tea is the main agricultural foreign exchange earner in Sri Lanka. Tea is commonly propagated by vegetative cuttings; the mostly adopted practice commercially, thus unable to fulfill the annual planting material requirements. Somatic embryogenesis (*se*) is considered as a rapid mass propagation method in woody perennials; however, in tea, potential has not been explored yet. This study was aimed to identify optimum growth regulator combinations to produce embryogenic calli from nodal cuttings and leaves of tea and to identify optimum conditions for somatic embryo induction from leaf calli. Sterilized field-grown explants *viz* nodal cuttings and leaf segments of TRI 2025, TRI 2043, and leaf calli of TRI 2043 were established on solid MS media with different plant growth regulator combinations under aseptic conditions. Ten replicates were used for a growth regulator combination and callus initiation was visually observed at weekly intervals. Initiated calli were qualitatively rated for callus mass. The highest callusing of nodal cuttings was observed in MS medium contained 0.11 mg L⁻¹ TDZ, 0.1 mg L⁻¹ IBA, 3 mg L⁻¹ GA3, 8.6 mg L⁻¹ AgNO3 for TRI 2025 while MS media contained 0.11 mg L⁻¹ TDZ, 0.1 mg L⁻¹ IBA, 3 mg L⁻¹ GA3 was reported as the best for TRI 2043. The highest calli induction from leaves was observed in MS medium contained 0.11 mg L⁻¹ TDZ, 1.86 mg L⁻¹ NAA for TRI 2025, and MS medium contained 0.0044 mg L⁻¹ TDZ, 0.1 mg L⁻¹ IBA, 3 mg L⁻¹ GA3 for TRI 2043. Meanwhile, results showed that early signs of somatic embryo induction in solid MS medium containing 0.044 mg L⁻¹ TDZ, 0.1 mg L⁻¹ IBA, and 3 mg L⁻¹ GA3 for leaf callus of TRI 2043. Among two cultivars, TRI 2025 showed a high response for calli initiation with higher callus mass in both nodal and leaf explants than TRI 2043. Identified combinations can be used to obtain embryogenic calli from nodal cuttings and leaf explants and results provide a foundation for developing a *se* protocol for tea.

Keywords: Tea, Explant, Somatic embryogenesis, embryonic callus.

Formulation and Standardization of Face Wash using Palmyrah Pulp and Aloe Vera Gel

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The facial skin is exposed to pollutants, microbes and old skin, necessitating the use of a face wash. Many, different face washes are available in the market, but most of them contain harmful synthetic chemicals which induce skin allergies as well as premature ageing of the skin. On the other hand, the Palmyrah fruit pulp has been reported to possess antioxidant properties and aloe vera gel has been being used for its moisturizing and soothing properties and both these plants are locally available. Hence this study was aimed at formulating a face wash containing Palmyrah pulp and Aloe vera gel. Six different types of face washes (F1, F2, F3, F4, F5, F6) were formulated by changing the ratio of Palmyrah pulp to Aloe vera while keeping the amount of the other ingredients constant. Here methylparaben and propylparaben were used as preservatives, sodium lauryl sulfate as a forming agent, propylene glycol as a humectant, and triethanolamine as a neutralizer, carbopol 940 as a gelling agent and water as a solvent. The total phenolic content of the different face washes was determined using UV spectroscopy and Gallic acid as the standard. The results showed the face washes containing pulp to aloe vera in 5:0 (F1) and 2:3 (F4) ratios contained the highest amount of total phenols. These two formulations were subjected to the physiochemical analysis. pH, viscosity, foamability, spreadability, thermal stability, washability, non-volatile matter, total surfactant, and density of the face washes were found to be within the limits expected for a facial cleanser. The anti-microbial activity of these two face washes was determined using Turbidometric method and the results demonstrate that these face washes possess the substantial anti-microbial activity and that F4 is more efficient than F1. Sensory evaluation to evaluate the appearance, colour, fragrance, texture, foamability, and washability of the face washes was conducted using thirty untrained panellists and 5-point Hedonic scale, and F4 was chosen as the best formulation based on the results. This study concludes that the formulated face wash (F4) has antioxidant and antimicrobial properties and is preferred in terms of texture, spreadability, foamability, washability, texture, colour and appearance.

Keywords: Aloe vera gel, Antioxidant, Anti-microbial activity, Palmyrah fruit pulp, Total phenolic content

Technical Efficiency and Inefficiency Determinants of Chili Cultivation in Vavuniya District of Sri Lanka

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Increasing the productivity of green chili is important to meet the market demand as well as to reduce the food import bill. However, farmers face productivity issues due to the lack of knowledge on how to maximize the level of output at a given level of inputs. This study focuses to evaluate the technical efficiency of green chili farmers and subsequently identifying the determinants of technical inefficiency in the Vavuniya district of Northern Province in Sri Lanka. The data used in this study were based on a direct interview survey of 297 randomly selected green chili farm households conducted in 2019. The stochastic frontier analysis was used to evaluate technical efficiency. The estimated stochastic production frontier model indicates that parameters used in production such as fertilizer, chemicals, land, labour, seed variety, and irrigation had significant effects on yield. The coefficients for land, labour, and fertilizer had positive values of 1.07, 1.93, and 1.99 respectively. The results show that the mean technical efficiency of farmers is 93% ranges from 74% to 97%. This implies that there is room to improve the efficiency level of farmers on average by 7% using current technology and available inputs. The variables of age, education level, access to extension, and household size negatively affected technical inefficiency. Therefore, this study proposes providing better farmer training programs and enhance the education level of farmers and providing farmers with the opportunity of accessing better extension services to improve technical efficiency.

Keywords: Chili Cultivation, Cobb-Douglas stochastic Production Frontier, Technical Inefficiency, Production Efficiency, Determinants

Present Situation of Floriculture Industry in Southern Sri Lanka

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The floriculture industry is considered as a popular agribusiness for decades in Sri Lanka. The Southern province was identified as a possible area for expansion of the industry. But lack of adequate literature and information on the present situation about the floriculture industry hinders the expansion. Therefore, this study was designed to identify the present situation of the floriculture industry in Southern Sri Lanka. Data were collected from the randomly selected 70 growers based on a pre-tested questionnaire survey conducted during August – November 2019 by visiting exhibitions and monthly meetings of flower grower societies in Galle (Galle, Nagoda divisional secretariat divisions), Matara (Matara, Akuressa, Weligama divisional secretariat divisions) and Hambantota districts (Ambalantota, Sooriyawewa Beliatta divisional secretariat divisions) belongs to the Southern Province. According to the analysed data, almost all (99%) the growers were female, educated up to O/Ls (54%) and the majority (73%) of them were more than the age of 45 years. Most (54%) of growers have earned monthly income more than Rs.10,000. Most (79%) of them had established shade houses while all growers are cultivating in the open field. This industry is involved in 43% of unemployed women and 57% of women after retirement from their occupations. Products are sold directly to consumers or in the exhibitions by 49% of the growers while a smaller number of products sold to a wholesaler and retailers. This business is run mainly (95%) by using family labour. Flowering plants (Anthurium, Orchids, Roses, Bogunvella, Aquatic flowering plants, Jasmine, etc) and foliage plants (Dracaena, Agloneama, Calathea, Philodendron, Cordyline, Maranta, etc) are sold as pot plants and high demand can be seen for new varieties. Planting materials are collected from local farms, exhibitions, or exporters. Chemical or organic fertilizer combinations are applied by the majority of growers (59%). Chemicals are mainly (81%) used for disease and pest control. Almost all the growers had been stated that there is sufficient demand for the floriculture industry in southern Sri Lanka (100%, p-value 0.05). Therefore, this study revealed that floriculture is a popular industry among people, further studies should be conducted to find potentials and constraints for expansion of the industry in the region.

Keywords: Floriculture, Growers, Present, Southern, Sri Lanka

Adaptation to Climate Change by Up Country Vegetable Farmers

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In Sri Lanka, climate change impact is the second most gravely affecting reason for food insecurity and agriculture is the most vulnerable sector to climate change. Specifically, vegetables, legumes, coarse grains, and potatoes are likely to be adversely affected. Thus, the need for adaptation is pressing for these seasonal cropping systems given the importance of climate change impacts on livelihoods. For successful adaptation policies and recommendations should be formulated based on a robust analysis of factors influencing farmers' decision to adopt. Based on a cross-sectional survey conducted for upcountry vegetable farmers, the study elucidates farmers' perceptions of climate change, ongoing adaptation measures, factors influencing farmers' decisions to adapt, and constraints. Data were collected from 150 farmers in Nuwaraeliya, Welimada, Badulla, and Bandarawela divisional secretariat areas. Multinomial logit model analyses factors affecting to the adaptation by farmers. Results indicate gender, education level, farming experience, income, willingness to take credit, the extension on the crop, climate change information, farmer to farmer extension, total annual rainfall, and average annual temperature as the significant factors. Further, early or late planting, crop or variety switching and intensive use of inputs are the commonly used current adaptation options. Results explain that farmers lack climate information. Moreover, higher costs to adapt and lack of vigorous seeds impede adaptation. The study suggests educating farmers about potential adaptation options is pivotal. Moreover, policies related to education, adaptation cost, and vegetable seed importation should be amended to promote adaptation. Providing comprehensive climate change information and improved crop extension service are the practices that need governmental support. Furthermore, intensive studies on climate change and networking farmers to initiate an information portal will nurture climate change adaptation.

Keywords: Climate change adaptation, Upcountry vegetable farmers, Multinomial logit model

Growth Response of Rubber (*Hevea brasiliensis*) Seedlings to Different Dosage of Inorganic Fertilizer

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Rubber cultivation in Sri Lanka has been confined in the past mainly to the Wet Zone where the extent of land under rubber declined rapidly with urbanization. Therefore, to meet the demand for natural rubber, cultivation has been extended to Uva Province too in the Intermediate Zone. Ideally, high quality budded plants are required to produce within the region. However, the time taken for this process is comparatively a little longer than that in the Wet Zone. The present study was conducted in the government rubber nursery at Monaragala to examine the effectiveness of different dosages of inorganic fertilizer and compost on the growth of rubber nursery plants for two months. Fertilizer mixture: 9:11:11:4 for N:P:K:Mg, respectively, recommended by the Rubber Research Institute was used. Three levels of fertilizer mixture: 1.25 (control), 2.5, and 3.7 g per plant at fortnight interval were applied. Two levels of compost: 0 and 50 g per plant were used for the potting mixture with topsoil. Compost and fertilizer levels were considered as two factors (4 replicates and 25 plants per replicate) and a nursery was arranged as complete randomized block design. Germinated seeds were transplanted into polybags which were filled with two potting media. Growth attributes *viz.* stem height, stem diameter, and number of leaves were recorded at the 2nd, 3rd, 4th, 6th, and 7th weeks; and chlorophyll content (SPAD), number of leaf whorls at the 7th week after transplanting. Data were subjected to ANOVA. There was no significant difference ($p>0.05$) in the growth attributes as well as in the SPAD value among the treatments tested. Therefore, use of currently recommended lowest dosage of the fertilizer mixture, *i.e.* 1.25 g per plant at fortnight interval without additional compost, when using topsoil is cost-effective in maintaining the rubber nurseries at pre bud grafting period in the Intermediate Zone of Uva Province.

Keywords: Compost, *Hevea* seedlings, Inorganic fertilizer, Intermediate zone

An Assessment of Information Needs of the Tea Leaf Collectors in Kalutara and Matara Districts, Sri Lanka

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The tea industry plays a significant role in the country's economy. There are two types of leaf collectors namely factory line collectors and independent tea leaf collectors. The latter faces many difficulties such as unavailability of correct and up-to-date information at the time of decision making. Hence this study was carried out to explore the information needs of the independent tea leaf collectors concerning five information categories. A survey was conducted in Matara and Kalutara districts, which accounts for the highest leaf collection in 2018 in the low country, using a structured interview schedule. Respondents were selected using stratified random sampling (n=72). Data were analysed using descriptive methods. The mean age of the respondents was at 48 years, while the average monthly income was 37,000 LKR. The average green leaf collection per month was 13,000kg. The most common types of information requirements were weather information (71.83%), technological information related to collecting and transporting leaves (64.78%), price information (81.70%), and subsidies (78.90%). Nearly half the respondents (56.30%) were interested to receive information regarding loan services. Furthermore, the majority (65%) agreed that they are not satisfied with the information dissemination methods used by the tea factories. Many (62%) were not satisfied with information systems available for the tea smallholder community, including the leaf collectors. Access to mobile phones was satisfactory: feature phones (55%) and smartphones (44%). While most (83%) of the respondents agreed that it is easy to use ICT tools to record leaf collection information. The study concludes that the leaf collector community needs up-to-date and effective information systems that can support decision making thus it is necessary to develop suitable information systems to cater to the information needs of the leaf collectors.

Keywords: Tea leaf collector, information, needs, ICTs

Analysis of *OsBBX13* Gene Responses to Salinity Stress Tolerance in *Oryza sativa* (Rice)

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The B-box (BBX) proteins are a subgroup of zinc finger transcription factors that contain one or two B-box domains. The B-box domain is a conserved motif. Genes that encode for BBX proteins are highly conserved across all multicellular species. BBX proteins were first identified in *Arabidopsis thaliana* that play a significant role in light and abiotic stress signalling. In *Oryza sativa* (rice) only a few BBX genes have been identified which are involved in flowering. Our previous study on ortholog search identified *OsBBX13* as a functional ortholog of the *Arabidopsis AtBBX21* gene that is involved in light and abiotic stress regulation. This study aimed to conduct an *in silico* analysis of the *OsBBX13* gene promoter to identify the presence of abiotic stress-responsive elements and to study the expression of the *OsBBX13* gene under salinity stress. Promoter sequence (1.0 kb upstream of translation start site) of the *OsBBX13* gene was retrieved from the Rice Annotation Project Database (RAP-DB). The tools of PlantCARE and New PLACE were used for scanning of abiotic stress-responsive cis-elements present on the promoter region of *OsBBX13*. The salinity stress-responsive elements, MYBCORE and GT1GMSCAM4, and Absciscic acid-responsive element (ABRE) which regulates the dehydration and salinity responses were identified in *OsBBX13* promoter region. Quantitative Real Time PCR analysis of 7 days old rice seedlings exposed to 200 mM NaCl stress showed significant up-regulation of the *OsBBX13* gene compared to the control. All these findings together suggested that the *OsBBX13* gene is involved in salinity stress responses in rice.

Keywords: BBX proteins, *OsBBX13*, Salinity stress, Abiotic stress

Effect of Biofilm Biofertilizer on Tea Cultivation

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In tea cultivation, decreased soil quality can be seen in places where tea has been grown for a long period. Although chemical fertilizers (CFs) release nutrients quickly, they are leached to the deeper layers of soil polluting water bodies. Also, CFs deplete beneficial microbes and insects, thus decreasing plant immunity and soil fertility, causing huge damage to the ecosystem. Biofilm is an assemblage of microbes adherent to each other and/or biotic/abiotic surfaces and embedded in a self-produced extracellular matrix of polymers. *In-vitro* developed biofilms can be used as biofilm biofertilizers (BFBFs). BFBFs can break the dormancy of microbial forms in the soil, thus enhancing biodiversity, nutrient cycling, plant immunity, and crop production. This study focused on analysing the effects of the BFBF on soil, plant, and microbial parameters. The study consisted of two uniformly managed tea lands in Badulla. The fields were applied with two treatments separately; (a) 100% CF of Tea Research Institute (TRI) recommendation of VPUva 925, and (b) 75% CF of TRI recommendation of VPUva 925 + BFBF 2.5 L ha⁻¹. All quantitative data were analysed with a two-sample t-test. An increasing trend was observed in endophytic diazotrophs ($p=0.08$) in BFBF treatment over the growers' 100% CF practice. Significantly ($p\leq 0.05$) higher soil pH, moisture, labile carbon, organic carbon, total nitrogen, leaf total polyphenols (SPAD), made tea production and the amount of soil carbon sequestered was observed in the BFBF practice over the growers' practice. However, a significant ($p>0.05$) difference could not be observed for soil available potassium and soil total phosphorous contents. Application of BFBF improved the nutrient utilization efficiency of plants and led to an increase in tea yield over the growers' practice of CF alone application while cutting down CF usage by 25%. Therefore, it is concluded that the BFBF is an eco-friendly and economically viable method to replace the growers' current practice of CF alone application.

Keywords: Biofilm, Biofilm biofertilizers, Nutrient cycling, Soil fertility

Effect of Drought on Shoot, Root and Yield Parameters of Selected Rice Lines

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Rice (*Oryza sativa* L.) is the major food crop in Sri Lanka. That occupy 34 percent (0.77 /million ha) of the total cultivated area in Sri Lanka. Drought is one of the major environmental constraints severely reducing rice yields, making serious threat to global rice production. This study was conducted using eight rice lines including newly improved and exotic rice lines. Drought tolerant rice variety, Bg251 used as the control. The experiment was conducted inside a plant cage using Complete Randomized Design with three replicates for each rice variety and with 96 experimental pots. Seven days old seedlings were established in pots and drought condition were initiated after two weeks of planting. Growth parameters like plant height, chlorophyll content, shoot dry weight and flag leaf length were measured and Drought Tolerant Degree index was estimated. Root parameters were measured using WhinRHIZOpro root scanning machine. Further yield parameters like panicle weight, spikelet no per panicle, Yield and 1000 grain weight were measured. ANOVA process was conducted at 5% significant level for data analysis. Mean comparison was done by using Turkey's comparison. And Pearson 'correlation was performed to investigate the relationship between the parameters. AERON 9-3, IRDTN 7-11 and IRBBN dhana were identified as highly drought tolerant compared with BG 251. AERON 9-3 identified as a cultivar with good yield as well as good Drought Tolerant Degree value. And Drought Tolerant degree index was identified as simple and accurate drought screening method.

Keywords: Drought Tolerant Degree, Drought Tolerance, Panicle weight, Spikelet no per panicle

Residual Effect of Municipal Solid Waste and Dewatered Fecal Sludge Co-compost Supplemented with Biochar on Growth and Yield of *Ipomoea aquatica*

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Due to the intensification of agricultural lands, soil fertility has declined to result in decreased land productivity. Hence, farmers excessively use expensive chemical fertilizers that have reported deleterious effects on the environment and human health. Co-compost of municipal solid wastes and dewatered fecal sludge has a high potential as an agricultural resource in Sri Lanka. Biochar, a soil amendment that has been proven to have many positive effects in improving long-term soil quality and increasing crop yield especially with soil conditioner and organic fertilizer. This study was focused on the residual fertilizer effect of municipal solid wastes co-compost with dewatered fecal sludge supplemented with biochar in sandy loam soil using *Ipomoea aquatic*. The field experiment was carried out at the Centre of Excellence for Organic Agriculture, Makandura. To assess the residual fertilizer effect, *Ipomea aquatica* was cultivated as a follow-up crop in a previously maize cultivated field fertilized with pelletized forms of different co-composts combinations with biochar and mineral fertilizer. Department of agriculture recommended chemical fertilizer was used as a control treatment. Randomized completely block design with four blocks and eight treatments was used. Plant survival rate, leaf area index, and plant height were measured as plant growth and yield data and were recorded 3 times until 15 weeks. Significantly ($p = 0.05$) higher residual fertilizer effect on yield could be obtained with biochar mixed municipal solid waste-dewatered fecal sludge co-compost pellets treatments (0.86 kg m^{-2}) compared to the mineral fertilizer treatments recommended by the department of agriculture (1.45 kg m^{-2}). It can be concluded that municipal solid wastes with dewatered fecal sludge supplemented with biochar can provide a significant amount of residual nutrients in long term and the residual benefits depend on the initial nutrient composition of applied manure.

Keywords: Biochar, Co-compost, *Ipomoea aquatica*, Municipal solid waste, Residual effect

A Novel Process to Manufacture Low Protein Contained Centrifuged Latex

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Removal of protein in Natural Rubber (NR) latex has been a focus of great importance as some users face serious allergy issues when they exposure to NR latex-based products. Therefore, in this study, an attempt was taken to develop a commercially viable and environmentally friendly hybrid route by combining fractionation and creaming processes, to manufacture quality centrifuged latex with reduced protein level. Firstly, preserved NR field latex was fractionated at four different Dry Rubber Content (DRC) levels: 15%, 18%, 21%, and 24%. Subsequently, all fractionated and diluted field latex samples at 10% DRC were creamed up to 30% DRC using sodium alginate at 20 phr concentration. Creamed latex obtained were then subjected to the centrifugation process. Fractionated Creamed Centrifuged Latex (FCCL) samples were compounded according to the basic formula and cured in a drying oven at 120 °C for 20 minutes. Latex properties and their film properties were studied according to the standard test procedures and compared with Single Centrifuged Latex (SCL) and Double Centrifuged Latex (DCL). The FCCL sample fractionated at 15% DRC (15% FCCL) showed the lowest nitrogen content than other centrifuged samples while other samples follow the order of 18% FCCL < 21% FCCL < 24% FCCL < DCL < SCL. Also, 15% of FCCL has the lowest VFA development than the other samples including SCL and DCL due to the lower amount of NRC. Moreover, it showed similar MST development with all other samples. However, films prepared using FCCL and DCL have higher swelling indices (lower crosslink density) and lower tensile strength and water adsorption as most of the protein removed during the process. In conclusion, the process of manufacturing centrifuged latex using creamed and fractionated at 15% DRC is more suitable to manufacture low protein centrifuged latex for sensitive advanced applications than currently available methods such as double centrifugation.

Keywords: Fractionation, Creaming, Low protein latex, Centrifuged latex, Natural rubber latex

Rainfall Pattern Changes in Non-traditional Rubber Growing Areas in Sri Lanka

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Rubber cultivation was extended to non-traditional areas of Intermediate and Dry Zones to expand rubber production in Sri Lanka. The most crucial climatic factor in rubber cultivation is rainfall; and agricultural operations are closely linked with rainfall. It is extremely important to study the changes in the rainfall pattern in these areas frequently. This study aims to find the changes in rainfall pattern in selected 11 weather stations which represent non-traditional rubber growing areas. Daily rainfall data of these stations from 1983-2017 were collected from the Meteorological Department. Rainfall anomalies were analyzed using Standardized Precipitation Index (SPI) for 1-month, 2-month, 3-month, 5-month, and 12-month timescales to represent monthly, seasonal and annual rainfall and Mann Kendall test was performed to identify trends in SPI time series. It was observed significant positive trends in 3-month SPI values in Anuradhapura, Wellawaya in Northeast monsoon, and in Muthuiyankaddu during Second inter-monsoon periods, which are recommended seasons for rubber planting in non-traditional areas. Vavuniya has shown a positive trend in 1-month SPI values in March which is recommended for fertilizer application. Whereas, negative trends were observed in 1-month SPI values in Badulla and Muthuiyankaddu in October and July respectively. Therefore, it can be concluded that the probability of having sufficient rainfall during planting and fertilizing seasons is high in Anuradhapura, Wellawaya, Muthuiyankaddu, and Vavuniya and favorable for non-traditional locations of rubber. As Badulla showed a negative trend in rubber planting season implying a risk of drought occurrence, it is advisable to proceed under effective water conservation techniques for rubber plantations in Badulla.

Key words: Non-traditional rubber growing areas, Rainfall, Standardized Precipitation Index, Trend Analysis

Preparation and Characterization of Deproteinized Crepe Rubber using a Serin Type Proteolytic Enzyme

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A serin type Proteolytic Enzyme (PE) was used as a substitute for traditionally used papain which has no reliable supply at present in the local market, for the manufacture of Deproteinized Crepe Rubber (DPCR). Field latex was coagulated by different PE dosages varying from 1 to 4 ml with 1 ml intervals per litre of the diluted field latex at 10% DRC and matured for 72 hours. The control sample was coagulated within 24 hours using 1% formic acid and all coagula were converted into pale crepe form. The impact of the maturation period (24-72 hours) on raw rubber properties was also studied using the selected sample which meets the lowest Nitrogen Content (NC) among all the candidate samples. Raw rubber properties, curing characteristics, and physicommechanical properties of all the vulcanizates were studied. All enzyme-treated samples showed lower NC (0.10-0.14%w/w) than the control (0.31%w/w). It was noticed that the increase of PE volume and maturation period reduced the NC in the samples. Raw rubber properties of the enzyme-treated samples with a 72-hour maturation period have complied with the required specifications of DPCR except for the Plastic Retention Index (PRI). It was found a reduction of PRI and ash content while increasing in Po values with the increment of PE dosage and maturation period. However, the enzyme treatment (4ml/liter) with a 24-hour maturation period was able to achieve the slightly higher PRI value (63.3%) than the recommended value (60%) for both control and DPNR. It was found that curing time (T90) of the control sample was higher than the enzyme-treated samples and the control sample showed better tensile strength than the enzyme-treated samples due to the protein reinforcement effect and higher crosslink density. Overall, it could be concluded that the selected enzyme has the potential to use it for manufacturing DPCR.

Keywords: Deproteinized crepe rubber, Nitrogen Content, Maturation period, Raw rubber properties

Developing Scientific Method to Calculate the Surface Moisture of Fresh Green Tea Leaves on Wet Days

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Plucking is the most labor-intensive field operation in tea plantations. Laborers are paid according to the kilograms of shoots plucked by the workers. Interview with workers as well as management has been used to deduct the weight of green tea leaf of 1 kg per plucking round only when there is rain during the plucking time. This is happened due to the water content in the green leaf or leaf carrying bags. Although this practice is approved by the estate level workers union, any estate does not have any systematic methodology or governing law/ regulation to demonstrate that this deduction is appropriately justifiable. Moreover, the pluckers have some doubts related to the deduction of the weight of leaf plucked by them. Therefore, this study was focused on generating and evaluating of the scientifically accepted method to determine weight reduction of tea shoots plucked from the moisture of shoots during rainy days. Nuwara-Eliya Estate, Labukelle, and Tyllurie Estate, Dikoya were selected for the study. Secondary data of rainfall within early 5 years periods were collected from the offices of the estates and primary rainfall data were obtained using a moisture analyzer after artificial rainfall was applied to leaf taken from selected fields. The quantitative analysis methods were used for data analysis including an analysis of independent and dependent variables, hypotheses testing, correlation, and regression analysis. A regression model was developed to calculate the surface moisture content of leaf during a rainy day. This model can be used to calculate the amount of weight to be deducted from the weight of tea leaf during rainy days and is only applicable to Nuwara-Eliya and Dimbula region.

Keywords: Plucking, Green leaf, Deduction of the weight of leaf, Surface moisture content, Wet days

Socio-Economic Influence on Growth Performance of Smallholder Rubber Cultivation in Uva Province

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Rubber cultivation in Sri Lanka has been extended to Uva Province (Intermediate Zone) to meet the demand for natural rubber. This study was conducted to find the growth performance of smallholdings in Uva Province and associated socio-economic factors. Using a stratified sampling technique, a hundred farmers were selected from four and six Rubber Development Officers' divisions in Badulla and Moneragala districts, respectively. A questionnaire-based survey including information on the family profile, income, expenditure, rubber land & its management, the government supports, yield & products, and marketing facilities was carried out. Also, stem girth, bark consumption rate, the quality of harvesting, and land management were evaluated by randomly selecting twenty rubber trees in each smallholding. Descriptive statistics and multiple regression analyses were performed. According to the results of age distribution, the majority of smallholders (45%) are in the 51-60 age group. Also, more than 50% have only primary and O/L education. According to the results, 93% farmer's cultivation area is less than 2 acres and most have cultivated RRIC 121 rubber clone. The majority (85%) had participated in training/extension programs conducted by the Rubber Research Institute of Sri Lanka and Rubber Development Department. When considering fertilizer usage, 52% of farmers use fertilizers; of them, 68% apply fertilizer yearly. Results of regression analysis revealed that rubber stem girth positively correlated with management practices, fertilizer usage, farming experience, and age of plants.

Keywords: Growth performance, Rubber smallholder, Socio-economic status

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Phosphorus Behaviour in Boralu Series Soil of Rubber (*Hevea brasiliensis*) Plantations

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Monoculture cropping system adopted for more than a hundred years in rubber (*Hevea brasiliensis*) plantation with same agro-management practices has resulted in nutrient imbalance due to either depletion or accumulation of nutrients in soils. Phosphorus (P) is an essential macronutrient for rubber plantations. The main objective of this study was to determine P behaviour in Boralu series soil in relation to soil pH, organic carbon, available P, moisture content, cation exchange capacity, and bulk density. Forty-eight soil samples representing Boralu series soil were evaluated for available P by $\text{NH}_4\text{F}/\text{HCl}$ and organic carbon by the Walkley Black method. Descriptive statistical data were derived and a regression analysis was also carried out to find a relationship between soil parameters. Available P varied from 30.77mg kg^{-1} in manure circle and 23.20mg kg^{-1} outside the manure circle. Organic carbon content in both areas, in and out of the manure circle, varied from 1.16 to 1.16%. Significant ($p=0.03$) differences were observed between the inside and outside the manure circle for organic carbon content. Whereas no significant differences between the inside and outside of manure circle were observed for the moisture content ($p=0.31$), available P ($p=0.37$), and cation exchange capacity ($p=0.13$). There was a positive correlation between organic carbon and available phosphorus with $R^2=0.27$ by the action of phosphorus solubilizing microbes. There was a negative correlation between the organic carbon content and soil pH with $R^2=0.27$ as well as available P and bulk density with $R^2=0.25$. Results show that available P content increase with organic matter.

Keywords: Available phosphorus, Boralu series, Bulk density, Organic carbon, pH

Developing an Effective Specific Gravity Measuring System for Solid Tyre Manufacturing Process

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Solid tyres are non-pneumatic tyres which are not filled with air. It consists of major three layers such as heel, cushion, and tread. The main steps of the solid tyre manufacturing process are compound warming, compound feeding, tyre rolling, curing, and final inspection. During compound warming, the specific gravity of the warmed compound is tested. According to that value, the required mass of compound for tyre is measured. Then It is transferred to the feeding mill and after that, it is transferred to tyre rolling. In the solid tyre manufacturing process, the specific gravity of the warmed compound should be measured before the tyre rolling. The current production process takes a total of 7 min for measuring specific gravity, which is higher than tyre rolling time. So, the current specific gravity measuring system is un-effective for the process. If the weight will be less than the required amount, tyre can be scrapped. It leads to economic losses to the company. Therefore, minimizing the total time for specific gravity measuring is important to increase productivity. In this research, eight types of experiments were designed to find the optimum time for a specific gravity measuring process. In each experiment major four parameters were considered, such as curing temperature, curing time, cooling water temperature, and cooling time. In this experiments three different curing temperatures (180 °C, 190 °C, 200 °C), two different curing times (2, 3 min), two different cooling water temperatures (30 °C, <10 °C) and five different cooling times (0, 1, 2, 3, 4 min) were used to test the specific gravity of the compound samples under 8 different experiments. The results revealed that the optimum curing temperature is 190 °C, curing time is 2 min., cooling time is 2 min., and the cooling water temperature is <10 °C. The total time takes by specific gravity measuring could be minimized to 4 min. It would be profitable for the company in many ways compared to the current 7 min operation.

Keywords: Cooling time, Curing time, Curing temperature, Specific gravity, Tyre manufacturing

Effect of Lead (Pb) on Germination and Early Vegetative Development of Selected Traditional and Improved Rice Varieties in Sri Lanka

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Contamination of soil by heavy metals is a worldwide phenomenon, which has dire consequences on human health, agriculture, and the environment. Among heavy metals, Lead (Pb) is one of the most abundant environmental pollutants. Being readily absorbed by plants, it exerts toxic effects causing altered plant morpho-physiological and biochemical attributes. There is a dearth of research studies in Sri Lanka to elucidate the effect of Pb on rice. Thus, the current study was conducted to assess the effect of Pb on germination and early vegetative development of selected five traditional (*Kuruluthuda*, *Pachchaperumal*, *Godaheenati*, *Suwandel*, and *Sudurusamba*) and two newly improved (Bg 352 and Bg 360) rice varieties. The plants were exposed to 0, 10, 50, and 100 μ M of Pb concentrations in a completely randomized design, with four replicates. Germination energy, speed of germination, and final germination percentage were taken 7 days after sowing. The average root length and average shoot length were taken 7th day after transplanting (14 days after sowing). The data were analysed using SAS 9.1 statistical software and mean separation was done using Duncan's Multiple Range Test at $p < 0.05$. The results revealed that the germination of each tested variety was not significantly ($p < 0.05$) affected even at the highest Pb concentration (100 μ M). However, even at the least Pb concentration (10 μ M), variety *Kuruluthuda*, *Pachchaperumal*, *Godaheenati*, Bg 352 and Bg 360 showed a significant ($p < 0.05$) reduction in shoot length (10.92 ± 0.76 , 14.77 ± 0.43 , 9.98 ± 0.69 , 8.43 ± 0.48 and 8.95 ± 0.63 cm respectively) and Variety *Pachchaperumal*, Bg 352 and Bg 360 showed a significant ($p < 0.05$) reduction in root length (12.08 ± 0.70 , 14.74 ± 0.92 and 13.3 ± 0.70 cm respectively) compared to the control. As per the preliminary results, *Suwandel* and *Sudurusamba* were least affected in the parameters tested. Thus, these two varieties have the potential to tolerate Pb toxicity in the early vegetative stages of development.

Keywords: Lead toxicity, Traditional rice, Improved rice, Germination, Early vegetative growth

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Patterns of Livelihood Diversification in Sri Lanka

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Globally a higher attention is given to the Livelihood diversification as an important strategy by which households may work to achieve sustainable livelihoods through mitigating the income risk. Since there are structural changes with the unique characteristics of the livelihoods in the Sri Lankan context, much attention is needed on analysing the nature of livelihood diversification. The objective of this study is to examine the patterns of livelihood diversification in Sri Lanka. Data were derived from the 2016 Household Income Expenditure Survey and were analysed from descriptive statistics, Probit regression, and OLS Regression. According to the results, only 15% of households from the total population have been diversified their livelihoods. Concerning the livelihood strategy, 53% of households from total households are adopting urban-salaried livelihoods and they have the least tendency towards Livelihood diversification. In terms of employment choice, only 6% of households with government employees have diversified their livelihoods. Households located in the urban sector and estate sector are less likely to being diversified. According to the OLS regression carried out specifically for the agricultural households which are having a high vulnerability to the income, risks implies that the livelihood diversification has a significant and positive impact on enhancing agricultural household welfare in terms of per capita expenditure and aggregate asset index. Probit regression results depict that the major determinants of Livelihood diversification decisions in Sri Lanka are human capital-related factors and regional differences. Programs for removing the regional disparities, promoting human capital development from quality education and skills acquisition, entrepreneurial development, and promoting concepts like “Flexible working hours” should be facilitated to successful livelihood diversification which will ultimately lead to enhancing the household well-being.

Keywords: Livelihood diversification, Sri Lanka

Determinants of Export Performances of Sri Lankan Spices

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Sri Lanka remains one of the major five exporters of spices in the world market. However, the Sri Lankan spices sector is still left behind its exact potential as spices account only for 1 percent of total exports of Sri Lanka. Therefore, this study examines the main determinants of the export flow of spices in Sri Lanka. Secondary data from the first quarter of 2010 to the fourth quarter of 2018 were used. The single equation error correction technique, which is mostly used to analyse nonstationary data, was employed for the analysis. Results revealed that the export volume of spices mainly depends on world GDP (44.9849) and the real wage rate index (-4.0416) in the short run. But, in the long run, this is mainly dependent on four factors such as Sri Lankan real GDP (-0.6435), world GDP (11.3477), real wage rate index (2.9925), and the sector productivity (-2.1437). However, the export value is determined only by the real wage rate index (-3.3309) in the short run and it mainly depends on the real wage rate index (-2.6150) and the sector productivity (-2.3803) in long run. The global financial crisis has significantly affected the export value of the Sri Lankan spices too. The study concludes that the real wage rate index and sector productivity are the significant factors that determine both the export volume and value of spices in Sri Lanka. Hence, this study recommends that policy measures should be taken to improve labour efficiency in the spices sector thereby reducing the cost of production of the sector.

Keywords: Agricultural exports, Determinants, Exports of Sri Lanka, Spices exports

Open and Distance Learning Course on Corporate Literacy for Small Scale Entrepreneurs

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The need for effective education and knowledge dissemination in the agriculture sector has highly emerged as it is a key factor for agricultural sector development in Sri Lanka. It is difficult to provide a formal education program to small scale entrepreneurs due to their different demographic characteristics. Hence open and distance learning is emerging as an effective mode of learning to empower them by facilitating knowledge regularly. Randomly selected 50 small scale entrepreneurs in Southern province were interviewed using a pre-tested questionnaire. Existing knowledge was assessed using seven sub-components of corporate literacy. Results discover that the overall knowledge level of the small scale entrepreneurs is moderate which indicates a mean value of 3.37. Likert scale analysis proves that 50% of the respondents have medium level knowledge on corporate literacy. The experience in the business and level of education have positively contributed to their total knowledge level. The type of course module, learning mode, medium, and course duration were selected as the main attributes of the respondents' preference. Results disclose that no respondents have currently joined in an open and distance learning program. According to the responses, 56% of the small scale entrepreneurs prefer to gain information as a voice message via mobile phone. Out of twelve course modules, 24% of the respondents are interested in learning about company registration. They wish to enroll for three months period in the Sinhala language. The study concludes that there is a higher demand for the concept of open and distance learning within small scale entrepreneurs in terms of its convenience, flexibility, and cost-effectiveness. This education system can be further improved by linking to various electronic sources of information on corporate literacy and facilitating live interactive communication sessions with agricultural experts.

Keywords: Corporate literacy, Entrepreneurs, Open and distance learning

Environmental Efficiency of Tea Production: The Case of Uva Tea Growing Region in Sri Lanka

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Sri Lanka tea industry needs to improve its productivity to remain competitive in the international tea market. Tea producers as individual decision-making units have a greater responsibility towards achieving and sustaining the required level of productivity. Many factors influence the productivity of tea producers, however, production environment characterized by the weather variables such as temperature, rainfall, and wet days are beyond the producer's control. The analysis of these environmental factors within a frame of total factor productivity concept or environmental efficiency analysis captures the role of the production environment of the producer. Surprisingly, studies on analysing environmental efficiency as a measure of the productivity of perennial plantation commercial crop production units are seldom in the literature. Based on a monthly panel data from 12 different tea estates on the Uva region over 19 years (2000-2018), this study analyses the environmental efficiency of estate level tea production. Specifically, we use a stochastic frontier production function to reveal the total factor productivity index (TFPI) for the selected estates over 19 years and decompose to the environmental efficiency of the tea production. According to our findings, the environmental efficiency scores of estate level tea production vary from 0.86 to 1.05 over the period from 2000 to 2018. More importantly, the environmental efficiency of 14 years throughout the studied period is less than one indicating the estates of the Uva region were operating in a poor productive environment. Our findings suggest that climate change impacts tea production moreover, these environmental factors may also affect the production environment of tea plantations in other tea growing regions in Sri Lanka.

Keywords: Productivity, Total Factor Productivity Index, Environmental efficiency, Plantation

Isolation of *Salmonella* spp, *E. coli* and *Proteus* spp from Broiler Chicken Meat and Their Antibiotic Sensitivity to Commonly used Antibiotics

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Development of antimicrobial resistance is a public health concern at the global level, and the spread of antimicrobial resistance are complex problems driven by numerous interconnected factors such as misuse of antimicrobials. Antimicrobial resistance among these foodborne bacteria is common with indiscriminate use of the antimicrobials in food animals. This study was aimed at isolating *Salmonella* spp, *Proteus* spp and *Escherichia coli* from broiler chicken meat and investigating their antibiotic sensitivity to commonly used antibiotics such as trimethoprim (25µg), Ceftriaxone (30µg), gentamycin (10µg), ampicillin (25µg) and ciprofloxacin (30µg) by disk diffusion assay. Meat samples were collected as pooled samples from eight retail shops in the Rathnapura area and 15 organisms were identified by the conventional phenotypic method. Most abundant were *Proteus mirabilis* (6/15), followed by *E.coli* (4/15), *Salmonella* spp (3/15), and *Proteus vulgaris* (2/15). All *Salmonella* isolates showed resistance to ampicillin and intermediate resistance to ciprofloxacin whereas all *Salmonella* isolates were sensitive to ceftriaxone and trimethoprim while 2 of them (*Salmonella* isolate) were resistant to gentamicin and 1 (*Salmonella* isolate) showed intermediate resistant. Although all *E.coli* isolates exhibited resistance to gentamycin and ampicillin some of them were sensitive to ciprofloxacin (3/4), ceftriaxone (2/4) and trimethoprim (1/4). Further, the study indicated that all of *Proteus vulgaris* are resistant to gentamycin and ampicillin whereas they all were sensitivity to ceftriaxone and ciprofloxacin. Out of six isolates of *Proteus mirabilis* five isolates were resistant to both gentamycin and trimethoprim whereas they were resistant ampicillin. But five isolates (6) were sensitivity to ceftriaxone. Moreover, some of the organisms (*E. coli* and *Proteus mirabilis*) showed multidrug resistance. The findings of the study concluded that there is a risk of development of antibiotic-resistant in broiler chicken and this will be an alarming sign to take precautionary actions.

Keywords: Isolation, *Salmonella*, *E. coli*, *Proteus*, Antibiotic sensitivity

Effect of Granite Herbicide on Paddy Soil Microbiota

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Granite, which is a systemic herbicide formulation, is widely applied by wet zone paddy farmers in Sri Lanka to control weeds during the initial vegetative growth phase of paddy. The active compound, Penoxsulam; 2-(2,2-difluoroethoxy)-N-(5,8-demethoxy[1,2,4]triazolo[1,5c]pyrimidine-2-yl)-6-trifluoromethyl) benenesulfonamide, destroys both grass and broad leaf weeds through inhibiting Aceto Lactate Synthase (ALS) enzyme. Paddy soil inhabiting microorganisms play a vital role in soil fertility management and suppression of diseases. But, a considerable attention has not been paid to see the effect of Granite on non-target soil microbiota. Thus, the present study evaluated the effect of granite on total microbial activity of rice fields inhabiting microorganisms. After basic soil characterization, 25 g uncontaminated soil was amended with the herbicide Granite to prepare a laboratory contaminated soil series (2.5, 5.0, 10, 15, and 20 ppm of Granite kg^{-1} of soil). The control consisted with no Granite. All treatments were replicated thrice. Three parallel experiments with 24 (T_{24h}), 48 (T_{48h}) and 168 (T_{168h}) h experimental time were carried out. At the end of each experiment, soil samples were taken from the treatments and soil total microbial activity (TMA) was measured. The highest TMA was measured from the treatment 2.5 ppm of Granite kg^{-1} of soil and T_{24h} , T_{48h} and T_{168h} exposure times for that treatment were 12.5 ± 0.06 , 12.1 ± 0.04 and 10.8 ± 0.34 , respectively. The lowest values of TMA recorded from the treatment with the highest contamination level (20.0 ppm of Granite kg^{-1} of soil) with T_{24h} , and T_{168h} exposure times of 9.6 ± 0.33 , and 8.1 ± 0.20 , respectively. Although, the results imply an increasing trend of TMA at acute exposure to lower concentration, the overall results showed a time and concentration dependent irreversible significant ($p < 0.05$), decrease in TMA of treatments with chronic exposure to higher contamination levels of Granite. The overall results infer the potential of negative impact of Granite on rice field inhabiting microbiota due to repeated exposure at high concentrations.

Keywords: Granite, Total microbial activity, Herbicide concentration, Exposure, Irreversible effect

New Rain Water Harvesting Method Using Stem Flow of Trees in Tea Lands

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Water is an important factor for all plants and different irrigation methods are practiced when and where necessary to assure the crop growth and development. Irrigation through rain water harvesting is not common in Sri Lankan tea lands at present. However, the need of any kind of irrigation is increasing in tea lands, especially when adapting to climate change. Therefore, the current study was conducted to identify a new rain water harvesting method using stem flow of Tea (*Cammelia sinensis*), Albizia (*Albizia mollucana*) and Gliricidia (*Gliricidia sepium*) at St. Joachim Estate, Ratnapura (6° 44' N, 80° 21' E) from October to December 2019. 20 Tea at same age, 2 Gliricidia and an Albizia were subjected to measure the stem flow. The selected Tea were TRI 2021, TRI 2027, TRI 2023 and TRI 2026 cultivars. Polythene gutters were fixed for each selected plant according to their diameter of the stem base and leak seal glue was applied over those areas using thumb tacks. Then 5 L plastic cans for Tea, 10 L clay pots for Gliricidia and 45 L plastic barrel for Albizia were placed at the end of each gutter to collect the stem flow. Collected water in each container was measured using a standard measuring cylinder. Daily rainfall data were collected from the Agro- meteorological station of the Tea Research Institute, Ratnapura. Finally, collected data were statistically analyzed using correlation coefficient procedure. The highest stem flow recorded from Albizia (10.978 L) while Gliricidia and Tea collected 2.8 L and 1.25 L, respectively under 11.1mm rainfall. Therefore, there is a feasibility to make use of this stem flow of water of Albizia to irrigate some tea plants.

Keywords: Micro irrigation, Rain gutters, Rain water harvesting, Stem flow, Tea

Role of Agriculture Cooperatives as a Farmer-Based Organization in Sri Lanka: A Case Study in Morawak Korale Tea Producers' Cooperative Society

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Agriculture cooperatives are considered as one of the most successful cooperatives in the world. They are also considered as Farmer Based Organizations (FBO). Successful FBOs are engaged in crop production and processing, value addition, and marketing activities. Such entities provide a vast array of services to the members such as capacity building, supply of inputs, credits, resources and extension services, processing, value addition, marketing, welfare, disbursement of profits etc. Morawak Korale Tea Producers Cooperative Society (MKTPCS) is the only cooperative belonging to a tea-growing community in Sri Lanka. Studies have revealed that many FBOs do not produce expected results. This study attempted to examine the role of MKTPCS as a Farmer Based Organization. Data were gathered from key stakeholders comprising of cooperative officials and its members through qualitative interviews. They were analysed using standard qualitative methods (Coding and Thematic analysis). Results revealed that MTPCS provides marketing facilities for the products of the members'. It earns profits and transferred to the members in the form of bonuses and various forms of welfare facilities. The production support system, such as the supplying of inputs and credit operate very effectively. However, the extension service is not in a satisfactory level in certain clusters. Due to the structural issues and lack of legitimate power, zonal committees are unable to perform a significant role in this system. The management is unable to link the ordinary members to the cooperative through the zonal committees. Certain conditions in the Cooperative Societies act No. 5 of 1972 (as amended) suppress the self-reliance state of the MKTPCS as an FBO. The members are the shareholders of the cooperative, and all the members have equal voting rights in decision making. MTPCS processes the members' primary products as a producers' organization, and the members strongly believed that the cooperative activities have positively affected on their lives. It is recommended that the present structure should be changed into the two-tiered federated structure with the decentralization of power into Zonal Committees.

Keywords: Tea producer, FBO, Cooperative services, Marketing and welfare facilities

Aquaculture and Fisheries

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Investigation on the Prevalence of *Aeromonas* spp. from the Aquarium Water in Uva Province and the Most Suitable Antibiotics for Treatment of *Aeromonas* spp.

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The ornamental fish industry is a globally fast blooming industry. *Aeromonas* spp. is known to cause infections in ornamental fish leading to huge economic losses. The pathogen can contaminate the water and helps for disease transmission. The present study aims to determine the prevalence of *Aeromonas* spp. in aquarium water collected from Uva province and to determine the resistance level of *Aeromonas* spp. to various antibiotics. A total of 54 water samples were collected from 14 aquariums in the Uva province. Bacteria were isolated using Tryptic Soy Agar and isolates were identified as *Aeromonas* spp. by Gram negative, oxidase positive, fermentative, and 0/129 resistant. Antimicrobial susceptibility tests were conducted using Amoxicillin, Tetracycline, and Chloramphenicol. The prevalence of *Aeromonas* was reported as 43%. Among *Aeromonas* spp. positive samples, 52% were reported from water samples with sick fish while 48% were reported in water samples without sick fish. The presence of *Aeromonas* spp. in water with the absence of sick fish confirms that they were opportunistic and that they can survive within the water leading to infections under unfavourable conditions for hosts. According to fisher's exact test, there is no significant relationship between water changing frequency and existence of *Aeromonas* sp. in water ($p>0.05$). Antimicrobial susceptibility test results showed that there is a significant difference between the sensitivity of the isolates to the different antibiotics ($p<0.05$). The highest resistance to Amoxicillin and highest susceptibility to Chloramphenicol (74%) and Tetracycline (65%) were reported. Since, Amoxicillin is one of the most common antibiotics used in aquariums, heavy use or abuse of amoxicillin might predispose current findings. In conclusion, 43% is the prevalence of *Aeromonas* spp. from aquarium water in the Uva province and Chloramphenicol & Tetracycline can be recommended as the best antibiotic to treat the infections of *Aeromonas* spp.

Keywords: *Aeromonas* spp., Aquarium water, Antibiotics, Ornamental fish

Growth Performances of Tilapia (*Oreochromis niloticus*) Fed with Duckweed (*Lemna minor*)

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Food fish is the most valuable protein source and highly enriched with many nutrients. The cost of feed is the major reason for decreasing food fish production. The present study was conducted to identify the effect of duckweed on the growth of Tilapia. Five different diets (experiment, 2, 3, 4, 5, 6) were prepared with 40% crude protein while control diet. Experiment 1 contained a 0% duckweed leaf meal. Fish meal in experiment 2-5 was partially replaced with 10, 20, 30, 40, and 50% of dried duckweed leaf meal. Tilapia fry (bodyweight 0.21 ± 0.007 g and standard length 0.73 ± 0.005 cm) reared in indoor glass tanks were used for each experiment's diets ensuring three replicates. Daily feed allowance (5% of body weight of fish) was offered at 0900 h. and 1500 h. Results showed that mean weight gain recorded in fish fed with the experimental diets 2, 3, 4, 5, and 6 were significantly different from that of fish fed with the control diet ($p < 0.05$). There was a significant difference in the Specific Growth Rate of fish fed with the control diet and the experimental diets. Survival Rate of the fish fed with the experimental diets 2, 3, 4 was not significantly different ($p > 0.05$) with a control diet, when diet 5 and 6 were significantly different ($p < 0.05$) with a control diet at the end of the study period. The highest Feed Conversion Ratio was recorded in fish fed with a control diet (1.28) and the lowest ratio was recorded in diet 4 (0.98). Protein Efficiency Ratio of fish fed with every 5 experimental diets were significantly different from the control diet ($p < 0.05$) at the end of the study period. The cost of production for 1 kg of feed was considerably low for diet 6 compared to the control diet. Present results showed that 30% of dried duckweed leaf meal in a formulated diet for Nile Tilapia fish is very effective and showed the highest growth rate.

Keywords: *Oreochromis niloticus*, Duckweed, Crude protein, Growth performance, Fish feed

Development of Seaweed Based Ready-to-Serve (RTS) Beverage using Elkhorn Sea Moss: *Kappaphycus alvarezii* - A Novel Approach in Value Addition to Seaweed Resources in Sri Lanka

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In Sri Lanka, the development of seaweed-based food products such as nutritious drinks still gained less attention. This study was focused on the identification of product processing potential with appropriate production technology for the RTS beverage using common red algae: *Kappaphycus alvarezii* having high culture potential in Sri Lanka. Preliminary trials were conducted to identify the composition of raw materials and ingredients for the development of RTS products. Then, final experiments were followed using 3 levels of *Kappaphycus* extracts (15, 20, and 25%) blended with 5% fresh lime juice. Final products were subjected to pasteurization at 90 °C for 5 min and stored at room temperature. The selected final product was analyzed for organoleptic parameters, proximate composition, and keeping quality characters. Results indicated the production potential of value-added RTS beverage using red algae. Final treatment with 20% of *K. alvarezii* recorded as the best product with the highest consumer preference. Based on the results, this RTS beverage contained a significant amount of minerals ($2.05 \pm 0.01\%$) and high antioxidant potential ($\sim 70\%$) with 0.001% of carbohydrate level closer to zero (atkins drink) compared to the market available products. pH level (4.37 ± 0.06 - 3.90 ± 0.05), antioxidant property (70.98 ± 1.7 - $53.3 \pm 2.0\%$), acidity (0.30 - 0.36%) and Total Plate Count (2.60 - $3.60 \log \text{CFU ml}^{-1}$) of final product had a significant effect with storage time period ($P < 0.05$). Total Soluble Solid level of the product (1.2 °Brix) was constant during the storage period due to extremely low sugar content. According to physicochemical parameters and microbiological tests, this product was safer for consumption within 4 weeks of the period. Moreover, the production cost is relatively lower compared to the market available, common beverage products. In conclusion, this seaweed-based product can be introduced as a healthy, low-cost, atkins drink as an alternative to conventional beverages.

Keywords: Nutritious beverage, Red algae, Atkins drink, Physico-chemical properties, Seaweed based product

Status of the Marine Ornaments Export Industry in Sri Lanka

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The marine aquarium industry in Sri Lanka has become a popular industry during the past few years. Exporters have shown an increasing trend for marine ornamental species exporting due to globally increased demand. Therefore, a study was designed to assess the present situation of the marine ornamental industry in Sri Lanka. Pretested questionnaire-based survey with visual observations of the exporting process was conducted by selecting 30 leading marine ornaments exporting companies to assess the situation of the industry. Export data that were gathered from Sri Lanka Customs were analyzed using descriptive analysis methods. The analysis figured that approximately 611,310 marine fish individuals in 2017 and 459,425 individuals in 2018 have been exported from Sri Lanka. Thus, 151,885 individuals of prominent decrease have been observed in exporting marine ornamental fish due to the reduction of fish catch from the wild. However, a prominent growth (49,468) has been observed in exporting marine invertebrates as 105,750 individuals in 2017 and 155,218 individuals in 2018. These ornamentals have the highest demand in the USA (336,452) followed by Japan (143,497) and UK (25,386). As per the regions, the North American region had the highest demand for marine fish approximately 406,470 individuals totally in both years and followed by the North Asian region by exporting 290,916 individuals. Family Gobidae (21.6%) was the most demanded fish family in the export market followed by family Serranidae (11.7%) Acanthuridae (10.7%), and Labridae (7.7%). Most demanded invertebrate family was Hippolitidae (83.9%) followed by family Rhynchocinedae (9.0%). However, these targeting particular species in wild capture fishery may highly affect to collapse the balance of Sri Lankan reef ecosystems. Therefore, suitable strategies should be immediately implemented to fulfill the huge demand in the exporting market while sustainably utilizing natural resources.

Keywords: Marine aquarium fishery, Wild catch, Reef fish

Occurrence of Microplastics in Gut and Muscles of Commerson's Anchovy in Madu-Ganga Estuary of Southern Province, Sri Lanka

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Plastic pollution causes serious ecological risks on biodiversity with toxicological effects on the biota. The objective of this study was to assess microplastic accumulation in seasonally common fishery resource: *Stolephorus commersonii* (Commerson's Anchovy) harvested from Madu-ganga estuarine ecosystem. Fifteen matured fish samples (n=15) were randomly collected from local fishermen from November 2019 to January 2020. Microplastic particles were extracted from the digestive tract and muscles of anchovies using the recommended protocol of 10% KOH digestion. Hot needle test and Fourier Transform Infrared Radiation (FTIR) analysis were used for the confirmation of microscopically observed microplastics in anchovy samples. Microscopically observed microplastics were counted and categorized according to the size, color, and shape of plastics. Results revealed the microplastic accumulation in both the digestive tract and muscles of anchovies. Microplastics accumulate into the muscles via translocation and different respiratory modes. The average microplastic accumulation rate of anchovy gut and muscles were recorded as 301.70 ± 3.58 items/g and 29.33 ± 1.19 items/g respectively. White/transparent microplastic particles were the most abundant type in both guts (145.50 ± 2.18 items/g) and muscles (13.55 ± 1.23 items/g) of fish. However, blue (71.33 ± 0.83 items/g: gut, 9.85 ± 1.13 items/g: muscle), black (37.85 ± 1.07 items/g: gut, 2.49 ± 0.44 items/g: muscle), red (28.31 ± 0.60 items/g: gut, 2.31 ± 0.3 items/g: muscle) and pink (15.31 ± 0.34 items/g: gut 0.96 ± 0.24 items/g: muscle) microplastic debris were also recorded from gut and muscle samples. The majority of accumulated plastics in both gut and muscles were at the size range of 0.50 -1.00 mm. Fiber shape microplastics were observed in all the samples. FTIR results revealed that polypropylene as the only polymer type of microplastics in fish muscles and gut. This polymer is a key component of fishing ropes, netting materials, bottle caps, and packaging materials that enter through tourism/recreational activities and fishery operations into the estuarine ecosystem. Therefore, the current study recommends sustainable, integrated fishery management and eco-tourism programs focusing on plastic pollution control and prevention activities in Madu-ganga estuarine ecosystem. In conclusion, this study highlights the occurrence of microplastic contamination in the estuarine biota and the urgent need for plastic wastes management programs.

Keywords: Coastal fishery resources, Estuarine ecosystem, Integrated fishery management, Microplastic accumulation rate, Plastic pollution control programmes

Present Status of the Marine Aquarium Fishery in the Eastern Coast of Sri Lanka

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Marine aquarium industry is a popular multimillionaire industry in the world and a considerable amount of global market is fulfilled by exporting from Sri Lanka since its beginning. Almost all marine ornamental species of Sri Lanka are collected from wild habitats which cause serious stock degradation of endemic and other marine species. The collection of marine ornaments has been establishing as a community-based industry on the Eastern coast of Sri Lanka due to high resource availability and accessibility compared to other regions; however, it is poorly documented. Therefore, a survey was designed to study the situation, threats, and issues of the industry on the East coast by using a questionnaire-based survey combined with field observations. Information was gathered from the collectors, suppliers, buyers, fisheries officers, and other relevant stakeholders. Almost 190 fish collectors and 15 suppliers are currently occupying during the southwestern monsoon period roughly from May to October in the Eastern coast. About 250 marine fish species (mainly butterflyfish, angelfish, damselfish, gobies, wrasses, surgeonfish, groupers, blennies & lionfish) and 50 marine invertebrate species (shrimps, Anemones, Sea Slugs & Sea lilies) are being collected mainly from Ottamavadi, Pasikudah, Kalkudah, Paul point, Adukkuparu, and Nilaweli reefs and rocky habitats. However, 01 - 05% of fish are discarding due to catching issues and 05 - 10% of caught fish are discarding due to improper handling, holding, and packing methods before reaching to local exporters. Dynamite fishing, overexploitation, fluctuations of price levels, mishandling of caught live forms, degradation of reef habitats due to natural and anthropogenic factors are the main identified threats so that the industry in the Eastern coast is certainly unsustainable. Therefore, it is highly recommended that a powerful management system should be rapidly established for the benefit of valuable marine ecosystems and the industry.

Keywords: Marine ornamental fish, Reef fish, Color fish, Trincomalee, Batticaloa

Development of Fish Feed Using Marigold Petals and Banana Peel to Enhance the Coloration of Koi Carp (*Cyprinus carpio*)

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Koi is an economically important fish variety because of the wide diversity of skin color patterns. Fishes are unable to synthesis carotenoids in their body. The culture of ornamental fish without supplementation of dietary carotenoids leads to fade coloration. But synthetic carotenoids are expensive. Marigold petals (*Tagetes erecta*) and banana peels (*Musa acuminata*) are inexpensive, abundant, rich in carotenoids, and discarded as wastes. The objective of this study was to develop a suitable color enhancing fish feed and enhance the skin color of Koi carp by using natural color pigments. An experiment was carried out for nine weeks to enhance the body coloration of Koi carp under laboratory conditions. Four weeks old, 252 Kohaku fish were randomly introduced into seven treatments with triplicates. Marigold petals and banana peels were sun-dried, ground into fine particles, and sieved. Color enhancing diets were prepared with different concentrations (5, 10, 15%) of sun-dried marigold petal powder and banana peel powder; with the control treatment; commercial fish feed. All seven feed types were analysed for crude protein, crude lipid, ash, and moisture. Feed samples were checked for changes in physical properties at room temperature and refrigerated conditions (4 °C) for one month. The total carotenoid concentration of all diets was measured using a UV spectrophotometer. The color analysis of the fish skin was done by a photographic method using Image J software. After 9 weeks from feeding, maximum skin coloration of Kohaku fish was achieved by the feed incorporated with 15% Marigold petal powder and 15% banana peel powder with significantly different. ($p < 0.005$). Marigold petal incorporated feed obtained high skin coloration than banana peels. The lowest skin coloration was achieved in commercial fish feed. The growth rate of fish did not show any significant difference among prepared feeds during the trial. This study showed that prepared diets using Marigold petals and banana peel with different concentrations provide adequate enhancement of coloration for Kohaku fish with a short time.

Keywords: Kohaku Carp, Fish feed, Skin coloration, Marigold petals, Banana peels

Socio-economic and Livelihood Related Issues of Cast Net Users in Koggala Lagoon Sri Lanka

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The study was conducted in the Koggala lagoon, Southern province in Sri Lanka to assess the basic socio-economic and livelihood related issues of cast net users. A cast net is one of the traditional, effective, environmentally friendly, fishing gear; the use of traditional fishing practices should be given priority to promoting sustainable fishing, better livelihood & socioeconomic wellbeing of fishers. Hence the current study of existing issues in cast net fishery provides baseline information that raises attention for appropriate management measures. The study has been carried out for four months. Sixty-six cast net fishermen were randomly selected as a sample and pre-tested and interviewed through a questionnaire survey. Variables related to socio-economics of the cast net users were collected and descriptive statistics employed to analyze the situation. Present cast net contributes 40% from total fish catch; 98% of male representation, 77% are old population & 73% have more than 33 years of experience among the lagoon fishermen. 80% have only primary education and 82% are doing fishing as the primary income method along with other fishing practices. 45% of fishermen have 4 - 5 family members. To cover monthly expenditure fishermen, take loans from various sources. Their monthly harvest ranged from 0 to 15 kg with an average of 7 kg. Lagoon mouth was a highly productive area for cast netting. Six livelihood issues were identified; crocodile attacks – 27%, low harvest – 20%, illegal fishing activities – 19%, mixing of fuel with water – 15%, net damage by oysters – 13%, chemicals from the factories – 6%. Crocodile attacks, low harvest, illegal fishing activities were the main issues prevailing for fishermen in Koggala lagoon. The current preliminary study upraised the necessity of proper surveillance of cast net fishery in Koggala lagoon in enhancing fisher livelihood and sustainable fishing which aid in proper management; however adequate attention should be paid in future studies in this regard.

Keywords: Cast net, Livelihood issues, Lagoon fishermen

Study on Illegal Fishing Practices Used for Exploitation of Fishery Resources in the Koggala Lagoon, Sri Lanka

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Koggala lagoon is located in Galle district with a significant contribution to the fishery sector of Sri Lanka. The inevitability of illegal fishing practices causing a threat to the commercially important fish populations due to strengthened demand, higher prices, and emerging competition in the market, had also been a serious issue in the fishery of Koggala lagoon. The objectives of the present study were to, identify the illegal fishing methods practiced in the lagoon and quantify the approximate illegal production. A self-administrated questionnaire survey was designed and pre-tested to collect socio-demographic details of the sixty fishermen and also average production data using illegal fishing gears over three months from October to December 2019. Catch data were collected to calculate the Catch per Unit Effort (CPUE) in common fishing gears. The Garret ranking technique was applied to assess the degree of severity of the fishing gears according to the lagoon fishermen's perception. Results of the questionnaire survey indicated that gillnets (97%) with less than 3 ½" mesh size and monofilament nets (48%) were the most common illegal fishing gears used among the lagoon fishermen. Among the wide range of mesh sizes of the gillnets, 57.15 mm (2 ¼") size was frequently (23.3%) used for fishing in the lagoon. According to the fishermen's perception on the weight of the harvest and the size of the juveniles, the fixed purse net was found to be the most detrimental gear used in the lagoon (1.79 kg hour⁻¹). However, considering the average catch data, the fixed purse net (7.64 kg) was also the most efficient gear used in the Koggala lagoon. The current study revealed that illegal fishing is very common in the lagoon violating government rules and regulations. Therefore, active legal enforcements and monitoring on illegal fishing practices such as usage of over-small mesh nets and monofilament nets are extremely important in preventing overexploitation of fish populations.

Keywords: Koggala lagoon, Illegal fishing, Sustainable utilization, Garret's ranking technique, Socio-demography

Illustration of Key Morphological Characteristics of Highly Demanded, Export Restricted and Export Prohibited Marine Ornamental Fish Species in Sri Lanka

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The marine ornamental fish export industry becomes a valuable foreign income generator over the past few years. However, illegal exporting of marine ornamental fishes has threatened the most marine species. Illegal exports continue, despite the available sufficient regulations including Fauna and Flora Protection Act No 49 of 1993 and Fisheries and Aquatic Resources Act No. 02 of 1996 of Sri Lanka. Illegal exporting of marine ornamental fishes also attributed to the misidentification of the marine species. Therefore, the present study aimed to develop a user-friendly marine ornamental fish identification guide based on a dichotomous key which aids to minimize the misidentification issues. Ten highly demanded marine ornamental species were selected from the Sri Lanka Customs database. In addition to that, 14 export restricted marine ornamental species and 17 export-prohibited species were chosen for preparation of the guide based on Fisheries and Aquatic Resources Act No. 02 of 1996. Secondary data were utilized to identify the morphometric and meristic characters that discriminate against the fish families. Morphological characters used to identify the species are included; body colour, body patterns, pectoral fin length, presence of stripes, number and position of the photophores, and head length. Fish species that live in the same area at the adult growth stage was used for collecting morphological characteristics among individuals of the same species. Forty-one species under the 16 families were included in the dichotomous key to find out from the study that Family *Chaetodontidae* has the highest number of restricted species ($n=12$). Under the prohibited species, family *Haemulidae* bears the highest number of species ($n=4$). The developed guide is important for fish divers, collectors, exporters as well as customs officers to identify the restricted and prohibited species. The dichotomous key developed in the present study will be utilized for the development of marine ornamental fish identification mobile application.

Keywords: Dichotomous key, Marine ornamental fish, Sri Lanka, Mobile application

Comparative Study on Growth Performance and Profitability of Shrimp Farming Industry in Sri Lanka: Native *Penaeus monodon* vs. Imported Specific Pathogen Free

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Until 2018, *Penaeus monodon* was the main commercial-scale cultured shrimp species in Sri Lanka and the seed production industry depended on wild-caught native broodstock. Due to the high prevalence of White Spot Disease among the wild-collected brood shrimps, the farming industry has been affected by post larvae shortage and disease outbreaks. As a solution, National Aquaculture Development Authority has decided in 2016 to introduce Specific Pathogen Free (SPF) broodstock to the industry imported from Thailand and they are planning to encourage the SPF shrimp farming in the country. Therefore, this study was focused to compare the growth performance and profitability of farming these two varieties. During the period of 21st March 2019 to 28th February 2020, 14 ponds for each variety were selected from the Ambakandawila area in Puttalam District for the study. Data collection was initiated after the 8th week of the stocking and continued up to the harvest. Specific Growth Rate (SGR), Survival Rate (SR), Average Daily Gain (ADG) of the body weight, Feed Conversion Ratio (FCR), total cost, revenue, and net profit were calculated. SGR was recorded as 2.51 ± 0.1 & 2.13 ± 0.06 and ADG of the body weight was recorded as 0.31 ± 0.02 & 0.23 ± 0.01 g day⁻¹ for SPF and native shrimp varieties respectively. SR was recorded as $70.1 \pm 3.4\%$ & $69.9 \pm 3.2\%$ and FCR was recorded as 1.51 ± 0.04 and 1.54 ± 0.07 for SPF and native shrimp varieties respectively. It recorded $1,482,311.62 \pm 50,687.49$ and $1,087,716.21 \pm 72,449.54$ LKR acre⁻¹ as the total cost of the farming of SPF and native shrimp varieties respectively. Total revenue was recorded as $1,783,733 \pm 102,197$ and $1,535,122 \pm 162,199$ LKR acre⁻¹ and estimated net profit was calculated as $301,421 \pm 105,412$ and $447,406 \pm 101,576$ LKR acre⁻¹ for SPF and native shrimp culture systems respectively. Although the SGR, SR, ADG, FCR are better in SPF shrimps than native shrimps, profitability mainly depends on the total cost.

Keywords: SPF *Penaeus monodon*, Shrimp farming, Growth performance, Profitability

Preliminary Study on Fishery of Gurunagar in Jaffna, Sri Lanka *Penaeus monodon*

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Gurunagar is one of the major fishing centers and its production rate also high compared with other fishing villages in Jaffna west. Effective sustainable fisheries management measures were not highlighted in Gurunagar fishery previously. This study aimed at collecting information on fishing practices, species composition, fish production, catch per unit effort, supply chain and market structure, and the level of awareness of fisher community as baseline information on fishery sustainability to improve fishery management. This study was carried out from October 2019 to January 2020. Primary data were pre-tested and collected using a questionnaire from 60 individuals, personal interviews, and direct field observation. Secondary data were collected from the Fisheries Department at Jaffna, and journal articles. Data were analysed statistically. The study revealed that a total of 12 types of fishing gears and 5 types of fishing crafts used in Gurunagar fishery. A total number of 53 species, representing 32 families were identified in the Gurunagar fish landing site during the study period. Average fresh fish and dried fish production were found 606 Mt and 56 Mt from October to December, respectively. Fishers caught 8 to 19 kg/100 net square meter-hours, 1 to 2 kg/100 net square meter-hours, 1 kg/100 net square meter-hours, and 3 to 4 kg/100 hook-hours using a trawl net, gill net, stake net, and long line on average, respectively. Gurunagar fishery supply chains represented both local and foreign market interventions. Average profit/kg for prawns, seer fish, and needle cuttlefish were 1700, 565, and 425 LKR respectively. Gurunagar fisher community has moderate awareness of the importance of fishery sustainability. Current study findings may pave the way to improve the fishery management system of the Gurunagar area.

Keywords: Gurunagar, Supply chain, Fishery sustainability, Catch per unit effort, Awareness

Development of Quality Assessment Guideline for *Litopenaeus Vannamei* (Whiteleg Shrimp) Post Larvae

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Penaeus monodon is the main brackish water aquaculture species in Sri Lanka which targets the production for the export market. *Litopenaeus vannamei* (*Penaeus vannamei*) was introduced in 2018 as a new species expecting a rapid increase in production in the country. As a management strategy implemented by the National Aquaculture Development Authority (NAQDA), the assessment of post larvae quality is a compulsory requirement to obtain a better harvest via better growth without disease infections. Quality assessment of the *P. monodon* is based on 10 criteria and a minimum of 80% marks are required to get the approval for stocking. Up to now, the same assessment method has been used for *P. vannamei*, and due to some morphological and anatomical deviations; it did not totally comply with the new species. Hence, this study aimed to develop a post larvae quality assessment guideline for *Litopenaeus vannamei* with a score allocation procedure for each quality assessment criterion. The characteristics of different post-larvae stages (PL 1 - PL 30) from three different culture cycles of *Litopenaeus vannamei* were evaluated under each criterion and performed microscopically and morphologically. The microscopic observations were *Monodon baculoviruses* and Baculovirus penaeid, condition of hepatopancreas and gut content, necrosis and deformities, epibiont fouling, muscle opaqueness, and gut to muscle ratio of post larvae. The average body length, rostral spines, and size variation of each PL stage were the morphological observations measured to apply as standard values. The obtained values for post larvae of *P. vannamei* differed from the values of *P. monodon*. This study reveals the incompatibility of using the same assessment method for both shrimp species. Revision of marks allocation procedure, validation of the quality assessment method, and introduction as a new guideline will contribute to the future development of the *Litopenaeus vannamei* farming industry in Sri Lanka.

Keywords: *Litopenaeus vannamei*, Post larvae quality, Quality assessment guideline, Shrimp farming

Comparative Study on Ring Net and Bottom-Set Gillnet Fisheries in Thalaimannar Pier, Sri Lanka

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Thalaimannar Pier, Sri Lanka was dominant with Ring net (Surukku) and Bottom-set gillnet fisheries. Details with those fisheries were lacking in the literature. A comparative study of both fisheries in Thalaimannar Pier was vital towards sustainable exploitation of fishery resources. The study aims at determining Catch-Per-Unit-Effort (CPUE), catch composition, and supply chain analysis of selected species from two fisheries last October (2019) to early January (2020). Total catch was recorded to the nearest kilogram and effort in-unit kilograms per square meter (kgm^{-2}). The total catch of fish species in ring & gill nets was recorded. Results showed ring net catch mainly comprised of finfish (97.8%), crustaceans (1%), mollusk (1%); 1.2% were non-target species. Bottom-set gillnet catch comprises of crustaceans (50%), finfish (25%), mollusk (20%), and echinoderms (1%). *Portunus pelagicus* was the major target species, nearly 43% of the total catch. Out of the total, 29% of the bottom-set gillnet catch was discarded as non-target species. Gillnet produced more non-target species. Mean CPUE (kgm^{-2}) and standard deviation of ring & gill nets were 0.205 ± 0.062 and $0.0711 \text{ kgm}^{-2} \pm 0.018$ respectively. CPUE for ring net increased from Late-November to Early-January; for gillnet, it decreased from mid November to early January. *Sardinella gibbosa* showed 71.11% of the price difference from wholesalers to outside retailers and *Pampus argenteus* (only exportable species) showed 47% of it from fishers to exporters in the supply chain. Ring net was harmful due to comparatively high catch per unit effort which may lead to overexploitation of commercially important fish populations. Gillnet was also harmful due to the high catch of non-target species. The current study provides baseline information that paves the way for sustainable exploitation of the aforementioned fisheries.

Keywords: Ring net & Bottom-set gillnet fisheries, Catch per unit effort, By-catch

Anesthetic Efficacy of Clove oil, Benzocaine and MS-222 under Simulated Long Transportation Conditions of Koi (*Cyprinus carpio* L.)

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Koi (*Cyprinus carpio*) is one of the most popular temperate ornamental fish species. Growth of the Koi trade in Sri Lanka is hindered by poor packing strategies and mortalities during transport. Therefore, the study aimed at evaluating the anesthetic efficacy of Clove oil, Benzocaine, and MS-222 in simulated long transportation conditions on Koi. 75 d old Koi with standard length (6.025 ± 0.04 cm) and weight (6.153 ± 0.23 g) were selected for the experiments. These individuals were subjected to four different dosages of anesthetics, based on the results obtained at the range-finding test. Each sample consists of 10 individuals and dosages were triplicated. Samples were exposed to simulated transportation conditions for 10, 20, 30, 40 h, and effective dose for each anesthetic was determined by assessing the Sedation Induction Time (SIT), Recovery Achievement Time (RAT), Mortality Rate and Post-exposure Survival Rate of Koi. Changes in water quality parameters including pH, ammoniacal nitrogen, and dissolved oxygen in transport water were recorded. Results obtained were analyzed using one-way ANOVA followed by Tukey's' method and General MANOVA using Minitab 17.0 version ($p < 0.05$). Among four different test concentrations used for clove oil, $145 \mu\text{LL}^{-1}$ was recorded as the best concentration while $140 \mu\text{LL}^{-1}$ and 70mgL^{-1} were obtained for Benzocaine and MS-222 respectively, based on the results obtained from statistical analysis of SIT and RAT ($p < 0.05$). Further, there were 0% mortalities for the 40 h test period and 7 d after recovery for all the three anesthetics at effective concentrations ($p < 0.05$). In conclusion, the present study indicates that all three anesthetics perform well in the above concentrations. However, clove oil can be used as a good substitute for synthetic anesthetics because of its efficacy at a lower dosage with higher safety at a low cost.

Keywords: Sedation, Ornamental carp, Ornamental fish trade, Mortality rate, Packing density

Some Aspects of the Population Characteristics of Selected Marine Fish Species (*Ambligaster sirm*, *Hyporhamphus dussumieri*, *Decapterus russelli* and *Atule mate*) in Trincomalee District

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Coastal fisheries of the eastern coast considerably contribute to the total marine fish production of Sri Lanka. Beach seining and gillnet fishing are renowned fishing practices in Trincomalee district and its catch mainly consisted of *Ambligaster sirm*, *Hyporhamphus dussumieri*, *Decapterus russelli*, and *Atule mate*. Fish population studies can determine the need for management measures to manage overexploiting fish stocks. However, detailed population studies on the above species are lacking. Therefore, the present study aimed at determining particular population parameters of selected fish species for evaluation of stock status. In total, 1187 individuals belong to four species were collected from four landing sites in Trincomalee district from October 2019 to January 2020. Samples were collected from gillnet catches. Total length and total body weight were measured to the nearest millimeter and nearest gram respectively. Total length ranges from 115 to 210 mm for *A. sirm*, 110 to 225 mm for *D. russelli* and 93 to 220 mm, and 200 to 274 mm for *A. mate* and *H. dussumieri* respectively. Results showed negative allometric growth ($b < 3$) for *A. sirm* and *D. russelli* species. This concludes *A. sirm* and *D. russelli* in the study area can grow faster in length than in weight whereas positive allometric growth was recorded for *A. mate* and *H. dussumieri* ($b > 3$). Stock status was determined using the Length Based Spawning Potential Ratio model. Result showed, Spawning Potential Ratio as 29% for *D. russelli* which signs status of the stock is above a limit reference point, stock status of *H. dussumieri* was determined as sustainably exploited with Spawning potential ratio of 33%. *A. sirm* and *A. mate* were determined as below limited reference point with spawning potential ratio of 12%. Accordingly, *A. sirm* and *A. mate* population in the study area is overexploited. In conclusion, *A. sirm* and *A. mate* population in Trincomalee district needs to be managed for a sustainable fishery.

Keywords: Length-weight relationship, Barefoot ecologist toolbox, Condition factor, Spawning Potential Ratio

A Preliminary Study on Potentials of Seaweed Culture as an Alternative Livelihood for Small Scale Fishing Community in Southern Coast of Sri Lanka

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Large scale seaweed mariculture is widespread in many Asian countries for decades. But Sri Lanka is still in its infancy. Therefore, promoting seaweed mariculture as a commercial-scale industry is an urged necessity. Seaweeds grow abundantly along the southern coast of Sri Lanka. Therefore, the study attempted to assess the socio-economic status of small-scale fishermen, the potentiality of using seaweed culture as an alternative livelihood, and awareness of fishermen regarding seaweed culture on the southern coast of Sri Lanka. Data were collected by key-informant interviews and questionnaire surveys from November 2019 to February 2020. Cluster sampling was used to draw a sample of 160 fishermen from 8 major landing sites. Results of the socio-economic analysis showed that 72% of fishermen were between the age group of 35 - 55 years. Due to the seasonality of fishing, 65% of fishermen are having below-average monthly income (LKR 12,000 - 15,000). In three landing sites, 25% of fishermen are seasonal fishers. But almost all fishers are active in other landing sites. In total, 90% of fishermen are interested in seaweed farming. Identified reasons for their interest in seaweed culture were, additional income (85%), manageable with fishing (65%), and women empowerment (58%). Results relevant to awareness on seaweed farming among fishermen 80 - 90% in four landing sites, 60 - 65% in two landing sites, and below 30% in the other two landing sites. Favorable environmental conditions, adequate workforce, and willingness to initiate seaweed culture were identified as potentials. Absence of proper mechanism to disseminate knowledge, financial support, and lack of knowledge on marketing were identified as constraints for the initiation of seaweed farming. Accordingly, knowledge regarding seaweed farming should be disseminated and effectively transferred. The overall results indicate greater potential to initiate seaweed mariculture as an alternative livelihood for small scale fishing communities in southern Sri Lanka.

Keywords: Seaweed, Mariculture, Fishing community, Alternative livelihood, Southern coast

Trophic Status and Spatial Variation of Cyanobacterial Diversity in Lunugamwehera Reservoir, Sri Lanka

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Lunugamwehera is a large man-made reservoir located in the South Eastern dry zone of Sri Lanka. It is the main source of drinking water, irrigation, and fisheries for more than 5000 families in the area. The occurrence of cyanobacterial blooms or high population densities in water bodies results in various environmental and health issues. Population density and composition of cyanobacteria in a waterbody may vary with the trophic status of water. There is a high potential of contaminating the Lunugamwehera reservoir with mineral nutrients that come from agricultural lands. However, considerable attention has not been paid to study trophic status and cyanobacterial diversity of the Lunugamwehera reservoir. Therefore, our objective was to determine the spatial variation of cyanobacterial diversity in the Lunugamwehera reservoir along with trophic status. Sub-surface water samples collected from 28 sampling sites representing the whole waterbody were microscopically examined to identify cyanobacterial species. Total phosphorous concentration, total chlorophyll-a concentration, and Secchi depth were determined to assess trophic status using Carlson Trophic State Index. Also, water quality parameters were measured using a multi-parameter water quality meter. Microscopic analysis revealed the presence of only two cyanobacterial species, *Microcystis* and *Oscillatoria* implying less cyanobacterial diversity in the reservoir. *Microcystis* spp. ($\sim 3.257 \times 10^7$ cells mL⁻¹) dominated all sampling sites with significant difference ($p < 0.05$) in cell densities among sites while *Oscillatoria* spp. (5 - 10 cells mL⁻¹) occurred rarely. Apart from cyanobacteria, *Pediastrum* spp., *Tribonema* spp. and *Nitzschia* spp. (1 - 2 cells mL⁻¹) were also identified scarcely. Water quality parameters were approximately similar in all sampling sites except increased turbidity near the inlet. According to the Carlson Trophic State Index (37.70), the water body was 'slightly oligotrophic'. Therefore, the overall results infer the presence of less cyanobacterial diversity and significant spatial variation in *Microcystis* spp. as the dominant species in the slightly oligotrophic water of the Lunugamwehera reservoir.

Keywords: Carlson trophic state index, Cyanobacteria, Oligotrophic, Spatial variation

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Trade Barriers to Develop Export Market of Sri Lankan Desiccated Coconut Industry

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The desiccated coconut industry is one of the main export-oriented food processing industries in Sri Lanka. The European Union and the United States of America are the main markets for Sri Lankan desiccated coconut, followed by countries like Canada, Asia, and the Pacific Rim. The main objectives of this study were to identify the trade barriers for exporting. This study utilized primary and secondary data. The primary data were collected through a questionnaire-based survey, and the secondary data were gathered from the reports of the Coconut Development Authority and also using the Trade Map. The main export barriers under the main five categories were figured out through the discussion with exporters, and officials of the Marketing Development and Research Division of Coconut Development Authority. Accordingly, a questionnaire was developed and 50 desiccated coconut exporting and manufacturing companies were interviewed. Descriptive analysis and bivariate correlation analysis were done. Descriptive analysis reveals that there are a high price and export volume fluctuation over years and a variety of destinations that export desiccated coconut in Sri Lanka. According to the correlation analysis, the resource barriers, product barriers, process barriers, and market barriers showed a significant negative correlation with the average income, whereas the knowledge barriers and market barriers show a positive significant relationship with the average income. Further, the resource barriers and market barriers were negatively correlated with the cost of production and the product barriers were positively correlated. Based on the findings, the government should intervene in providing technical knowledge and trade facilitation to improve production.

Keywords: Desiccated coconut, Trade barriers, Export market, Sri Lanka

Internal Control Components that Determine the Financial Performance of State Owned and Private Commercial Banks in Sri Lanka

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The banking sector is the main liquidator provider for any economy. Internal control system is a vital component to achieve intended performances and profitability as well as to maintain the assets of a company and ensuring the accuracy and reliability of financial reporting and other procedures and enhance operational efficiency. Especially in banking organizations internal control are very crucial to determine how banks achieve their performance within the competitive environment. Therefore, this study attempted to study internal control components that determine the financial performance of private and state-owned commercial banks in Sri Lanka: with special reference to Central province which could make an important contribution to the management field in decision making. In this regard, five hypotheses were proposed and tested based on internal control components in the Committee of Sponsoring the Organization of the Treadway Commission (COSO) framework. Sample size comprises 110 respondents from state banks and 47 respondents from private banks representing executive-level employees. The employees were selected based on a stratified sampling technique. The statistical approaches such as correlation and regression analysis were used to achieve research objectives. Findings revealed that control environment, control activities, and risk assessment are internal control components that determine financial performance in state banks while control environment, risk assessment, information and communication, and monitoring are the determinants of financial performance in private banks. It is recommended to concern much on internal control determinants for private and state banks separately to enhance financial performance.

Keywords: Components of internal control system, Financial performance, Private and state-owned commercial banks

Is Cash Dividend an Everlasting Stimulus? Impact of Cash Dividend on Share Price of Manufacturing Companies in Sri Lanka

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Shareholder wealth consists of dividends and capital gain. The risk-return trade-off in these two returns drives the investor preference. The former is considered to be risk-averse whereas the latter is perceived to be risky. From one extreme dividend is a return for common stock to another a source of funding for public limited Companies. The objective of a for-profit organization is to maximize shareholder wealth, but disbursing dividends may not always in the best interest of shareholders. Theoretically retaining dividends may also increase share prices. The objective of the study was to measure the stimulus of cash dividends on share prices of 22 companies from 2011 to 2019, for 198 observations, listed on the Colombo Stock Exchange under the manufacturing sector. The novelty of this study is the use of advanced modeling and visualization techniques which eventually helped choose statistical methods with the most adequate assumptions. The Arellano Bond estimator is specifically selected given the nature of data properties and lagged variables. Market Price per Share (MPS) termed as the dependent variable whereas Dividend per Share (DPS), Dividend Payout Ratio (DPR), lagged MPS termed independent variables. The log of sales selected as a control variable through the forward selection criterion. The stationary tests performed, subject to log transformations and first differences revealed none of the variables are I (2). The results validated theoretical literature such as signaling effect and bird in hand theory but questioned previous empirical hypothesis. The study further validated cash dividends as a stimulus to investors given the strong positive relationship between DPS and MPS. The Granger Causality test reflected a short-term bidirectional relationship between MPS and DPS. This study sets a guideline for investors making the right investment choices and companies to keep the right balance between dividend policy and reinvestment strategies given the stimulus contained in dividends.

Keywords: Panel data, Dividends, Share price, Arellano bond estimator, Shareholder wealth

Impact of Employee Motivation to the Employee Retention in Construction Sector of Sri Lanka. (With Special Reference to Construction Sites in Uva Province)

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Though there is a significant contribution from the construction sector to the national Gross Domestic Product (GDP), there's a poor concern on the ground level employees in the field. The objective of this analytical research was to identify the relationship between self-motivation, and their job retention while concerning the factors that affect to the behavior, by using both primary and secondary data with special reference to the construction sites stated in Uva province. Through a random sampling method, 75 ground level employees were selected from different construction sites in the Uva province. As the demographic factors gender, status, age gaps, and service period were concerned. Here mainly identified a major gap between age below 25 and above 60 from the total. It should contemplate once initiating future development programs. Poor education and guidance lead the younger generation this state while elders earning for daily routines. High turnover levels & less effective succession plans were significant. Employees' motivation measured by physical, financial rewards, promotion & growth, supervision, job security. For analyzing data, SPSS 21 version was used and results proved that, there was a positive correlation between the factors related to employee retention at construction sites in Uva province, with the need for the physical requirements having the highest positive relationship. Next it prioritized with financial rewards on workload, own talents with self-capacity, and payment standard followed by promotion and safety, fewer hopes due to not having proper succession plans on the career while ignoring the working risk for basic needs. Concerning two-factor theory motivators should have been empowered before the hygiene factors while proving support to gain the essential needs on usual activities. Authority should highly commit to the work safety though the employees neglected it. Further research is recommended to improve future succession plans to implement in this sector.

Keywords: Employee self-motivation, Employee retention, Construction sites, Rural areas

Investigation of the Impact of Green Marketing Tools on Customer Purchase Intention of Fast-Moving Consumer Goods: With Special Reference to the Youth Sector

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Consumer awareness of environmental issues has become a major concern in the society. Therefore, organizations have moved towards the green marketing concept to achieve sustainable growth. Eco-brand, eco-label, and environmental advertisements are the tools that businesses use to enhance knowledge and awareness of consumers while influencing their purchase decisions. Previous studies show inconsistent results in terms of customer purchase behavior in relation to these tools, indicating a knowledge gap to be addressed by researchers. To this end, following the theory of planned behavior, it would be rational to investigate these tools as predictors of customer purchase intention. Moreover, as a context, Fast-Moving Consumer Goods (FMCG) sector was selected as it is an industry that focuses more on environmental issues. Observably there is a significant lack of empirical studies on these tools as this concept is new to the Sri Lankan market. The specific objective of the study was to investigate the impact of green marketing tools on customer intention to purchase FMCGs in Sri Lanka. Taking Sri Lankan young consumers as the population, 384 individuals were selected as the sample of the study using a convenience sampling technique. The research was quantitative and primary data were collected through a self-administrated questionnaire. Simple and multiple linear regression analysis was performed to test research hypotheses. Results and findings revealed that each tool has a significant and positive impact on customer purchase intention. Accordingly, the study concludes that eco-brand has a salient impact on purchase intention than the eco-label and environmental advertisement. The research recommends that these tools should be promoted more in the market and it is required to concern more on adopting eco-labels to achieve sustainability.

Keywords: Green marketing tools, Eco-brand, Eco-Label, Environmental advertisement, Purchase intention

Impact of Perceived Organizational Support on Employee Turnover Intention: The Role of Psychological Contract Violation as a Mediator with Special Reference to the Operational Level Employees in Sigiriya Area Hotels

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The tourism industry in Sri Lanka has developed to a greater extent after the civil war. Since employee turnover is one of the significant matters related to this industry, scholars tend to be aware of psychological factors in predicting this turnover intention and actual turnover. Perceived organizational support and psychological contract are two important psychological factors that affect employees' perception and behavior. There is a significant lack of empirical studies which has focused on psychological factors and turnover intention relevant to the tourism industry in Sri Lanka. The objective of this study was to identify the mediation effect of the psychological contract violation between perceived organizational support and employee turnover intention. The study is quantitative and it was conducted by taking 982 employees from hotels in the Sigiriya area. 276 of them were selected by using the stratified sampling technique. Primary data were collected by using a self-administrated questionnaire and Partial Least Square-Structural Equation Modeling was performed. Descriptive statistics were used to identify the level of perceived organizational support, psychological contract violation, and employee turnover intention. As per the path modeling results, the psychological contract violation was created a significant partial mediating effect between the perceived organizational support and employee turnover intention. Further, the perceived organizational support directly impacted on the employee turnover intention. The study suggests, psychological contract violation as a key consideration between perceived organizational support and employee turnover intention and provides recommendations and practical implications for hotel management.

Keywords: Perceived organizational support, Psychological contract violation, Employee turnover intention, Turnover

Does Entrepreneurial Resource Bricolage Lead Nurturing Social Innovation?

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Social entrepreneurs are primarily focused on the development of innovative solutions to society's most challenging problems. The behavioral theory of "entrepreneurial resource bricolage" attempts to understand the art of combining extant resources to overcome novel challenges and constraints. This study aimed at investigating how entrepreneurial resource bricolage is used as a method of social innovation in a resource-constrained context. The study further investigated whether entrepreneurial resource bricolage influences nurturing social innovations while observing the moderating effect of entrepreneurial alertness. Taking a qualitative research approach, the study surveyed 264 social entrepreneurs in Sri Lanka. Descriptive statistics, Pearson coefficient correlation, and regression analysis were used to analyze data. The findings manifest that entrepreneurial resource bricolage significantly influences on nurturing social innovations whereas entrepreneurial alertness positively influenced the relationship between entrepreneurial resource bricolage and social innovations. Thus, by doing so, this research provides empirical evidence on how entrepreneurial resource bricolage triggers social innovations. The study provides social entrepreneurs with precious implications to enhance the values and innovations and contributes significantly to the emerging discussion on social innovation and entrepreneurship in the context of the developing country.

Keywords: Behavioral theory, Social entrepreneurs, Social innovations, Entrepreneurial alertness, Entrepreneurial resource bricolage

Social Entrepreneurship and Impact on Securing Triple Bottom Line in Social Enterprises

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Creation of innovative solutions to solve most pressurized social problems is the core of social entrepreneurship while performing the major role of changing agents by social enterprises and entrepreneurs. The study questioning the rise of social enterprises to balance economic, social, and environmental factors in the Sri Lankan economy. Thus, this study aims to determine whether the social entrepreneurship dimensions help social enterprises to secure the triple bottom line by drawing from the knowledge and empirical gaps. Online questionnaires were used as a research instrument to collect data from 137 selected social enterprises through a quantitative research approach. Cronbach's alpha value has ensured the reliability of the questionnaire developed based on past literature. Data were analyzed using descriptive, correlation, and regression analysis. The findings prove that social entrepreneurship positively impacted on achieving triple bottom line goals and highly impacted environment performance rather than economic and social. Finally, this study recommends beginning discussions regards to the social entrepreneurship to fill the academic and industrial lacuna in Sri Lanka.

Keywords: Social entrepreneurship, Social entrepreneur, Social enterprise, Social entrepreneurial dimensions, Triple bottom line

The Impact of Celebrity Endorsement on Brand Recall

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To aware of the product presence in the competitive market the promotional mix plays a major role. Among the promotional mix, advertising using celebrities has significant effects on the brand. Therefore, the celebrity endorsement practices have been intensively used in the modern market. It is crucial to identify the cause and effect of celebrity endorsement before implementing the marketing plan. The usage of celebrity endorsement has been gradually enhanced within the field of cosmetics in the Sri Lankan context. Therefore, this study explores the impact of celebrity endorsement on brand recall regarding the fairness products in Sri Lanka since the limited number of studies has been performed related to this research area. The present research contributes to bridging the knowledge and theoretical gaps that exist in both local and international contexts. The primary objective of the study was to assess the impact of celebrity endorsement on brand recall while using attractiveness, trustworthiness, and expertise as the dimensions of celebrity endorsement. To collect data a survey was undertaken through the distribution of questionnaires. The millennial population was selected as the sample for the research and descriptive, correlation, and regression analysis were conducted to generate results. A strong positive relationship between celebrity endorsement and brand recall was identified in the fairness product. Moreover, a significant impact of celebrity endorsement on brand recall was discovered. Findings revealed the expertise as the prominent impactable celebrity endorsement dimension on brand recall and the attractiveness and trustworthiness align, respectively. Findings encourage the managers to recruit celebrities with expertise knowledge and attractive appearance in order to endorse the fairness products in Sri Lanka. Further research regarding the proposed area is encouraged.

Keywords: Celebrity endorsement, Attractiveness, Trustworthiness, Expertise, Brand recall

Open Innovations in Apparel SMEs: Special Reference to Western Province

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Open innovation leads firms to use external knowledge in the firm innovation process. In this dynamic environment, use of external knowledge to accelerate innovation practices is vital for organizations. Small and medium firms are facing challenges in adopting innovation practices due to the size and have limited resources for introducing the innovation effectively in the market. Even with those challenges, firms are engaging with open innovation in developing the firm innovation process. The main objective of this study was to assess the degree of applying open innovation practices within small and medium apparel firms and the sub-objective was to identify the challenges of open innovation within the small and medium apparel sectors. This research study accomplished those objectives by gathering primary data through an in-depth interview from 12 small and medium apparel firms in the Western province in Sri Lanka by using a convenience sampling method. An equal number of respondents from each district were selected and interview guidelines were used to ensure the interviews were heading in the right direction. Further, data analysis was done using the thematic data analysis method. The study found that small and medium enterprises are applying open innovation practices through customers' involvement, suppliers' involvement, competitors' involvement, and strategic alliance. Additionally, this research found the internal and external challenges of open innovation. The research fundings support creating a platform which connects with external parties and provides awareness of the open innovation practices. Further their research may identify the management involvement of practicing open innovation to develop firm innovation practices.

Keywords: Open innovation, Small and medium firm, Apparel sector, External ideas

Impact of Social Competencies on Social Performance of Social Enterprises (Special Reference to Northern Province in Sri Lanka)

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Social enterprises are continuously searching for new ways to develop and achieve better social performance. Thus, consideration has been given to understand the social competencies which have a great significance on social performance. Numerous forerunners have shown success with the social performance of social enterprises. The present study focuses on identifying the level of social competencies and social performance of the social enterprises in Northern province while examining how social competencies affect the social performance of the social enterprises in Northern province. Further, the study expected to identify the most influencing social competencies on the social performance of the social enterprises in Northern province. The population of this study was all the social enterprises situated in Northern province. A stratified sampling method was used to select a sample of 100 social enterprises. Data were collected using a questionnaire. Both descriptive and inferential techniques were used to accomplish the objectives in which inferential, Pearson's correlation analysis and regression analysis were used to indicate relationship and impact between social competencies and social performance of the social enterprises. Results indicated that there is a positive relationship between social competencies and social performance. Also, the result of regression analysis stipulated that the ability to recognize social problem showed the highest positive relationship with social performance. According to the study results, some valuable suggestions and management implications were provided to the management for achieving better social performance by increasing the social competencies.

Keywords: Social enterprises, Social competencies, Social performance

Causes of Unemployment among the Educated Youth in Sri Lanka

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Educated youth unemployment is one of the major problems in many developing countries like Sri Lanka. It does not reflect the utilization of scarce resources that would be significant to the socio-economic development of countries. Unemployment among educated youth in Sri Lanka is an increasing trend over the last few years. The issue of unemployment among the population aged between 15 - 24 is the subject of this research. Literature argues that demographic and socio-economic factors significantly affect the educated youth unemployment. Thus, the major objective of this study was to analyze the causes of unemployment among the educated youth in Sri Lanka using the Labour Force Survey data of 2016 conducted by the Department of Census and Statistics of Sri Lanka. The study mainly applied the Probit regression model to analyze the data. The results suggested that the areas of living had a positive and statistically significant relationship between educated youth unemployment. However, education level of head of household, gender and vocational training showed a significant negative relationship with educated youth unemployment in Sri Lanka. Further, adding to that, participation in vocational training of respondents caused a decrease in unemployment of educated youth in Sri Lanka. The study recommended that improving access to the education system in Sri Lanka and promoting entrepreneurship among educated youths as two best solutions for the reduction of unemployment among the educated youth.

Keywords: Educated youth, Unemployment, Probit regression model, Labour force survey

Impact of Credit Risk Management on Performance of Microfinance Institutions (Special Reference to Mannar District, Sri Lanka)

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Credit risk management in microfinance institutions has become more important not only due to the financial crisis that the industry is experiencing currently but also a due to the crucial concept which determines the financial and social performance. The objective of this study was to identify the impact of credit risk management on the performance of microfinance institutions and to identify the significant factor of credit risk management which affects the performance of microfinance institutions. The researcher has used a controlled environment, credit risk assessment, monitoring, and control activities as the key elements in managing credit risk. The study used a purposive sampling technique to select a sample of fifty employees from ten microfinance institutions in the Mannar district. Primary data were collected by distributing five-point Likert scale questionnaires, which consisted of thirty questions from two dependent variables and four independent variables. Descriptive statistics, correlation analysis, and multiple regression analysis were used to analyze the data. The study identified that credit risk management has a positive relationship with the performance of microfinance institutions concerning the Mannar district. Moreover, it ensures that monitoring had a significant impact on financial performance with the highest value of 0.59, and control activities had a significant impact on social performance with the highest value of 0.34. Finally, the study suggests to establish overall credit control and to have a system for monitoring the condition of individual credits.

Keywords: Micro finance institutions, Credit risk management, Financial performance and Social performance

Impact of Leadership Styles on Employee Engagement: With Special Reference to Apparel Industry

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Maintaining and increasing employee engagement is one of the critical problems in the apparel industry in Sri Lanka. Novel organizations have become aware that leadership styles are determinant that can increase employee engagement. Leadership styles create intercommunication between the leader and the subordinates in the organizations. Thus, the study empirically evaluated job stress as the mediator between leadership styles and employee engagement of the middle and operational level employees in the apparel sector in Sri Lanka. Self-administered questionnaires were distributed by using convenient sampling method to secure responses from 100 middle and operational level employees working for top 05 apparel firms in Sri Lanka. The data were analyzed using correlation coefficient, regression, Baron and Kenny mediator assessment method, and Sobal test. The results of the study indicated that there is a positive relationship between leadership styles and employee engagement. Mediator assessment and Sobal test identified that job stress partially mediates the relationship between leadership styles and employee engagement. The findings show the importance of managers in building a positive and naive relationship with their middle and operational level employees to enhance employee engagement. Moreover, the study makes several recommendations. Managers should improve a good and friendly relationship between supervisors and subordinator. Furthermore, they should allow employees to raise questions, complain, and give comments at any time.

Keywords: Leadership styles, Employee engagement, Job stress

Impact of Green Human Resource Management Practices on Employees' Job Commitment: With Reference to Apparel Industry in Sri Lanka

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The need for a proactive approach has been emerged due to the increased environmental effect caused by businesses in various means. Therefore, most of the businesses tend to transform their business processes into the green. In that process transforming human resources of the business organizations into the green is crucial. Yet few pieces of research related to the Green Human Resource Management have been carried out in Sri Lankan context. As this field of study is still young, to bridge the gaps in the existing literature this study was carried out to investigate the awareness, level of adaptation of Green Human Resource Management practices in the Sri Lankan Apparel Industry and the impact of Green Human Resource Management Practices on employees' job commitment. A quantitative research design was adopted in the research. Self-administered questionnaires were distributed to collect data. A convenient sampling technique was used to select 150 managerial level employees as the sample, getting 50 employees from each top three key players in the industry. Findings revealed that green employee empowerment and participation and green training and development have a very high level of adaptation in the Sri Lankan apparel industry. Moreover, a significant impact of both green recruitment and selection and green training and development on the employees' job commitment was identified. To create sustainable development in the environment further adaptation of Green Human Resource Management Practices is essential.

Keywords: Green human resource management, Green human resource management practices, Job commitment, Sustainable development

Impact of Stock Market Performance on Economic Growth of Sri Lanka: An Econometric Analysis

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Capital markets long played an important role in economic development. Recently, attention was grabbed by the stock market performance and economic growth. The objective of this study was to explore the causal relationship between stock market performance and economic growth. The study used time-series data throughout 1990 - 2018. Data were collected from the Colombo Stock Exchange, World Bank data, and Central Bank annual reports. Market capitalization was used as the proxy for stock market performance and Gross Domestic Production (GDP) was used as the proxy for economic growth. The macroeconomic variables such as export, Foreign Direct Investment (FDI), inflation, and capital formation were used as the control variables in this study. According to the Augmented Dickey Fullar (ADF) test, the data set was stationary at the first difference form. Johanson co-integration test, Vector Error Correction Model, and Impulse Response Functions were used to check the short-run dynamics and long-run relationship between the stock market performance and economic growth. The co-integration test results confirmed that there is a long-run relationship between stock market performance and economic growth. The Impulse Response Function suggested that shocks from the stock market did not make an immediate effect on economic growth but in the long run there existed a positive relationship. Other macroeconomic variables showed fluctuated negative impacts on economic growth while Foreign Direct Investment managed to create a positive relationship in the long run. Therefore, the study recommends the policymakers to increase the concern towards the stock market performance to boost economic growth.

Keywords: Economic growth, long-run relationship, Macroeconomic variables, Market capitalization, Stock market performance

Influence of Marketing Mix Variable on Consumer Buying Behavior of Mobile App-Based Taxi Service in Sri Lanka (Special Reference to Colombo Metropolitan Area)

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Conventional taxi service is converted into a mobile app-based taxi service through a technology revolution. In Sri Lanka, people in the Colombo metropolitan area widely use this service due to heavy traffic and easiness. When mobile app-based taxi companies provide service, they cannot ignore service marketing mix and consumer buying behavior. However, there is a significant lack of empirical studies regarding the mobile app-based taxi service in Sri Lanka. The objectives of this study were to identify the impact of marketing mix variables on consumer buying behavior of mobile app-based taxi service and to identify the relationship between marketing mix variable and consumer buying behavior of mobile app-based taxi service. 150 respondents participated in this study and the convenience sampling method was used as the sampling method. For the research, data collection was done through questionnaires and those primary data were collected from the Colombo metropolitan area. Data were analyzed by correlation coefficient analysis and multiple linear regression techniques. The findings indicated that service marketing mix variables and consumer buying behavior of mobile app-based taxi service had a significant positive relationship. The research revealed product, process, and physical evidence significantly impacted the consumer buying behavior of mobile-app based taxi service. According to the study, results were able to provide a strong implication on the knowledge available regarding the relationship between the service marketing mix and consumer buying behavior of mobile app-based taxi service.

Key words: Service marketing mix, Consumer buying behavior, Mobile app-based taxi service, Colombo metropolitan area

Impact of Corporate Social Responsibility on Corporate Financial Performance: Evidence from CSE Enlisted Manufacturing Companies in Sri Lanka

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Corporate Social Responsibility (CSR) is considered as an approach that contributes to sustainable development by delivering economic, social, and environmental benefits to all stakeholders. However, there is no consensus in the literature on the relationship between CSR and financial performance of corporations. Hence this study endeavored to explore the impact of CSR on corporate financial performance referring to the manufacturing companies listed in the Colombo Stock Exchange in Sri Lanka. The Stakeholder Perspective Theory provides valid insights to develop a CSR scale and it was used to measure CSR whereas the Return on Assets and Return on Equity were used as the proxies for the Financial Performance of corporations. Further, the risk ascertained through the Debt-to-Equity ratio considered as the control variable. The sample of this study consisted of ten manufacturing companies listed in the Colombo Stock Exchange and the sample period spanned for five years from 2011 – 2018. Accordingly, the study used 50 firm-year observations for the analysis and this study was based on secondary data and quantitative approach. Descriptive statistics, correlation coefficient, and panel data regression analysis techniques were used to accomplish the objectives of the study. The results revealed that CSR had a significant positive impact on the corporate financial performance of listed manufacturing companies in Sri Lanka. Moreover, it revealed that the control variable of risk had a significant negative relationship with Return on Assets while an insignificant relationship with Return on Equity. This study recommends the companies to maintain CSR activities at optimum level for all stakeholders as it leads to improve financial performance.

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Keywords: Corporate financial performance, Corporate social responsibility, Colombo Stock Exchange, Return on assets, Return on equity

A study on Social Entrepreneurs' Attitudes and Impact Investment with special reference to Western and Central Provinces in Sri Lanka

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Researchers have identified that there are funding problems for social entrepreneurs to do their social enterprises. One of the main reasons to occur this funding problem is the attitude of social entrepreneurs and mismatch of the requirement between social entrepreneurs and impact investors. This study aimed to identify the social entrepreneurs' attitude towards impact investment with special reference to Western and Central provinces in Sri Lanka. To achieve the objective of the research, the study was conducted as a qualitative research using Sri Lankan social entrepreneurs. Fifteen social entrepreneurs from Western and Central provinces were selected as the sample of the research using the Snowball sampling technique. Data were collected through semi-structured interviews and the thematic analysis technique was utilized as the method of analysis of the research data. The study found that there were seven themes and fourteen child themes as attitudes of social entrepreneurs towards impact investment. Those attitudes were reluctant to lose control, distrust, past expense, person's social network attitude, financial literacy, risk management, and being proactive. The result of this research is a significant source for government policymakers to recognize attitudes of social entrepreneurs towards Impact Investment and to identify the perception of social entrepreneurs about the supporting system. The research recommended developing an appropriate environment platform to improve attitudes of social entrepreneurs towards impact investment, to provide support and direction for the social entrepreneurs to connect with the impact investments.

Keywords: Social entrepreneurship, Impact investment, Funding, Attitudes

Impact of Perceived Service Customization on Building Customer Loyalty with Mediating Effect of Trust and Perceived Effective Communication (With Special Reference to Automobile Maintenance Service Sector in Sri Lanka)

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Lack of academic and theoretical knowledge about perceived service customization among front line employees of small size automobile repair centers is one of the main problems of the automobile maintenance service sector in Sri Lanka. The underpinning theory reveals how and why customer relationship marketing connects with customer loyalty. To bridge the knowledge and empirical gaps in existing literature, this study was carried out to investigate how the impact of perceived service customization on building customer loyalty with the mediating effect of trust and perceived effective communication in automobile maintenance. The study was based on a quantitative research approach that was carried out with 312 customers selected using stratified and convenience sampling methods from the western province. Data were collected through a structured questionnaire and analyzed by using Partial Least Square-Structured Equation Modeling and Statistical Package for the Social Sciences. Descriptive statistics, coefficient of determination, specific indirect effect, average variance extracted, and bootstrapping were used to analyze the data. The findings manifested that perceived service customization significantly impacted on customer loyalty with a positive partial mediation between the relationship with trust and perceived effective communication. The study provided perceived service customization with precious implications to enhance the relationship with customers. This study suggests future research based on other underpinning virtues with perceived service customization and customer loyalty in different service sectors. Also, it will help to gain loyal customers in the long run.

Keywords: Perceived service customization, Customer loyalty, Customer trust, Perceived effective communication

An Empirical Study on Investigating the Factors That Influence on Customer Adoption of Virtual Banking (With Special Reference to Western Province)

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In the current era, banking sector plays a vital role when providing financial services and managing financial assets. Due to the development of technological advancements, the invention of internet banking helps deliver traditional banking products in a more advanced way. The banking sector in Sri Lanka has undergone a rapid transformation with the adoption of Information Communication Technology (ICT) based banking solutions. However, no many studies investigated the factors that may help the bankers to design virtual banking services which are suitable for and adoptable by virtual banking customers. This study fills this gap and examines several factors affecting virtual banking adoption by customers. It is very clear that the potential value of web-based service adoption by customers depends not only on the benefits but also on overcoming several barriers. The present study is focused to find the determinants that influence the customer adoption of virtual banking in the western province. 400 questionnaires were administrated to collect primary data. Stratified random sampling method was used to select the sample size. Both descriptive and inferential techniques were used. With respect to inferential, Exploratory factor fnalysis was used to find the most significant determinant that influence on virtual banking adoption. SPSS was used to analyze the data. Results indicated the demographic profile of virtual banking users and the most significant factors that influence virtual banking adoption. According to the results of the study some valuable suggestions and management implications provided to the virtual banking service providers for gaining competitive advantage by enhancing the service quality and eradicating the service barriers that can promote or motivate banking users to adopt technology-based virtual banking facilities.

Keywords: Virtual banking, Adoption, Technology, Financial, Customer

Exploring the Influential Factors on E-marketing Adoption of Small and Medium Restaurants in Ella, Sri Lanka; Using TOE Technology Acceptance Model

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E-marketing is turning into a more crucial inside gift of generation, that is characterized via global markets, excessive opposition, and open borders and small and medium enterprises are the backbone of every economy. SMEs play a major role in the Sri Lankan economy and Small and Medium Restaurants (SMRs) comes under the SMEs. However, E-marketing is still in the infancy stage in Sri Lanka due to. Different kinds of factors affecting E-marketing adoption by SMRs. Previously technology adoption models and theories like TOE Framework, TAM model, and IDT theory have been introduced by scholars. But limited research is on factors affecting on E-marketing adoption. Therefore, this study aims to explore the influential factors on E-marketing adoption of small and medium restaurants in Ella, Sri Lanka, using the TOE framework. Amidst that, the TOE model was developed by combining dimensions of technology, organization, environment with E-marketing adoption. Primary data were collected from 35 small and medium restaurants in the Ella area, applying a convenient sampling technique. Data analysis was performed using descriptive statistics, simple regression analysis, and qualitative analysis. Descriptive analysis revealed a high level of E-marketing adoption by SMRs and the results of multiple regression analyses show technology as the most influential factor for E-marketing adoption. Further, high training costs. Time for training, lack of knowledge, and lack of technical support were identified as the challenges faced by SMRs. Based on finding managers and owners of small and medium restaurants should be attention to further development areas and the government pays attention to develop the E-marketing and provide particular facilities for E-marketing adoption. For the future, it would be more attractive to evaluate the feedback from other sectors also, by extending sampling groups into different small and medium enterprises groups (Manufacturing, services) to get a more diversified sample.

Keywords: E-marketing, Small and medium restaurants, E-marketing adoption

Bottom of the Pyramid (BOP) Market Orientation and BOP Focused Product Innovations in FMCG Industry in Sri Lanka

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The global Bottom of the Pyramid (BOP) market is estimated to be with around 5 billion consumers who spend approximately 2 USD per day. Fast Moving Consumer Goods (FMCG) industry plays a vital role in the Sri Lankan economy as it has been seen as the engine of growth to the economy as a result of its ability to create a job, generate revenue, reduces poverty and drives economic growth. Market orientation is a set of actions within the organization that create value for the customer which results in profitability and finally facilitates achieving sustainable competitive advantage which consists of three behavioral elements customer orientation, competitor orientation, and inter-functional coordination. Product innovation could create a firm's performance and profit growth. Leveraging on these diverse fields, this study investigated the relationship between BOP market orientation and BOP focused product innovation. Data were collected across fifty major high performing FMCG companies in Sri Lanka, according to industry capability report using a theoretical sampling technique. Data analysis was performed using descriptive statistics and Pearson correlation analysis. Simple regression analysis was used only as a supportive analysis to prove the relationship further. Results indicated that BOP market orientation significantly and positively affected to BOP focused product innovation. The study demonstrated that FMCG companies have adopted activities with BOP market orientation as a business strategy which has improved its BOP focused product innovations. In conclusion, the research findings can be applied to other industries not only on product innovations but also for other innovation types.

Keywords: Bottom of the pyramid (BOP), Market orientation, Product innovation, Fast Moving Consumer Goods (FMCG)

Impact of Stakeholder Pressures on Adopting Green Innovations

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Green innovation has emerged as a salient approach to amplify business sustainability. Yet, stimulating green innovations is still confronting developing countries. The contradiction between economic efficiency and stakeholder pressures on green innovation hinders sustainable development in a country. Hence, this study addressed this unexplored area in green innovations which investigates whether the stakeholder pressures have impacted the decision of adopting green innovations. Previous literature has mainly focused on a single factor rather than the overall consideration of both internal and external stakeholder pressures together. Also, previous findings were mainly based on the manufacturing industry. This research was conducted to assess internal and external stakeholder pressures on adopting green innovations together in both the manufacturing and service industries. A quantitative study was conducted by a questionnaire survey involving 205 managers selected by a stratified sampling method in companies certified with International Organizations for Standardization 14001. Descriptive statistics, regression analysis, and Pearson coefficient correlation were used to deduce the impact and to prove the hypothesis by analyzing data. Findings manifested that external and internal stakeholder pressures significantly impacted on adopting green innovations. Despite the stimulation provided by the internal stakeholder pressure, external stakeholder pressure has been identified as the most influential factor that impacted on adopting green innovations. The study provided managers with implications to enhance the competitive advantage by forging value to the stakeholders. The study also contributes to the literature of green innovations and stakeholder theory. However, further research is suggested based on disparate samples and considering diverse stakeholder pressures in the future to validate the findings further.

Keywords: External stakeholder pressure, Green innovation, Internal stakeholder pressure

Impact of Human Resources Practices on Supply Chain Efficiency (With Special Reference to Western Province Supermarket Sector)

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Organizations experience lengthy supply chains with complex organizational structures and networks with the globalization. Supply chain management and its functions have been widely accepted with the terms of supply chain effectiveness and efficiency to gain a competitive advantage over rivals. Influence of the Human Resources Management (HRM) implications has been identified as the main element of supply chain success. However, the Logistic Performance Index (LPI) has shown a gradual decline with the past three years in Sri Lanka and one of the main reasons to decline is identified as poor supply chain management. It has been mostly affected by the supermarket retail industry which is mostly engaged with the supply chain and warehousing activities. Literature has demonstrated that organizational performances heavily depend on individual performances and different kinds of HRM practices enhance human performances. This study focused to identify how HRM practices help organizations to enhance the supply chain efficiency in supermarket retail industry. 120 middle-level employees of three leading supermarkets were selected for the study and the study was adopted a quantitative approach based on the survey questionnaire. Structural Equation Modeling (SEM) and descriptive statistics were used to analyze the data to fulfill the research objectives. Findings of the research emphasize that HRM practices such as selection, compensation, and evaluation were at high level of adaptation in the supermarket sector and compensation showed the highest adaptation level. Selection, compensation, and evaluation significantly and positively impacted on supply chain efficiency in supermarket retail sector and training was non-significant but showed a positive relationship with supply chain efficiency. Findings of the research are important to the top-level employees who are working in the supermarket and retail industry within the fields of human resources and supply chains to make decisions regarding the HRM practices and supply chain performances. HRM and supply chain policymakers will identify the necessity of establishing HRM practices within the supermarkets to enhance the supply chain efficiency and the existing level of HRM practices in the industry.

Keywords: HRM practices, Supply chain efficiency (SCE), Supermarket retail sector

Impact of Working Capital Management on Financial Performance of Non- Banking Financial Institutions in Sri Lanka

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Working Capital (WC) is reckoned as the animating spirit of an entity's concern. Consequently, it is imperative to accommodate the smooth running of operations in any organization. Yet the non-banking financial sector encountered many issues regarding managing cash as a component of WC and there is no consensus in the literature regarding the link between Working Capital Management (WCM) and financial performance. Hence, the objective of this study is to examine the impact of working capital management on the financial performance of non-banking financial institutes in Sri Lanka. WCM was measured using creditor's payment period, debtors' collection period, cash conversion cycle, current ration, and financial performance was measured using the return on assets and return on equity. Data were extracted from the annual reports of non- banking financial institutes covering a period of eight years from 2011 to 2018. Ten non- banking financial institutes out of 63 were considered as the sample based on the Fitch ratings. Data were analyzed through the Eviews statistical software using Pearson correlation and random effect panel regression model. The results reveal that there is a significant negative relationship between the debtor's collection period and financial performance. Further, it exhibits an insignificant positive relationship between creditors' payment period and cash conversion cycle and finally found that there is a significant positive relationship between the current ratio and financial performance. In line with the above findings, it is recommended that the non-banking financial institutes maintain a shorter debtor's collection period as much as possible and a higher current ratio to enhance the financial performance. Further, it is recommended to adopt a conservative working capital strategy while paying a higher attention to the current ratio as the most affecting factor to the financial performance of non- banking financial institutes in Sri Lanka.

Keywords: Working Capital Management (WCM), Financial performance, Return on Assets (ROA), Current ratio and conservative strategy

The Study on the Impact of Green Human Resource Management Practices on Employee Engagement (With Special Reference to Domestic Commercial Banks in Sri Lanka)

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In the last few decades, both academics and practitioners are paying more attention to green human resource management concepts due to the increasing global warming in recent years. However, few researchers are followed about the Green Human Resource Management (GHRM) on the banking industry and it was an emerging trend in the Sri Lankan context. Banks play a very crucial role in the economic development of nations with huge human capital. The purpose of this research study was to identify the “Impact of Green Human Resource Management Practices on Employee Engagement (with special reference Domestic Commercial Banks in Sri Lanka). This overall research study was structured based on the conceptual framework built up referring to the two research objectives, to identify the existing level of GHRM practices in domestic commercial banks of Sri Lanka and to identify the impact of GHRM practices on employee engagement in domestic commercial banks in Sri Lanka. Quantitative research was conducted through a questionnaire using 150 employees who are working in the human resource department of domestic commercial banks in the Sri Lankan context. Data analysis was performed using multiple linear regression and descriptive statistics. Results of the analysis indicated that the existing level of GHRM practices in the domestic banking industry in Sri Lanka were a small dispersion from moderate level GHRM practices, it significantly and positively affects on the employee engagement, and also the green involvement was a most significant GHRM practice in domestic commercial banks of Sri Lankan context. Finally, this study suggested a various kind of actions for the management of the banking industry to improve GHRM practices.

Keywords: Green human resource management practices, Employee engagement

A Comparative Study on the Impact of Brand Image towards Local Consumers Buying Behavior in Franchised Fast Food Restaurants (With Special Reference to Colombo District)

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Fast food is one of the most pronouncing words in the world and it is one of the fastest-growing sectors in the food industry. Fast food could be identified as the mostly purchased foods in the quick service restaurants format due to its unique attributes such as convenience, taste, and lower price. The main objective of this study was to identify the difference between the impact of brand image on consumers' buying behavior of "Residents" and "Non-residents" in the Colombo district. This research was carried out as a comparative study that compares resident and non-resident fast-food consumers. The convenient sampling and purposive sampling methods were followed and 150 resident and non-resident respondents in the Colombo district were interviewed with a structured questionnaire. As the analytical methods, descriptive statistics and regression were used. The results of the study indicated that there was a positive significant impact of the brand image on consumers' buying behavior of both groups. Since this study found that Pizza Hut is the most preferable fast-food brand, it is recommended that foods like Pizza may be profitable type of fast food. Furthermore, brand attitudes and perceived benefits were the key influential factors for consumers' buying behavior. Hence, it can be recommended that, when marketing a brand, it is necessary to concern about advertisements, functional, and experimental benefits. Future researchers can focus on different areas in the local context and can access the impact of brand equity, different promotional tools towards consumers' buying behavior.

Keywords: Consumers' buying behavior, Brand Image, Brand attitude, Brand attribute and Perceive benefits

An Empirical Study on Factors Affecting on the Microcredit Demand in Agriculture Sector (Special Reference to Kurunegala District)

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Microcredit is one of the empowerment tools that have the potential to the agriculture sector and change the life of farmers from a situation of abject poverty to a more dignified life. At present, farmers face many problems when borrowing microcredit loans and there are many factors that affecting on the demand for microcredit. Kurunegala district accounts for the highest microcredit loan demand and agricultural loans borrowed from other loan schemes in the last three years. Finding what factors affecting on the microcredit demand in the agriculture sector in Kurunegala district seems important and this research design to understand the drives of microcredit demand for the agriculture sector. Accordingly, the objective of this study was to ascertain the determinants of the demand for microcredit in Kurunegala district from the perspective of microcredit consumers. A total of 100 microcredit consumers were selected from the Kurunegala district using convenience sampling technique. The primary data analysis was done using SPSS software. Simple regression with dummy variables was applied to determine the influence of the demographic factors. The results of the study indicated that the respondents mostly subscribe to agricultural credit products and then credit products that focused on developing agriculture activities. The results further illustrated that income level of microcredit holders, financial literacy and information availability had a significant influence on the microcredit demand of the consumer. Gender and employment status were non-significant to the microcredit demand. Financial literacy and information availability were positively correlated with the microcredit demand. Findings suggested to educate the farmers on loan acquisition process and to implement private-public integrated policy in Kurunegala district to effectively handle the agricultural loans.

Keywords: Agriculture loans, Financial literacy, Credit worthiness, Credit awareness microcredit demand

Applicability of the Risk Model Identified by Basel Framework on Advancing Financial Performance: Special Reference to Licensed Commercial Banks in Sri Lanka

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The Basel framework is an international regulatory accord that introduced a specially designed set of reforms to improve the regulation, supervision, and risk management of the banking sector. Credit risk, market risk, liquidity risk, and operational risk are the main four risk factors in the Basel III framework. As the risk being the main challenge faced by the banks, they tend to apply the Basel framework to mitigate it but they are exposed to various risks and thus the performance of the framework is not guaranteed. Therefore, this study endeavored to explore the applicability of the risk model identified by the Basel framework on advancing the financial performance of licensed commercial banks in Sri Lanka. Further, this study expects to identify other risk factors which are not identified by the Basel III framework to develop a new risk model. This study was conducted using a mixed-methods approach. The quantitative method was applied to investigate the risk in Basel framework on financial performance and data were collected from 10 licensed commercial banks for a span of 10 years. The qualitative approach was used to identify other risks faced by the banks and data were collected from 10 bank managers using the in-depth interview method. The panel data regression analysis was used to analyze the quantitative data using E-views software. The thematic analysis was used to analyze qualitative data. The results revealed that there is a significant relationship between capital adequacy ratio in credit risk and the financial performance while other risk factors show an insignificant relationship. Then, the researcher has expanded the Basel Framework by introducing a new risk model using the thematic analysis. The researcher recommended to apply the most compatible risk model to derive better measurement to calculate bank risk in future research.

Keywords: Capital adequacy, Financial performance, Basel Framework, Bank risks

Market Orientation and Entrepreneurial Orientation in Social Enterprises (With Special Reference to Jaffna District)

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Staying closer to their market is viewed vital in gaining strategic goals and sustainable goals for social enterprises since the approach widens their strategic capabilities on different fronts. Inventing this important knowledge gap, this study focused on identifying the role of market orientation nurturing entrepreneurial orientation of social enterprises. The research specifically focused on identifying the existing level of market orientation and entrepreneurial attributes of social enterprises and identifying the relationship between market orientation and entrepreneurship while assessing salient market orientation attributes influencing the entrepreneurial level. Relying on a quantitative research approach, 100 social enterprises from Jaffna district were surveyed. Descriptive statistics, correlation analysis, and multiple regression analysis were used to analyze the data for achieving the respective research objectives. Findings revealed that there is a positive relationship between market orientation and entrepreneurial attributes. Detailed findings further uncovered that barring the beneficiary orientation, donor orientation, peer orientation, and inter-functional coordination done in the region strongly influence the entrepreneurial level. Finally, this study contributes theory and facilitates social enterprises in Sri Lanka in reaching greater heights and it specified a growth way to the sector with the comparison to other business sectors.

Keywords: Social enterprises, Market orientation, Entrepreneurial orientation

Impact Service Quality Failure on Customer Switching Behavior in Mobile Telephone User: With Special Reference to Kandy and Nuwaraeliya Districts

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Sri Lankan telecommunication industry is fast growing and there are several operators engaged in huge competition, and also newcomers are coming into the market in the recent past. In this context, the competition is increasing and market growth is reaching the saturation in the operators' perspective. They need to sustain their customers and at the same time to attract other customers. Due to the rapidly growing and intensive competition of the mobile communication market and the fast-tracking customer sophistication, the bargaining power of customers in switching service providers has been a benefited option rather than being loyal to one subscriber. In this study, the researcher attempted to find the influencing factors of customer switching behavior in the Sri Lankan telecommunication market. This study aims to reveal why customers switch from one operator to another, what are the determents factors of their behaviors, and to identify the service quality failures impacted on switching in the local market. Referring to previous literature it was found that core service failure, services encounter failures, service responds failures are the main determents of costomer switching and the research design was developed considering those factors. The sample of the study was mobile users in the Kandy and Nuwara-Eliya who have switched among mobile connections from all leading networks. The sampling method was random sampling and sample size of 200 customers were selected from both districts. Primary data were collected through a self-administrative questionnaire and secondary data were also collected. Data analysis were done through SPSS 16.0. According to data analysis, results showed a positive relationship between the service quality failures and customer switching behavior in the Sri Lankan telecommunication market.

Keywords: Service quality, Customer switching behavior

Effectiveness of Pictorial Warnings in Cigarette Packs on Quit Intention

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Smoking and tobacco usage have become a widely spread problem in Sri Lanka. Further, the linkage between smoking and lung cancer has become very obvious. In contrast, 45.7% of men, 5.3 % of women, and 25.8 % overall are the current users of tobacco in any form. Meanwhile, as to resolve the issues of tobacco usage, many health researchers and professionals consider that the implementation of graphic warning labels on cigarette packages as a breakthrough in anti-smoking communication efforts. It can be predicted that smokers' intentions to quit smoking will increase as the depiction of the pictorial warning becomes more graphic. Accordingly, this study was designed to evaluate the effectiveness of pictorial warning on the quitting decision of tobacco smokers. Primary data for the study were collected through a structured formal questionnaire. The sample consisted of 261 respondents who are currently smoking and living within the Western Province, Southern Province, and Central Province and the Snowball sampling technique was used. The data were analyzed using descriptive analysis, correlation coefficient, simple regression analysis, and multiple regression analysis. Test results indicated that the pictorial warnings in cigarette packs are effective and have an impact on quit intention. The findings of the study can be useful to public health officials to identify the effectiveness of their warning labels and to educate the general public about the negative effects of smoking.

Keywords: Pictorial warnings, Anti-smoking promotional tools, Quit intension

The Impact of Non-work Roles on the Success of Women Owned SMEs With Special Reference to Western Province)

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Entrepreneur success research suffers from a lack of consistency in defining the scope of non-work (life outside work). Considering the evolving life preferences of modern women entrepreneurs, entrepreneur success researchers should have a broader view of life which expands beyond work-family and include other non-work domains of life. This study is an attempt to establish that for today's women entrepreneurs. For this study, several non-work domains were identified from previous literature. The research was based on primary data and the data were collected through 160 women entrepreneurs selected using a stratified sampling method and convenience sampling method by distributing self-administrated questionnaires. To validate research objectives, 10 women entrepreneurs out of 160 were selected who have achieved success in their business. Data were analyzed using descriptive analysis, structural equation modeling, and thematic analysis. Results indicated that there is a significant positive relationship between non-work roles (marital role, parental role, community involvement, leisure activities, and religious involvement) and the success of women's owned SMEs. Findings further revealed that the women entrepreneurs were satisfied with the existing level of non-work roles participation in Sri Lanka. Women entrepreneurs identified family support, personal factors, and quality employee base as supportive factors for engaging and balancing their non-work roles. Hence women entrepreneurs also should focus on non-work roles as same as work roles in attaining success. This study provides an insight into future researches, policymakers, and academics to a novel direction of the curriculum.

Keywords: SMEs success, Non-work roles, Women entrepreneurs

A Study on Impact of Service Quality on Customer Satisfaction (Special Reference to Life Insurance Companies in Sri Lanka)

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The insurance industry has recorded a high growth rate in Sri Lanka in recent years. The delivery of high-quality service is vital to success in service industries. All business entities are trying to attain customer fulfilment over improved service quality. Service quality denotes of a firm's performance. Customers are likely to choose an insurance company that has a high quality of service such as provide complete information about the product and services, a well-known and positive corporate image, handle the complaints. Service quality is a recent and more dynamic decisive issue in marketing thought. Customer's perceptions about life insurance seem to have been largely ignored by life insurance companies in developing countries. Therefore, to understand and identify the relationship between customer satisfaction and service quality dimensions in the insurance industry, this research selected a quantitative research method. A sample of 100 customers who have life insurance policies in the top five insurance companies which are lapsed within one year was selected by using stratified random sampling and questionnaires were administrated to collect primary data. Further to analyse the impact, both descriptive and inferential techniques were used. The Pearson's correlation analysis and regression analysis were used to identify the relationship and impact of service quality on customer satisfaction in the insurance industry. The findings of the study indicated that all SERVQUAL dimensions have a significant effect on the level of customer satisfaction in the Life Insurance Industry. Further, it was identified that the most influential dimension which contributed to customer satisfaction was the tangibility, responsiveness, assurance, and empathy. In the study, continuous improvements of service quality dimensions are recommended to maintain a competitive edge to get and retain strong loyal customers by keeping them at a satisfactory level in the Life Insurance Industry.

Keywords: Service quality, Customer satisfaction, Insurance industry, Service quality dimensions

Do Innovations Lead to Achieve Triple Bottom Line

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Sri Lankan rubber manufacturing industry is a developed industry and is largely a sustainable focused industry. The most critical issues identified in the rubber manufacturing industry are high level of chemical practices, high wattage, high energy consumption, environmental pollution, and other various social-economic issues. Hence rubber manufacturing organizations are implementing number of complex and innovative business practices. Organizations strive to achieve sustainability through triple bottom line goals. Innovation has become one of the most important functions of an organization since it deals with achieving the goals of the triple bottom line. Thus, this study evaluated the association between innovations and triple bottom line goals. Quantitative research was carried out and questionnaires were distributed using a theoretical sampling technique to collect the primary data from 50 managerial level employees who are working in rubber manufacturing organizations registered under the Board of Investment (BOI), Sri Lanka. Moreover descriptive, correlations, and regression analysis were performed to analyze the data. The results of the study indicated that there is a positive relationship between innovation and triple bottom line goals. Further identified there is a positive impact of innovations on triple bottom line goals. The results encourage managers in the rubber manufacturing industry to innovate to achieve the triple bottom line. Future researches regarding the proposed research area is encouraged through the study.

Keywords: Innovations, Triple bottom line, Rubber manufacturing industry, Sustainability

A Study on Impact of Brand Extension on Brand Personality with the Mediating Effect of Perceived Quality: Special Reference to Dairy Industry in Sri Lanka

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Branding is one of the highlights of competitive business trends in the Dairy product sector in Sri Lanka. Due to the reason that the dairy sector is a highly competitive industry with fewer barriers to entry. Hence the future of dairy companies lies in the brand. The brand offers added value to the customers and this brand value creates brand loyalty and brand personality for the products. Brand extension, perceived quality of the parent brand, and the extended brand are highly contributing in creating brand personality attributes in the dairy sector. However, lack of research attention has been given on the impact of brand extension on brand personality for the dairy products where perceived quality playing a mediatory role. Having identified the knowledge gap and empirical gap, this research study aimed to provide evidences to encourage marketing, branding, and for symbolic brands because brand personality is an important determinant of what the brand symbolizes. Accordingly, this study developed a model to identify the impact of brand extension on brand personality mediated by perceived quality in the dairy product sector in Sri Lanka. Data were collected from 200 dairy product consumers from Western Province using multistage sampling and convenient sampling techniques. Further, data were analyzed using descriptive statistics, coefficient correlation analysis, regression analysis, and mediator. According to the findings of the analysis, it was concluded that there is a positive impact of brand extension on brand personality and there is a partially mediated impact of perceived quality on the purchase behavior of dairy product consumers. As per the findings, the impact of brand extension on brand personality was positive so that marketers would concern about brand personality when extending the brands into new product categories. The results provided both knowledge and managerial implications and as well suggested some further research areas for future research.

Keywords: Brand extension, Brand personality, Perceived quality, Dairy sector, Parent brand

A Visual Framework for Longitudinal and Panel Studies (with Examples in R)

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Visual analysis is an essential part of modeling as it helps identify potential data issues and select appropriate methods for further analysis. We focus on simple yet effective visual tools applicable to panel and longitudinal data. Our objective was to find suitable tools for the following sequence of tasks: i) detect data anomalies/outliers, ii) describe patterns for missing and zero values, iii) identify data patterns and patches requiring special attention or modeling approaches, iv) assess the properties of distributions for the variables of interest, v) choose most suitable transformations, vi) assess the evidence for trends. This study demonstrates that existing software is not always suitable for the above tasks and there are areas for improvements and also found that many journal papers lack the visual analysis part for panel studies providing only summary tables, which does not give a clear picture of data features. Thus, the study proposes a framework aiming to solve the above tasks using a methodology based on a set of principles for effective statistical graphics. One well-known difficulty when plotting panels occurs due to the problem of overlapping: when a lot of points belonging to different panels are shown on one plot, the plot becomes hard to read. The framework proposed consists of a set of visual techniques that help solve this problem and increase the readability of plots. In particular, the study use colors and symbols with high visual discrimination and several plots to describe different data features keeping consistent colors/symbols for all plots. Th study describes several tools for the improved analysis, provide our guidelines and present R codes for the implementation of the tools. The study demonstrates the flexibility and the ease of use of R to plot, summarize, slide-and-dice panels, and to transform or impute variables. And the study used real data (relating to financial variables of Sri Lanka's companies) to show how the framework works.

Keywords: Exploratory data analysis, Visual tools, Panel data, Longitudinal data, R programming language

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Image Processing Approach for Time-Saving and Convenient Parking Slot Detection

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With the globalization, businesses around the world started to expand from the local boundaries to the international markets. As a result of that, transportation system management and parking management are gradually becoming key factors for successful businesses. Most of the Sri Lankan parking areas in operation are manually functioned and inefficient. Because of that reason on busy days, drivers may take extra time driving around the parking area to find a free parking space. Failure to find a free parking slot may cause traffic congestion, extra Carbon Dioxide emission, and arising the stress level of drivers. The free parking slot detector developed using the technology of image processing can be introduced as a great solution for all these issues. The shortest path algorithm contained in this detector assists drivers in finding the nearest vacant parking space. The camera of this detector is acting as a sensor. Since there are no sensors employed, the mechanical and electronic functionality of the system is reduced to a great extent. In previous researches, the Canny Edge detection method was used to identify the vehicles. In this research, the Yolo algorithm was used to detect the presence and the type of vehicles in the parking area since its' high accuracy compared to the Canny Edge detection method. After detecting the vehicles, the mean pixel value of each vehicle is taken. The coordinates of the parking slots are taken to an XML file when the parking area is empty and mark the polygon area of each parking slot. Ultimately, each parking slot is uniquely numbered and the status of the parking slot is decided according to the mean value of the vehicle. The updated status of each parking slot is displayed at the entrance of the parking area. The accuracy of the system was approximately 95% in different weather conditions and various angles of images. The developed system may lead to an effective transportation system.

Keywords: Free parking space detection, Shortest path algorithm, Convolutional neural network, Image processing

Farm and Sell: Mobile and Web-Based Solutions for Efficient Distribution of Agricultural Products in Sri Lanka

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Sri Lanka is an agricultural country and agriculture highly depends on weather conditions, considerable use of family labour, and infrastructure facilities such as irrigation, transport and electricity facilities in remote areas. Several difficulties are experienced by small- and large-scale farmers in Sri Lanka in selling their harvest including not getting the price for their harvest as they expected, difficulties in identifying good buyers from the larger buyer community and excess production during the particular times of the year. Although several mobile-based and web-based applications have already been introduced to Sri Lankan agriculture community, it's difficult to find an advanced and efficient application to deal with the problems in the agricultural value chain like inefficient distribution of products, excess supply, and middlemen involvement. The main objective of this research was to develop web and mobile-based systems that facilitate farmers, buyers, and transporters to deal with above problems. Initially, the information required to create the mobile and web applications were gathered from the farmers and Agricultural Instructors of Matara and Hambanthota area. Collected data were analysed to develop different User Interfaces and systems to facilitate important functions such as advertising of farm produces, request orders from buyers and transporters, request items and making payment of advance by the buyers upon farmer's approval, and notifying the transporters to pick up the package. The Android Profiler and several test cases were used to test the performance of mobile and web applications. Then, both web and mobile applications were evaluated with different users and obtained more than 90% positive feedbacks. According to their comments and feedback, the system was refined.

Keywords: Agricultural products, Efficient distribution, Mobile and web-based solutions

Pairwise Drug Interaction Prediction, Integrating, Clustering, and Classification

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Investigating drug interactions is vital when administrating multiple drugs for patients. However, experimentally-based drug interaction prediction consumes a large investment of money and time. Computational-based drug interaction prediction has shown significant benefits during the last two decades. Supervised and unsupervised machine learning approaches are frequently used to classify drug interactions based on drug characteristics. However, drug interactions cannot be classified only based on homogeneous properties as they have their limitations. Hence, investigating computational methods for heterogeneous data integration becomes necessary. Moreover, employing a representative training sample is crucial for obtaining a better classification of drug interactions. Though there are standard data on harmful drug interactions, there are no standard data for non-harmful drug interactions. Thus, investigating methods to find representative negatives is crucial. The proposed approach has two folds: (i) using an unsupervised two-tiered clustering approach for drug-pair clustering and (ii) using supervised classification for drug interaction classification. This study considered chemical, disease, protein, and side effects characteristics of drugs providing an opportunity to demonstrate drug characteristics from those four perspectives. The two-tiered clustering approach was used in the first fold that enables drug-pair clustering as well as heterogeneous data integration. The clustered result can be used to infer plausible negatives for drug interaction classification. In the second phase, binary classifiers such as Support Vector Machine, Logistic Regression, and Random Forest can be used. Applying an ensemble learning model integrating with the results of multiple classifiers could further improve the clinical significance of the predicted drug interactions.

Keywords: Drug interactions, Heterogeneous data integration

Designed Artefacts for Analyzing and Evaluating Autism Spectrum Disorder (ASD)

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According to the recent statistics, 1 in 63 children are affected with Autism. Autism is a neurodevelopment disorder of early childhood, it is a condition that occurs due to the abnormal growth of mind, where these children exhibit extra-ordinary behavioral patterns. There is no well-defined treatment for Autism Spectrum Disorder (ASD), and early diagnosis is essential to manage the condition. An ICT based artifact (more specifically, a set of software) can be introduced as a novel approach, which intends to expose the child behavior. Furthermore, the outcomes of such an artifact could be used by any psychiatrist for predictions of ASD. These artifacts are designed by considering three main impaired areas of ASD which are Eye Contact, Maturity level, and Intelligence level. Therefore, the developed system is comprised of an Eye Movement Tracking tool where a common sample video is shown to the participants and a record of their eye movement is taken and this recorded data is then processed and finally displayed graphically. A module capable of identifying the Maturity Level provides a drawing canvas where participants are allowed to draw shapes and the analysis is done by the way they draw correct shapes with time in graphs. Moreover, an Intelligence Level Measuring Tool compromised with color and number-based activities is used and their responses are taken for decision making. Besides, these artifacts are capable of giving an analysis by comparing both ASD patients and a Neurotypical person. Testing and evaluation of the system were done with three (3) ASD patients and ten (10) Neurotypical persons from the age groups of 3-5 years. This experiment showed that, computer-based software tools are effective for acting as a platform to provide data and for taking decisions in ASD predictions.

Keywords: Autism Spectrum Disorder (ASD), Eye contact, Intelligence level, Maturity level, Neurotypical person

Open BevyBot 2020 – An Open Source Low Cost Educational Robot for Effective Learning

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The modern world with lack of availability of an effective learning platform for students who are tired of traditional learning techniques. In the present day, basic mathematics is the most valuable fact for primary level students to improve their problem-solving skills. This study is carried out to develop a cost-effective open-source robot with a rewarding system for the children of the age group between five and ten years. The open-source robot chassis designed with computer-aided designing which can print by using 3D printing technology. In this research, a Java-based library is developed to communicate with the microcontroller of the robot and the hardware of the smartphones. And also, there is another problem that they have to spend more strive to build a robot as it is not a work that can be done in less time with a low budget. Throughout this study, present solutions such as Cosmo, Poppy, Q.bo-one are considered to gather information. But these robots are costly and also lack of opportunities to use for education purposes and that robots need external hardware sensors. But in the modern world, most people own a smartphone and it contains the above hardware (Processor unit, Sensors.). If can reuse that mobile phone hardware as robot hardware it will much cost-effective. Researchers decided to combine three ideas of open-source hardware/software, 3D printing technology, and reuse mobile phone hardware. As the final solution researchers build an open-source robotic platform with reusing mobile phone hardware combining the android library and finally they build an educational robot to evaluate the platform. Furthermore, researchers analyse the effectiveness of the built educational robot by providing a questionnaire to the students (age group 5-10 years) & getting feedback from them. Researchers plan to use PCB designs as hardware circuits into one platform which reduces the circuit space and commercialization of the product in the future.

Keywords: Educational robots, Open source, 3D printing technology, Low cost, Mobile phone

Enrich the Awareness of Road Rules in Sri Lanka for the Tourists Using a Game-Based Driving Learning System

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Tourism is one of the major economic sectors which affects the country's Gross Domestic Product (GDP) and Gross National Product (GNP). Traffic safety within the cities which are highly attracted by tourists is becoming an important problem in the country. Based on investigations it is identified that unawareness of rules and lack of practice to hazardous incidents are the main reason for that. Although most of the tourists have a valid driving license, they may be having very low knowledge about the road rules in Sri Lanka. So, when they are driving in the country, they need to have a proper understanding or an awareness about the road rules in the country. The primary objective of the system is to provide the tourist a platform to allow practicing to overcome the hazardous challenges and to have a self-evaluation about their knowledge about the road rules in the country through a point-based method defined upon the rules, road conditions and driving ethics established in the country. To provide a realistic environment that is similar to the country, virtual environments are modeled based on different criteria. Through the usage of Artificial Intelligence techniques like non-player characters and objects, the reality of the environment was enhanced. It can be concluded that training the learners in a virtual environment that similar to the real environment with a proper assessment of their awareness of the rules and road signs, and driving ethics will solve most of the problems we face today.

Keywords: Driving game, Tourism, Simulator, Rules, Traffic safety

Enhancement of English Language Speech and Comprehension Through Means of Virtual Reality for Sri Lankan Context

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Speaking is one of the essential skills needed to be developed by any English learner. But the English curriculum taught by Sri Lankan schools often focuses on providing English vocabulary, grammar, and comprehension but pay less attention to enhance oral communication skills. This leads to a lack of practice in spoken English. Therefore, that affects a wide spectrum of applications such as business communication, presentation of creative work, etc. Other problems are anxiety, fear, lack of confidence, and nervousness of speaking English. This research focuses on designing a Virtual Reality (VR) based application for the above-mentioned problems and it facilitates a more convenient and yet natural experience through the use of techniques such as VR, Natural Language Processing (NLP), etc. to expand the English oral and understanding ability. This VR based solution will enhance the oral practice of the language and reduce the lack of confidence while improving the speech and comprehensive skills of Sri Lankan school students. Users can practice the application anywhere with common real-world scenarios such as conversing during a doctor's appointment, buying dresses from a shop, etc. This game-based learning tool helps to evaluate the users and they can get scores according to their performance. At the same time, it facilitates to expand their English speech and comprehension ability. To measure the effectiveness of this application, user evaluation was done as a pre-experimental method with a one-shot case study with the use of pre-test and post-test design. A total of 30 local students following the local English language curriculum between grades eight and ten were selected as a sample for this purpose. The t-test analysis showed a value of 2.34 alongside a table value of 2.131 which depicts a clear correlation between the usage of the application. Significant enhancement of oral and comprehensive skills of the users was observed through the evaluation.

Keywords: Virtual reality, Natural language processing, Voice recognition, Speech synthesis, Artificial intelligence

E Business Evolution: Perspective and Strategy

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Electronic Commerce is also known as e-commerce that consists of the purchasing and selling of products or services through electronic systems. In this modern world of technology, e-commerce is becoming a very significant option for many businesses as there are lots of companies that are interested in developing their online stores. The main purpose of this study was to review the concepts of e-business and its' emerging strategies. Herein, the authors conducted a comprehensive literature review of textbooks, academic journals, and conference proceedings, as well as web documents, and e-commerce guidelines in an iterative manner. The study findings revealed that the positioning, website, blog, social media, copywriting, marketing e-mail, viral marketing, autoresponder, paid advertisement in search engine and squeeze page are the most important strategies that can be used to promote e-business activities while the Customer Relationship Management (CRM) plays a vital role to grow and expand business effectively. Furthermore, the study examined the relationship between business domains and business functions in the view of business architecture and the relationship between each e-commerce business model. E-business models allow companies to link their internal-external processes more efficiently and effectively, work more closely with suppliers and partners to better satisfy the needs expectations of their customers, leading to improvements in overall business performance. Finally, the study reviewed the challenges of e-business and its' strategies together with opening the path for future researchers in this field.

Keywords: Business architecture, E-business, E-business environment, E-business model, E-CRM strategies

Artificial Intelligence Based Traffic Light Control System for Emergency Vehicles

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Numerous nations on the planet are confronting the issue at traffic light convergence that causes mishaps between emergency vehicles and the other open vehicle. The quick reaction of the crisis administrations, for example, ambulances or fire administration vehicles has gotten a difficult circumstance nowadays. Some of the time the rescue vehicle stalls out in rush hour gridlock and those minutes can cost people life. There are existing systems to manage traffic light controls for emergency vehicles based on image processing, Radio Frequency, and IR technology. But the current framework gave an extraordinary opportunity to the emergency vehicles to release even non-emergency circumstance time. So, in this project, we proposed an “AI-based traffic light control system for emergency vehicles” that has allowed emergency vehicles to leave only in actual emergencies. which can get the maximum benefits and save many lives. The main objective of our research is identifying the emergency vehicles at intersections and doing the more accurate AI-based traffic light control system to release them when stuck in traffic jams to identify vehicles, we developed and trained object recognition models by using image processing techniques especially for the ambulance, fire truck, and VIP vehicles. The system identifies every object from the video, emergency vehicles were considered as specifications to differentiate emergency vehicles from other vehicles. we have designed the sound identification model to identify the siren sounds, here we have trained various siren sounds, our system which gain sound as an input from a microphone and our system trained to filter noises to identify the emergency vehicle’s sirens sound and combine both Sound & Image identification process when both conditions are true, the system changes the red signal to green or extend the green signal duration by detect the siren sound and emergency vehicles, and release the emergency vehicles path/way in an emergency.

Keywords: Artificial intelligent, Emergency vehicle, Image processing, Machine learning, Neural networks, Siren sound, Sound analysis, Traffic lights

High Tech Vision to Detect Currency Denomination and Virtual Wallet to Retrieve the Monetary Position for Visually Debilitated People

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The transformation of currency notes and coins denomination recognition to an automated system as a solution for visually debilitated individuals to overcome the difficulties facing when handling monetary transactions. This research presents a model to detect currency notes and coins to visually debilitated individuals and to retrieve the current monetary position of them as per their obligation and provide audio output in the Sinhala language. The general procedure of the system includes digital image processing, convolutional neural network, voice identification algorithm, and monetary position calculation algorithm. Sri Lanka currency notes and coins images were captured in a wide variety of environments, in association with lighting conditions and background to make the data set, using the image preprocessing technique. The YOLOv2, R-CNN network model which is a high speed, real-time object detection algorithm to verify objects as currency notes and coins. Then by using Keras Xception model, predict images, feature extraction and fine-tuning have been done to train the data set. The Computer vision used to improve machine perception to retrieve real-time detection. The detected currency notes or coins denomination is provided as an audio output, then retrieves the obligation of the user, which is whether to debit, credit or to retrieve the current monetary position. The monetary position provides audio output in the virtual wallet as a substitute for a real-world wallet since impairments have a scarcity in memorizing their actual balance. The study revealed a system to detect and retrieve the currency denomination and monetary position of blind individuals with the overall accuracy rate of 100% in algorithm experiments.

Keywords: Visually debilitated individuals, Currency recognition, Virtual wallet, monetary position

Modelling Daily First Time Through Status for a Top Brand in a Leading Apparel Manufacturing Company in Sri Lanka

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There is an effect from the apparel industry to the total export earnings of Sri Lanka. This paper consists of a case study relevant to the product quality of a leading apparel manufacturing plant in Sri Lanka. Quality is measured using daily first time through (FTT) percentage that calculated using daily output and number of defects. The main purpose of this study is to identify the factors affecting the daily FTT and to build a model to forecast daily FTT status. Factors affecting daily FTT were identified using multiple linear regression and Yeo Johnson power transformation methods. According to the attained results material defect, incorrect fabric direction, missing trim, and needle cut were identified as the influential factors for daily FTT. The factory standard is to maintain FTT 98% or above. For lower FTT measurement out and color, shading was affected. Data mining techniques were applied due to the violation of statistical assumptions in the aforementioned traditional methods. Classification tree and Probabilistic neural network (PNN) techniques were applied to the classes of daily FTT values of high and low as a classification problem based on the factory standard level. The under-sampling technique was used due to a class imbalance problem. The best split attribute was the number of damages and daily output was the afterward split attribute in the classification tree. In PNN the best model was selected using adjustment of the spread parameter from 0 to 1. Least false positive and false negative values were in the spread value 0.80 with the highest true positive and true negative values. PNN model consists of 1857 and 2 hidden neurons in the first and second hidden layers respectively. Accuracy was 0.98 in the classification tree which is higher than the accuracy of PNN, which of 0.93. However, both models can be used in forecasting with high accuracy. This research can benefit the apparel field to get remedial actions before arising quality issues.

Keywords: Apparel industry, First time through, Data mining, Classification tree, Probabilistic neural network

Augmented Reality-Based Approach to Improve Learnability of Sri Lankan History

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Augmented Reality (AR) being one of the most trending technologies in the world has offered many possibilities to improve existing traditional approaches in day to day tasks. In Sri Lanka, the existing model of education is mostly based on a passive learning system. But as the technology is growing, all the education systems are moving towards digital. The low-cost tablet PCs would replace textbooks soon. In Sri Lanka, there are some schools where the tablet PCs are already using as a learning element. However, there is not enough learning material to be used with these high-end devices and the curriculum of the local education is not optimized to take full advantage out of these devices. This study is focused on how AR-related applications can be used to improve the learnability of students, allow students to learn in an active learning environment in history, and archeological education using AR and evaluate the feasibility of implementing an active learning environment. In this study, the evaluation has been done using two main areas in archeological history education in Sri Lanka. Which are archeological places and arts and crafts that have an archeological value? The evaluation has been done using a mobile AR application-HistoriaAR. The researchers select a group of students to study a given lesson that covers the history and archeological aspects using textbooks and AR-based mobile application in two instances. After that, students were evaluated with a paper-based questionnaire and an in-built evaluation component in the mobile AR application, respectively. According to the results, the mean score of performance (7.13) using textbooks has been improved to mean score of (8.10) using AR related to archeological places. And mean score of performance (6.92) using textbooks has been improved to mean score of (7.63) using AR for to arts and crafts section. At the end of the study, results have proven that the performance of the learning of students can be improved using AR.

Keywords: Augmented reality (AR), Sri Lankan education, History & Archeological studies, Active lear

Is Rainfall Prediction Model Tested in One-Time Point Sufficient?

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Many rainfall predictions models have been proposed. The common methodology followed by those models is that the model is trained using the data before the target and tested the model in one or a few points and claimed that the model is generalized. However, this project shows that the above procedure is not sufficient to generalize a rainfall prediction model as in some target periods the models failed to achieve a decent prediction quality. The models such as Multilayer Perceptron (MLP), M5P, and Linear Regression-were trained from the weather data collected between the years 2002 and 2015 from the station located at Badulla, Sri Lanka. Initially, the target period was set in the last week of the dataset and the training period was one week before the target week. Then, the training period was extended by one week, until the maximum length of the training period reached, keeping the target fixed. Next, the target period was brought back one week and the same procedure was repeated resulting in 695 models. The prediction quality was measured using Mean Absolute Error (MAE) and represented in heat-maps. The heat-maps show that the prediction quality varies over time. The highest accuracy was given by the MLP so that the MAE has fallen between 0 and 10 mm in 61.7% of the total instances. This indicates that testing models in one or a few time points are not sufficient for the generalization. Further, the reasons for such drastic changes in prediction quality will be investigated in our future projects.

Keywords: Linear regression, M5P, Prediction, Multilayer perceptron, Rainfall

A Crowdsourcing Approach for Observation of Drinking Water Supply System

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Drinking water availability is a varying factor in Sri Lanka due to weather changes, natural disasters, and the breakage of pipelines. In such situations, people tend to share information regarding a lack of consumable water availability through social networks. That information is decentralized and unorganized so decision-making is difficult. The objective of this study is to represent and summarize up-to-date spatial information of drinking water availability by providing a platform for commercial water utility companies that supply water and customers to meet up and getting the general public and social service involvement. A low fidelity prototype was designed to capture the concept. To test the usability of the solution, a high-fidelity prototype was implemented for a selected set of functionalities such as social login, social sharing, viewing, and filtering posts. The web application was developed using Angular 6, Node.js web framework, and Leaflet, a free JavaScript map library. The system provides dedicated interfaces for customers to post, view information, and the user-friendly interfaces for customers to send request messages without any failures. Each request is recorded together with the geographical location, time, and tag, a search key used to filter outposts. A case study was conducted to test and evaluate the functionalities of the system and the members of the Rotaract Club in Badulla were taken for the case evaluation. The thinking aloud method was used to collect feedback and to capture the user's thoughts while interacting with the system. Therefore, this system successfully provides a solution to the general public to gain attention on an arising water availability issue, and the commercial water utility companies are provided with a platform to advertise their services and identify areas with potential customers. A future improvement was suggested to adhere to the line and polygon data to achieve advanced Geographic Information System (GIS) features.

Keywords: Crowdsourcing, GIS, Web application, Water availability

Social Media and Online News Analytics for Identifying Crime Patterns in Crime Prediction

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Social media provides opportunities for users to share their thoughts freely. Every year they generate a large volume of data. In the context of social media, they may include hidden details, which may convey significant events. Crime prediction with the help of Social media provides new dimensions in researches. This research aims to collect data from Twitter posts and validate them using online news to avoid false data. First and foremost, we selected the top crimes happening in the world after an extreme literature review. We used Twitter API and News API to fetch data from Twitter and News blogs. We used two filters to collect data. In the first filter, we fetch Twitter posts and News posts for a specific time duration. These data are fetched by using keywords that relate to crime. In the second filter, eliminate noisy Twitter posts from the collected dataset. We have collected many noisy posts in both sources, i.e. Twitter and News. With the help of collected datasets, we will compare each tweet and news datum and give ratings for comparison data. We can build a crime prediction model with integrating data. The result shows that 68% of collected Twitter posts are excluded after using the second filter. Future development can divide into two main parts. To get more accuracy, we can integrate other factors that affect crime prediction such as weather, human behavior analysis data and we can improve the second filter using the SVM algorithm. Secondly, we can integrate other Social media platforms to fetch data.

Keywords: Crime prediction, Social media, Twitter, News

A Comparative Study: Best Machine Learning Algorithm for Social Media Sentiment Analysis

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Sentiment analysis is a field of study that aims to derive the sentiment or the opinion of a text using natural language processing techniques. Performing sentiment analysis on Twitter data has a vast number of applications including predicting stock market prices, product recommendations, etc. Sentiment analysis can be done in lexicon-based, machine learning-based, or hybrid approaches. K Nearest Neighbor, Support Vector Machine, Logistic Regression, Naïve Bayes, K Means Clustering, Decision Trees, and Random Forest are the few most popular machine learning algorithms. This study aims to conduct a comparative analysis among the usage of K Nearest Neighbor, Support Vector Machine, Logistic Regression, and Multinomial Naïve Bayes machine learning algorithms combined with sentword net lexicon to suggest which one provides the best accuracy in sentiment classification of Twitter data. A data set of 1028 tweets was acquired using the Twitter Standard Search API (Application Programming Interface) and Tweepy python library. The name of a popular brand of mobile phones was used to search for tweets. 570 tweets remained after the duplication removal and cleaning process. Then the remaining data was classified as positive, negative, or neutral using sentiword net lexicon and used to train selected machine learning algorithms. 80% of the data was used for training and 20% was used for testing. Word counts in the tweets were used as features. Multinomial Naïve Bayes is proved to be the best machine learning algorithm with a model accuracy of 74.56% and K Nearest Neighbor (k=3) is the worst-performing algorithm with an accuracy of 54.38%. Logistic Regression and Support Vector Machine (linear kernel) respectively had accuracies: 72.80% and 70.17%. The result of this research proves Multinomial Naïve Bayes performs relatively better in Twitter sentiment analysis than K Nearest Neighbor, Support Vector Machine, Logistic Regression. This is because two basic assumptions for applying the Multinomial Naïve Bayes algorithm: feature independency and multinomial distribution are well satisfied by the features selected for this study. Also, Multinomial Naïve Bayes can perform well with high dimensional data like tweet text. On the other hand, the poor performance of the K Nearest Neighbor is due to the same reason. K Nearest Neighbor cannot handle a large number of features very well.

Keywords: Sentiment analysis, Twitter, Hybrid approach, Machine learning algorithms, Comparative analysis.

IOT Based Strategic Solution for Tea Leaves Quality Optimization Using Machine Learning Data Model Predictions for Local Tea Industry

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Environmental factors play a major role in tea growing and plucking stages and these factors must have to be within the favourable range to get quality tea production. At present tea, pluckers cannot identify the exact duration for tea plucking and they do not have sources to identify and pick tea leaves from tea buckets without overflowing which can cause *physical* damages to tea leaves. This research addresses the above issues by creating data forecasting models that provide significant guidance to make decisions in many areas especially in tea cultivation, plucking, and transportation. Three devices were developed to capture real-time weather data namely soil PH, surface temperature, and Humidity. Above sensors data were transmitted over GPRS using a GSM module. Evaluated results of datasets with actual data values and analysed with different prediction algorithms such as Voted perceptron, Decision table algorithm, Multilayer perceptron, and Simple linear regression. After observing all the aspects, several variables, and prediction accuracy for data samples, the most relevant algorithm to build the prediction models were decided. The models were executed with a different combination of factors and analysed the output prediction result to sort the most accurate factor combination for the dataset. Models were built to predict the most suitable periods having optimum environmental conditions to pluck tea leaves, production forecasts by considering environmental and soil conditions, and transport scheduling for plucked tea leaves before quantity overflows. Above mention, the model was helped to schedule the plucking process while enhancing the quality of tea leaves. Further, this study introduced the smart tea plucking basket to control the real-time weather conditions and reduce human malpractices while maintaining optimum quality. The research recommends assessing this model with different algorithms to fine-tune the performance and to build a general model that can be applied when enhancing other quality factors.

Keywords: Internet of Things (IOT), Voted perceptron, Decision table algorithm, Multilayer perceptron, Simple linear regression

User-Friendly Applications for Sri Lankan Farmers: “Govi Nena”

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Most of the Sri Lankan farmers are used to cultivate any selected crop traditionally, as they are taught to be from their farming society. Due to this reason, there will be an overproduction from the same crop within a particular season. Even several crop forecasting applications are available in Sri Lanka, lack of reliability is the main drawback of these applications. These applications fail to guide the farmers to get a detailed review due to the interfaces of these applications are unable to visualize the required data reliably. In this research, a “Govi Nena” mobile-based application and a web-based dashboard were developed to select the most accurate crops to be cultivated to get the highest market demand and yield in an instant and reliable way with the user-friendly interfaces. Farmers have to enter the data about the conditions of their land, soil types according to their agro-ecological zone to the mobile application when they register to the application. The mobile application links with crop knowledgebase and provides crop lists of what they need to cultivate and crop calendar for each crop based on the planting dates inserted by the farmers. The analysed information based on the farmer inputs through a mobile application will be visualized on the dashboard, which consists of multifunctional, proper, understandable, and user-friendly interfaces including tables, charts, and graphs. When a farmer uses this dashboard, he/she can get a clear understanding of; how the yield of each crop varies with the time, most compatible crops which have been cultivated in different areas, how the market price for the crops varies with the time, etc. The dashboard shows the relationships, comparisons, composition, and distributions of the information/knowledge. Farmers can get a clear picture through understandable visualizations via this dashboard for selected crops.

Keywords: Web-based dashboard, Mobile-based application, Sri Lankan agriculture, famers

Enhancing the Centralized Information System as a Distributed System in Higher Education: Design Science Approach

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The information systems (IS) provide several enormously important services to conduct and manage operations in different fields in government and private sector organizations. Hence, there should be a complete IS solution to acquire such a precious service. However, among the identified problems, less awareness of numerous ways of the information and process duplications, and some improper document management practices are identified problems in an organization for this research. At the same time, the interoperability problem with the use of ISs is a critical issue within these problems. Thus, more ISs are running as isolated systems within the organization. Ultimately, this may have a high impact on the total productivity of the organization. The objective of the study is to develop a centralized system to find a better solution to minimize the identified issues and then, to check the validity of the developed system. Then, the design science approach was used as the research approach in this study. Problem identification, system design, system development, system implementation, and system evaluations were major research process followed by this study. Based on the above approach and developed software model, a centralized system was developed to keep connectivity with all isolated systems using database driver mechanisms. Then, the system validity was checked based on the selected case site in the evaluation part of the methodology. The evaluation was conducted with the collected data from the information on services and facilities provided by departments or branches of the University of Ruhuna. Data were analysed by regression techniques using the statistical tool to check the improvement and compare it with the current system. According to the findings, the developed system is more suitable for the selected case site comparing with the current system. Finally, the system was selected as a better solution for the identified problems.

Keywords: Distributed information system, Profile management system, Model view controller

Movie Success and Rating Prediction Using Data Mining Algorithms

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This project developed the models to predict the success and the ratings of a new movie before its release. Since the success of a movie is highly influenced by the actor, actress, director, music director, and production company, those historical data were extracted from the Internet Movie Database (IMDb). The Box Office Mojo stores information about the cost of production of a movie and the total income of the movie. This information is helpful to determine whether the movie is successful or not in terms of revenue. A threshold was defined on revenue based on heuristics to categorize the movie into success or failure. Teasers' and trailers' comments were extracted from YouTube as those are very helpful to rate a movie. The keywords were extracted from the user reviews using a Natural Language Processing (NLP) technique and those reviews were categorized into positive or negative based on the sentimental analysis. A Random Forest Algorithm was trained using the features extracted from IMDb to predict the success of a movie. Further, the Naïve Bayes model was trained using the user reviews extracted from YouTube to predict the rating of a movie. The models were tested on real datasets and the accuracy of those were evaluated respectively. Finally, two conclusions have been met that the rating of a new movie cannot be predicted in advance through the YouTube trailers' and teasers' comments and the success of a new movie can be predicted in advance by using the data or features collected from online. The performances of the models are decent enough compared to the existing models in the literature. The Success Prediction model can be used as an early assessment tool of movies since it has gained 70% overall accuracy and hence, useful for the people in the movie industry and the audience of the movies. YouTube allows us to extract a limited number of user comments and hence, this factor could be negatively affected by the accuracy of the movie rating prediction.

Keywords: Rating prediction, Data mining algorithms

A Deep Learning Based Method for Predicting DNA N6-Methyladenine (6mA) Sites in *Eukaryotes*

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DNA N6-methyladenine (6mA) is an epigenetic modification, which is involved in many biological regulation processes like DNA replication, DNA repair, transcription, and gene expression regulation. The widespread presence of this 6mA modification in *eukaryotes* has been unclear until recently. Therefore, for *eukaryotes*, the study of DNA 6mA is insufficient. Accurate identification of 6mA sites genome-wide provides a deeper understanding of the epigenetic modification process and the biological processes it involves. Existing experimental techniques are time-consuming and computational machine learning methods have room for performance improvement. DNA N6-methyladenine prediction in cross-species shows low performance. Hence, there is a need for a highly accurate, time-efficient method to predict the distribution of 6mA sites in *eukaryotes*. Deep learning models have shown higher accuracy in many experiments in bioinformatics. In this regard, we develop a customized VGG16 based model using convolution neural networks. We introduce a novel 3-dimensional encoding mechanism extending the one-hot encoding method for the given DNA sequences of length 41bp to support the VGG16 model input. Specifically, the 10-fold cross-validation on the benchmark datasets for the proposed model achieves higher accuracies for cross-species, Rice, and *M. musculus* genomes. The cross-species data set was prepared by integrating the benchmark datasets of Rice, and *M. musculus*. This model outperforms the existing computational tools SNNRice6mA, iLM-CNN with a current validation accuracy of 97% for the prediction of 6mA sites. The model trained with cross-species data predicts 6mA sites of other species *Arabidopsis Thaliana*, *Rosa Chinensis*, *Drosophila*, and Yeast with a prediction accuracy over 70%. Thus, this model can be used for the genome-wide prediction of 6mA sites in *eukaryotes*.

Keywords: DNA Sequence encoding method, Deep learning, Epigenetics, Bioinformatics, DNA N6-Methyladenine

Real-Time Bus Tracking System for Minimizing Passenger Time Wastage in Sri Lanka

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Bus transportation has become the major transportation mode in Sri Lanka due to ease of access and cost-effectiveness. However, the passengers, mainly those who are in the middle stations, face the difficulties of getting a bus because of the unavailability of a solid mechanism to get the real-time bus location. After several field visits and interviews with the respective bodies, the study has introduced a solution for the passenger time wastage by developing an Arduino based device and a simplified user environment. This device consists of UNO microcontroller, SIM800c GSM module, and NEO 6m GPS which is capable of achieving the highest sensitivity of the industry by tracking up to twenty-two satellites on fifty channels. The Tiny GPS++ library was included and some conducive core sub-objects like the latest position fix, latest altitude fix, the number of visible participating satellites, and horizontal diminution of precision adapted to succeed in the process. After setting up the configuration of the GSM, checks the availability of AT commands. AT commands are used for receiving an SMS sent by the user requesting the current location. As the user environment, a Cross-Platform web application is developed, including bus information in which the user can get bus journey/fare details, bus ID which is provided by the system to uniquely identify a particular bus, and its real-time location. The user can receive the location just via an SMS as a google maps link, using that bus ID. Moreover, to assess the functionalities and usability, the Arduino based tracking device was placed in a bus and a potential user was provided with the web application. The user could manage simple operations and get information about the desired bus. Further, the study recommends the use of this web application to trivialize the time wastage and irregularity of bus service and make people more attracted to public bus transportation.

Keywords: Arduino-based device, GSM Module, GPS, Real-time bus tracking

Smart Reply Generation for SMS Using Natural Language Processing

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The use of Short Message Service (SMS) is increasing due to the rapid increase in mobile phone usage and the simplicity in sending SMS messages. With the increasing complexity of human lives, people are seeking more efficient activities to save time. This research proposes an end-to-end method that automatically generates short responses known as Smart Replies by identifying the content of an SMS using natural language processing. There are a few pieces of research done on the topic of Smart Reply. Most of them are carried out for the emails. And the efficiency and the size of those existing models cannot be used in an offline mobile device. The application will use Natural Language Processing to process an incoming message and then uses a neural network to predict the most likely responses which will allow us to send it directly or edit it before sending it to the recipient. The Ubuntu Corpus dataset was used for training and testing the model by analysing its properties. It is identified that there are three main approaches: TF-IDF, Recurrent Neural networks (RNN), and Long Short-Term Memory (LSTM) that can be used in the model. After a performance test, identified the most suitable approach is LSTM. Accordingly built a Sequential Neural Network with a Dense with sigmoid activation using LSTM. Finally, extract the highest three responses from the trained model to show in the SMS application. This proposed model achieved around 92% percent of accurate results and it can be used offline and also it is a lightweight file that can be easily handled in a mobile device.

Keywords: Smart reply, SMS, Natural language processing, Long short-term memory, Sequential neural network

Smart SMS Classification for Android Operating System Using Natural Language Processing

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The use of Short Message Service (SMS) is increasing as more people exchange SMS messages very frequently due to the rapid increase of mobile phone usage and the simplicity in sending SMS messages. However, this has led to an increase in mobile device attacks using SMS Spam. The two main categories of SMS Messages are spam messages and ham (legitimate) messages. Up to now, several kinds of research were done on SMS classification but all of them are on spam filtering techniques by using various algorithms and machine learning techniques. In this paper, we present a novel approach that can detect and filter both spam and ham messages into a better organization under six different predefined categories named as Primary for legitimate messages, Bank and Finance, Social and Web, Promotions, Service Provider Messages, and Spam Messages by using Natural Language Processing for Android Operating System. A smart messaging application that can properly organize SMS into categories will help to identify the SMS easily as they are classified under different tabs. Even though SMS can be identified and categorized manually with little or no effort by people, it remains difficult for mobile phones. A dataset is created according to the Sri Lankan context and various experiments are performed to evaluate the performance of the SMS Classification. Initially, the features were selected based on the behavior of messages and extracted the features from the dataset to get the feature vectors. Naive Bayes and Support Vector Machines algorithms were used to select the best classification algorithm. With the highest accuracy rate, the Support Vector Machines algorithm is selected to train the model while k-Fold cross-validation is used to perform the validation. Our proposed approach achieved a 93% accuracy rate and the model is deployed in the Android environment and its performance is confirmed using a proof of concept.

Keywords: SMS classification, Natural language processing, Support vector machines, Naive bayes algorithm, Android

Embedded System for Identifying the Quality of Grass Using Colour Patterns for the Sri Lankan Dairy Industry

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Sri Lankan dairy sector operates at its suboptimal level. Efficient and reliable technologies are needed to increase productivity enabling farmers to make farm management decisions based on accurate and current information. Precision farming technologies could be successfully integrated to monitor farm-grown pasture and make real-time decisions to optimize utilization. The present study is aimed to develop an embedded system-based method to efficiently monitor and utilize available pasture in dairy farming. A custom-made drone with F450 frame and Ardu pilot mega 2.6 was used in the study. The drone was tested at Uva Wellassa University and NLDB farm, Melsiripura. Flight controller was automated using the mission planner tool to fly at an automated waypoint flight of a Grid pattern. Drone mounted go-pro camera was used to acquire pre-processed images contained GPS metadata and webODM tool merged images with GPS data to produce a georeferenced output (Orthomosaic image). Developed shadow removal algorithm converted BGR to YCbCr color space and computed average Y channel and intensities. Subsequent process detected shadow regions and saved binary shadow images. Then the algorithm computed average pixel intensities of shadow and non-shadow areas adding difference with Y channel. Furthermore, the color identification algorithm obtained shadow processed image and applied the median filter (blur/Sharpened image) to convert color mode from RGB to HSV format. The image was color filtered based on identified color ranges of high yield grass. To identify overall color identification, an aerial map was marked by an expert in the field, subsequently algorithm processed image and marked image compared. Images were measured by pixels coverage of marked area and results provided a 90% identification rate through the algorithm. Results revealed, developed an embedded system-based method successfully measured field grass coverage compared with a manual method.

Keywords: Embedded system, Pasture, Precision agriculture, Colour identification

Learning Modality based E-learning Approach to Enhance the Sri Lankan Education System

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Sri Lankan education system is based on a teacher-centered education approach. Mostly the students do not have an opportunity to learn according to their learning modality. According to the statistical reports released by the Department of Examinations of Sri Lanka, there is a considerable failure rate in the General Certificate of Education Ordinary Level Examination, especially in Mathematics. Through these reports, we can observe that there is a weakness in the current teaching approach. This study addresses the above-mentioned problem by evaluating the effectiveness of learning according to the learning modality-based e-learning approach instead of the teacher-centered education approach. Visual, Auditory, and Kinaesthetic learning modalities are considered in this study. Grade eight English medium students were randomly selected into two samples with twenty in each. Similar portions were selected from the units 'Sets' and 'Volume' from the Grade eight Mathematics syllabus. One sample was selected and their learning modality was identified through the e-learning platform and facilitated to learn through the e-learning platform based on the identified learning modality. The other sample was facilitated to learn the same unit with the teacher-centered education approach. The learning approach applied for the samples was interchanged in the next unit. A paper-based test was given to the two samples at the end of each unit and marks were recorded. Two sample t-test was used to analyse the results. Analyzing the results, calculated p-values for the units 'Sets' and 'Volume' are 0.03530 and 0.03542 respectively with a 95% confidence level. It is concluded that there is an improvement of marks in the learning modality-based e-learning approach than the traditional teaching approach. This modality-based e-learning approach can be applied to increase the effectiveness of the education system by mitigating weaknesses that occurred in the teacher-centered education approach.

Keywords: E-learning, Learning-modality, Visual, Auditory, Kinaesthetic

Sensitivity Analysis of a Redox System Model to Understand the Initiation of Chronic Kidney Disease of Unknown Etiology Progression

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Identification of the most significant parameter set in a mathematical model is very important to understand the model behavior. Sensitivity analysis is carried out to accomplish this purpose. Chronic Kidney Disease of unknown etiology has been identified as a disease with very high death rates in many tropical countries around the world including Sri Lanka, India, Egypt, and some Mesoamerican countries. Heavy metal exposure is one of the identified evidential factors of this disease progression. Oxidative stress is the main pathological mechanism that leads the kidney tubular cells to cell death pathways with heavy metal exposure. Oxidative stress is raised due to the unbalanced production of reactive oxygen species inside the cells. In this study, a sensitivity analysis was carried out on an existing mathematical model of the Redox system of the body to identify the parameters which are significant in controlling the process of reactive oxygen generation. After simulating the existing mathematical model, a sensitivity analysis was carried out including a local sensitivity analysis which gives the individual effect followed by a global sensitivity analysis which gives the group effect of parameter perturbations. According to the study, five parameters out of sixteen parameters in the mathematical model were identified from the local sensitivity analysis as the most sensitive parameters. Global sensitivity analysis was used to rank them according to the P values of the KS test. A constant was identified which is related to superoxide variation in the system has the highest sensitivity. Also, most of the identified sensitive parameters are correlated with enzyme driven reactions. According to the researchers' perspective, heavy metal exposure also affects the enzymes in the redox system of the body. Therefore, when modeling heavy metal toxicity we can conclude that much consideration should be given to those reactions correlated with enzymes.

Keywords: CKDu, Oxidative stress, Mathematical modeling, Sensitivity analysis, Parameters

Automated Essay Type Paper Marking System

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Automated paper marking is a very important research tool for the education evaluation process. Some researchers indicated that almost every study's challenge was to get the semantic similarity of an essay rather than keyword matching. Another major problem is the lack of sufficient data that needed to train the system for a specific domain with a supervised learning approach and there are some issues with the unavailability of educator's involvement with the scoring systems, also there were no studies that behave like a complete system. The automated scoring or evaluation for written student responses have been, and are still a highly interesting topic for natural language processing (NLP) and Machine Learning (ML) research. This study is focused on building a complete system that automates essay paper marking with a novel approach using NLP and ML. Primarily, researchers have used a hybrid approach to get the semantic similarity between two textual objects which contain word-vector-similarity, knowledge-based- similarity, and word-order-similarity. As one of the main advantages, our system uses an unsupervised learning approach, so that the system can work independently without training for a specific subject domain. The emerging of word embedding encouraged the calculation of the word-vector-similarity with Vector Space Model and cosine-similarity mechanisms. On the other hand, the word-net knowledge base was used to calculate the semantic distance between the documents and word-order-similarity played a major role in the accuracy of the final result. Also, machine learning techniques and a vast number of NLP techniques have been used for implementation. Besides, the proposed study contains an OCR to identify student's handwritten characters and also a website to easily interact with the system. In conclusion, the system was tested and evaluated with 30 samples of essays and the manual scores given by the educators. As a result, it indicated a strong positive correlation of (0.882) between manual scores and the system scores.

Keywords: Automated essay scoring (AES), Natural language processing (NLP), Machine learning (ML), Optical character reader (OCR)

Low Cost Railway Tracking and Mobile Application Based Train Monitoring System

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The railway is one of the common and low-cost transportation systems which is used by many passengers in Sri Lanka. However, delays in trains are frequent and passengers cannot find the actual location of the train since these facilities are not supported by the current system. The main intention of this work is to provide railway tracking and monitoring to the railway passengers at a low cost. This system would help passengers to know the train delays earlier, the actual arrival time of the train, to know the nearby railway station and the shortest path. The assumed system consists of a system administrator, a set of passengers, and a tracking device. Each passenger should have a smart device with an Android operating system. The tracking device needs to be positioned in the engine controlling room of the train. The prototype software was mainly developed for the users to find the actual location of the train. The proposed system works on Arduino, GPS/GSM module. While waiting for the train, the passenger should enable the data connection and GPS if they wish to know the nearest train location and the shortest path to reach the nearest location. When the tracking device is powered on and connected to the network coverage, it will be automatically connected to the server and the location data would be uploaded. Users can run the application and select the train to view the real-time map, estimated arrival time, and other data. Moreover, if the passenger doesn't know the nearest station, the system would automatically select the nearest station, show the shortest path, and predicted travel time to the user. The cost for the construction of the system is less than 25\$ and this system can be applied to the buses in public transport or school busses. Other systems in the market cost around 80\$. The pilot system provides the actual location of train and arrival time with high accuracy and the average error is 46 seconds. Using this method, the railway transportation system can be carried out as a diligent service.

Keywords: Real time tracking, GPS, GSM, Android, Arduino, Train

Sharing Economy Business Models: A Case of Accommodation Sector in Sri Lanka

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The tourism industry has long been one of the largest export earners in the Sri Lankan economy. Accommodation is a major sector in the tourism industry that needs to be thoroughly investigated for the potential benefits to be reaped through the successful integration of ICT. The sharing economy is defined as an economic system in which assets or services are shared among individuals and/or organizations either free or for a fee, usually through the use of the Internet. Airbnb is among the best examples for such businesses that connect hosts and travelers, facilitating the process of renting without owning any such facility. However, the opportunities brought by ICT integration in the tourism industry are yet to be grasped by the Sri Lankan rural community which is nearly four times the urban population. Taken together, the main aim of the proposed study is to investigate the sharing economy business models to adopt them in the accommodation sharing business in the rural areas of Sri Lanka. The study would be supported by a comprehensive review of sharing economy business models adopted worldwide. Further, a SWOT analysis is to be carried out analysing the respective competitive environment. Based on the findings the study aims to provide a set of guidelines and recommendations to be adopted in creating and revising relevant government policies and regulations and to develop a business model for successfully implementing a sharing-based accommodation business by the Sri Lankan rural community. As a pilot study, a questionnaire survey will be carried out centering Dickwella city, Matara district employing different stakeholder groups including hosts, travelers, and relevant institutions. As also investigating the associated key concerns including sustainability, security, and privacy, the study is believed to help enhance the participation of the rural population in the sharing-based accommodation business and thereby towards improving the national economy.

Keywords: Sharing economy, Business model, Tourism industry, Accommodation sector, Sri Lanka

A Data Mining Approach for Taal and Laya Recognition 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 analyse musical structures: notes, chords, rhythms, and patterns thereof. While western classical music is extensively explored, North Indian classical music remains to be explored computationally. Meanwhile, our recent review of the literature revealed that *Raag* identification is among the frequent data mining tasks applied to North Indian music. However, recognition of their rhythmic structures is also important as it serves in a multitude of applications e.g., intelligent music archival, enhanced navigation and retrieval of music, and informed music listening. Rhythm in North Indian classical music revolves around the theme of Taal - the cycle of beats of specific syllables and beats. It is the most basic information for listeners to follow the rhythmic structure of music. Laya is the speed of Taal and may vary between Vilambit (slow), Madhya (medium), and Drut (fast). Taken together, the main aim of the proposed study is to apply data mining for the recognition of Taal and Laya in North Indian classical music. A dataset of 151 excerpts (2mins; 44.1 kHz; stereo; .wav) from CompMusic Hindustani test corpus, belonging to four popular Taals is used in the study. For each *Taal*, there are excerpts in three *Layas*. Acoustic features pertaining to fluctuation, beat spectrum, onsets, event density, tempo, metre, metroid, and pulse clarity will be extracted using MATLAB MIRTtoolbox. The performance of frequently adopted algorithms e.g., k-Nearest Neighbor and Support Vector Machine is to be compared in the study with the aim of developing a classifier with higher accuracy. 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

Keywords: Music data mining, Taal and Laya recognition, North Indian classical music, Rhythmic analysis, Computational musicology

An Improved Deep Learning Based Method for Protein Family Classification

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Proteins are large and complex molecules that play a critical role in various aspects of life. Only 20 amino acids provide millions of proteins by combining into chains called polypeptide chains with different types of amino acids, lengths, and folds. Therefore, they are considered the building blocks of life. In proteomics, proteins are classified into families to achieve many goals such as predicting functional properties of novel proteins, discovering new drugs for new diseases, etc. As biological experiments are more expensive to deal with a large number of new proteins, one of the main computational approaches of protein classification is deep learning. Nowadays, with the progress of computational techniques, deep learning plays a key role in many areas. In this paper, our goal is to offer an improved alignment-free deep learning-based method for pattern recognition in proteins for classification. In this research work, we were based on one of the recent deep Learning approaches called DeepFam. We designed an improved method using the concepts which have been used in image classification and natural language processing. We extensively experimented with using the Clusters of orthologous Groups (COG) and G-Protein-coupled receptor (GPCR) datasets. our method showed higher validation accuracy than DeepFam and other methods that had been experimented using the same data sets.

Keywords: Bioinformatics, Protein family prediction, Deep learning, Deep convolutional neural networks

ICT Integration in Agriculture: A Case of Sri Lanka

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Information and Communication Technology (ICT) has become an indispensable tool in several sectors including the agricultural sector. It embodies all the digital technologies used to capture, store, process, and exchange information. Traditionally, agriculture has been the backbone of the Sri Lankan economy and in the transition towards food self-sufficiency in Sri Lanka, ICT integration in the agricultural sector would be imperative. Accordingly, the main aim of the proposed study is to develop a framework for ICT integration in agriculture taking into account the Sri Lankan agricultural sector. The study would be supplemented by a systematic review of literature that identifies the different domains of research related to ICT in agriculture, existing frameworks for ICT adoption in agriculture around the world, and the global initiatives for ICT integration in the agricultural sector. The study will also survey major barriers and challenges in ICT integration in agriculture and it will provide insights on the future of ICT integration in agriculture in Sri Lanka. As a case study, the study considers the Permanent Crop Clinic Programme (PCCP) which is a plant pest and disease diagnostic and recommendation service implemented through farmer group structure called the Crop Clinics (CCs). CCs serve as an extension tool contributing to promote sustainable agriculture and also provide a unique educational experience for farmers through making recommendations based on the diagnosis of live samples. Based on a questionnaire survey employing different stakeholder groups including officers from relevant government authorities, instructors, and farmers, the study aims to provide recommendations on where and how ICT can be better integrated into the above program thereby supporting the realization of the PCCP objectives.

Keywords: ICT integration, Agriculture, Sri Lanka, Permanent crop clinic programme

Software Defect Prediction and Bugs Classification

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Defect prediction empathizes a main role in the Software Development Life Cycle. Having defects in source code is unavoidable but identifying and reducing the bugs in source code in early stages save time and effort. The quality of the source code is primarily measured based on the defect rate. Software defects have a strong relationship with software metrics. As a developer once they build the code, it redirects to the quality engineers to test the code, and if there is any fault with the software, they will send it back to the developers with their comments. Since the software was built by many developers, each developer has to go through the code to find the faultiness. This process will have a significant efficiency improvement if the developer responsible for the bug is identified at the beginning. This tool provides a practical solution, where once we get the feedback from the quality assurance engineers, tool labels the developers(n), and redirect all the comments to the relevant bucket. Then the developers can easily identify their faults and fix bugs. To understand the status of the code, researchers collected several metrics which are related to defect prediction such as Cyclomatic Complexity values and Halstead Complexity values, then using the Principle Component Analysis, it identifies the most relevant software metrics for defect prediction and builds the dataset. Using the dataset researchers developed a machine learning model to predict the code status, Whether the code is in Good, Moderate, or Weak Level. Natural Language Processing used to analyse the Git issues, with the aid of the Latent Dirichlet allocation algorithm, it is based on clustering and create needed categories for a given input(n). Once the user gives the link of the source code, the tool identifies the defect rate, responsible developer for each bug, most committed authors, and the frequencies of most used words. The result shows that the tool solves the practical problem more accurately in the programming environment.

Keywords: Defect Prediction, Software Metrics, Git Issues, Defect rate, Machine

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Construction Delays in Water Supply Schemes of Plantation Sector in Nuwara-Eliya District

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Delay is the most considerable factor in all kinds of projects in all industries. In construction projects, a delay is a key considerable factor. The time length between the completion of the project and the given time period for the project is called a project delay. The length of the time period will be the most considerable factor in the success of the project. Construction delays can be seen in all kinds of construction projects worldwide. It is a common factor that most of the Water Supply Scheme projects in upcountry Sri Lanka are failed to complete the project within the estimated time period. Nowadays, the Construction of Plantation Water Supply Schemes in Nuwara-Eliya district, Sri Lanka is also facing the project delays. With the information gathered through the discussion between project participants (Client, Consultant, and Contactor), in Nuwara-Eliya Water Supply Scheme projects, and through the literature review, factors affecting Water Supply Scheme project delays were identified and a questioner was prepared considering those factors. An investigation was carried out to identify the effectiveness of those factors to the Water Supply Scheme projects. Leads in financing the projects by contractors, Lack of teamwork among all involved parties in the construction, Delays in gathering approvals from Client, Poor project management of Contractor, Skilled labour shortage and especially Political involvement in Tea Estates (Beneficent parties) and Environmental leads such as heavy rain, landscape, and other natural leads has been identified as the most effective factors for the delays in Water Supply Scheme projects in Nuwara-Eliya District. Conclusion and recommendations are made to overcome the identified most effective factors influencing project delays in future Plantation Water Supply Scheme Construction projects.

Keywords: Projects, Delays, Construction projects, Water supply schemes projects

Life Cycle Energy Assessment for Domestic Biogas Systems

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With the rapid economic development and urbanization, Sri Lanka is facing a huge challenge in terms of energy security and environmental pollution due to the drastic increase in burning fossil fuels. Therefore, it is important to explore the potential of renewable energy sources for domestic and industrial consumption. Biogas is one of the best solutions for these issues as it provides triple benefits namely sustainable environmental protection, energy generation, and agricultural & farming support. However, to further development of biogas energy technologies in Sri Lanka, it is important to do a detailed energy analysis of this technology by considering the initial energy requirements and energy generation at the end. The life cycle energy assessment (LCEA) can be used for this analysis and can be used as a basis for the calculation of energy pay-back time (EPBT). This analysis includes the energy requirements during the collection and transportation of waste, construction, and operation of the plant, upgrading the biogas produced and final energy generation from the biogas. In this study, different sizes such as 8, 10, 12, 15, 22, 35, and 65 m³ of Chinese fixed dome type biogas plants were analysed using LCEA to determine the EPBT. Embedded Energy Values (EEVs) were evaluated from the quantity of materials used for the construction of different sizes of biogas plants and EPBT of the plants were calculated using EEVs and final biogas energy production. As per the analysis, the relationship of EPBT and the volume (in m³) of the biogas plant (X) was $EPBT = 0.0006 X^2 - 0.008 X + 0.590$. Accordingly, the construction of the higher capacity plant has lower EPBT and therefore it is more energy-efficient than a smaller capacity plant. However, a detailed economic analysis is required to carry out when selecting the optimum size of the biogas plants.

Keywords: Biogas plant, Life cycle energy assessment, Embedded energy values, Energy pay-back time

Statistical Modeling of Reselling Price of Suzuki Model Used Car in Colombo District

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Car reselling is a timely, very popular heading in Sri Lanka and a large number of cars are resold daily. A lot of people are in the practice of reselling their car every time based on different reasons. Many different factors affect the reselling price of used cars. This study aimed to identify the factors that influence the reselling price of used Suzuki cars in Colombo, Sri Lanka, and to find the best multiple linear regression model. For this study, the 90 reselling prices of Suzuki used cars in Colombo district were collected from January 2019 to March 2019. In this study, Mileage of the car in km, Age of the car in years, Model of the car (Swift, Alto, Wagon-R, A-star, and Spacia), Color of the car (Light, Dark) and Number of past owners of the car were considered as independent variables. In this research, a multiple linear regression model has been used to identify the factors that affect the reselling price of the car. Furthermore, the forward selection, backward elimination, and stepwise regression methods have been used to find the best multiple linear regression model. According to the final results of this study, the principal factors that affect the reselling price of used Suzuki cars in Colombo district were mileage of the car, age of the car, the model of the car, and the number of past owners of the car. Finally, the model obtained in this study will be useful for both buyers and sellers.

Keywords: Reselling price, Colombo, Used car, Suzuki car, Multiple linear regression

Active and Passive Safety System for Differently Abled People and Adults

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15% of the world population encompasses the differently-abled community of a diversified range. It is a vivid fact that enough attention is not being paid towards the differently-abled ones who are residing within the residence, such where the guardian is not available. Hence research was conducted to produce a developed asset that supports in detecting and generating a signal during where the utmost care and attention are required. The developed asset is carried out as an oriented scenario of assistive technology being supported by video and image processing. The potential study in this regard is almost a success and improvements can be done by adding some advanced features such as facial expression detection system and emergency alert on the health care provider.

Keywords: Safety system, Differently abled safety, Adults safety, Assistive technology

Time Series Modeling of Blood in Demand for Kurunegala District, Sri Lanka

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In general, blood comes into four main Groups; O, A, B, and AB. The most common and highly demanded blood is Group O. Blood can also be subdivided into its main components; red cells, white cells, platelets, and plasma. Unfortunately, red cells only have a shelf-life of 35 or 42 days, while platelet shelf life is even less, only five days. Blood cells are essential components of the human body. Blood cannot be manufactured mechanically and can only be obtained by donation. Human blood pressure and heart rate will stay close to normal as one human loss up to 30% of blood. If they lose more than 40% of blood they will die. It's important to get to a hospital to start receiving blood transfusion to prevent this. Blood transfusion is generally required in surgeries, childbirths, organ transplants, and for patients who are receiving treatments for diseases such as cancers and anaemia. Therefore, it is essential to study the blood in demand for the near future. According to Sri Lanka, the National Blood Transfusion Service (NBTS) is the sole supplier of blood and blood products to all state hospitals and it has ninety-six blood Banks Island-wide. This study investigates to develop a suitable time series model for the monthly blood demand for Kurunegala district. The data was obtained from the NBTS Sri Lanka, which consists of the monthly demand for red blood cells from January 2011 to November 2017. The modeling has been done using the Box-Jenkin's Auto-Regressive Integrated Moving Average (ARIMA) procedure. Moreover, to identify the best fitting model, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Mean Square Error (MSE) were used. Through the analysis, it was identified that ARIMA (0, 1, 1) is the most appropriate model for the monthly blood in demand for the Kurunegala district.

Key words: Blood in demand, Blood groups, Red cells, ARIMA

IoT Based Health Monitoring System

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Scarcity of the medical resources likes hospital spaces and the availability of doctors has become a serious problem for patients in our country. IoT is a concept that is revolutionizing the current world which can be utilized to find a solution to this problem. IoT plays a key role in many industries in the present world. Its uses can be seen in agricultural, industrial, medical, and many other fields. An IoT device having the functionality to replace doctor or medical personnel will be a solution. A device which will be able to monitor patients who don't need and emergency treatment, by keeping them at home and alert them and doctors in case of an emergency for the patient is a remarkable solution for this problem. A system having the capability to read the vitals of the patient using sensors and analysis the data and monitor the patient, alerts patient and doctors in case of emergency and keeps a record of the vital measurements for the future analysis is developed. Using the ECG sensor, pulse rate sensor and temperature sensor the pulse rate, ECG, and body temperature will be measured and will be compared against the reference values and if the deviation is above the tolerated level it will immediately provide an alert. Here the node MCU will function as the main communication hub, while Arduino mega will get the readings from the sensors and transmit it to node MCU module. The sensors used in this prototype are available in the local market, with an affordable price range. MYSQL is used as a database management tool. A visualization interface for the stored data is also integrated, which will make the doctors work easy for the analysis of the patient's current health conditions. IoT is used as the basic backbone for the gathering and storage of the sensor data.

Keywords: IoT, Health care, Patient monitoring

Real Time Data Transmission to an Online Server using IoT Technology

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Real-Time Data transmission is an important activity in every mechatronic system. Nowadays, the usage of IoT (Internet of Things) is the state-of-the-art method for real-time data transmission. This paper discusses real-time data transmission from a water distribution network to an online server using *nodeMCU* (IoT device). This method facilitates rapid and accurate real-time data transmission when compared with existing manual methods. Most industries, like the National Water Supply and Drainage Board, Ceylon Electricity Board are still using manual methods for data collection and transmission, which costs a lot of money. Automatic data collection and updates to an online server using a smart IoT system can be applied to water distribution networks. This paper introduces an accurate and simple method for automatic data collecting, transmitting, analysing, and publishing which was successfully applied to the Water Supply and Drainage Board of Sri Lanka. This research work consists of four main parts. First, the water usage was read using a flow meter and update it real-time on an online server called Thingspeak using a *nodeMCU* Wi-Fi device. This online server collects water meter readings and calculates the water usage in liters and water bill in Rupees at every 10 minutes. Therefore, every 10 minutes, the user receives the water bill and water usage to his/her mobile phone. This period may be adjusted by users according to their requirements. Matlab was used to read, analyse, and calculate water usage data and the bill amount in real-time. This can be used to monitor the daily water usage and water bill. This system provides an advanced technique for water billing rather than a meter reader visits every house and calculate water bills. This saves time, government money, and labour.

Keywords: Real time data transmission, IOT, *nodeMCU* module, Thingspeak online server, Matlab

Development of Wearable Haptic Device Using Soft Materials to Deliver Kinesthetic Feedback in Virtual Environments

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Fluidic actuation has been using in soft robotics to make grippers and actuators. Only a few of the studies have used fluidic actuation to produce kinesthetic feedback in virtual environments. A haptic device was designed to be used in the field of virtual reality to render kinesthetic sensations such as grip force, weight, and impact forces to the user. It was fabricated using silicone rubber (Ecoflex 00-30) and consists of several soft actuators. All actuators are capable of delivering forces to render the aforementioned kinesthetic sensations through pressurized air. Soft actuators were fabricated using a 3D printed mold which was made by acrylonitrile butadiene styrene. Each actuator can be actuated separately and simultaneously using a compressed air supply to achieve a complete device actuation. Atmel328 microcontroller was used to control the soft actuators with solenoid valves. Miniaturized DC air pump (12 V /-90×103 N m⁻² pressure) was used to supply the compressed air. The overall actuation of the device can be controlled by the microcontroller based on the virtual environment feedbacks. The result showed that the haptic device is capable of delivering forces by changing the shapes of soft silicone structures according to applied pressure. The relationship between the delivered force and the applied pressure was linear ($r= 0.9975$, $p\text{-value}= 0.4233$ and $R^2= 0.9951$). In addition to that proposed haptic device has higher degrees of freedom and low weight compared to heavy mechanical developments. Therefore, soft material-based developments are effective to deliver kinesthetic feedback in virtual environments as per the findings of the study. Furthermore, higher user compatibility and wearability are additional advantages of the device.

Keywords: Haptics, Soft Robotics, Pneumatic

Design and Development of Automated Sprayer for Greenhouses

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The chemical uses of nutrients and pesticides are one of the most important agricultural processes and one of the most dangerous agricultural operations in the world. Automated sprayers are being developed for the use of greenhouses to improve the safety and effectiveness of the chemical application process, which results in reducing: chemicals, labor costs, occupational hazards, and harmful environmental damages. Most frequently, sprayers have been controlled by Programmable Logic Controls, Robot Q, Raspberry Pi, and Arduino platforms. This study was intended to develop an affordable Autonomous sprayer equipped with existing technology and adding values in rich path following, multi spraying, best target controlling, and crop identification ability in Sri Lankan Greenhouses content. A four-wheeler differential steering base robot was designed and built to act as a greenhouse sprayer. The overall robot is run by using a drive unit that consists of two brushless direct current motors. The Proportional-Integral-Derivative controller was developed to follow the paths of lines which are located on the floor correctly. Moreover, the crops were identified using image processing. The spraying system also inbuilt to the robot, i.e., pump, reservoir, nozzle, etc. The fully completed autonomous robot was tested on rough terrains and it can be able to navigate on pre-defined paths in greenhouses very high accuracy. Future developments will be focus to add high processing power for digital image processing and artificial intelligence.

Keywords: Programmable logic controls, Brushless direct current motors, Proportional-Integral-Derivative, Artificial intelligence

Effect of Wall Materials on Building Sustainability: A Comparison of Different Wall Materials

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Amidst increasing concerns about environmental impacts such as global warming, greenhouse gas emission, and air pollution, the world is trying to find measures to mitigate these impacts. The construction industry plays a major role in this regard. Sustainable building construction seeks to minimize the negative environmental impacts from buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. There are only a few studies that relate to the impacts of building materials on the three pillars of sustainability in the Sri Lankan context. This study investigates the most suitable wall material for an urban residential building in Sri Lanka to satisfy the environmental, social, and economic sustainability requirements. Wall materials considered in the study are solid concrete blocks, hollow concrete blocks, burnt clay bricks, and compressed soil bricks. The environmental burdens associated with embodied energy and CO₂ emission were identified using the cradle-to-gate life cycle assessment of the wall materials, while the life cycle cost of materials was used for economic analysis. Also, social aspects related to wall materials such as thermal comfort and aesthetics were considered in identifying the sustainability of wall materials. Data related to raw material extraction, material production, and transportation were collected from visiting material manufacturing facilities and conducting interviews with relevant personnel. The three sustainability aspects of each wall material were compared using a sustainability index and compressed soil bricks were identified as the best wall material to be used for urban residential buildings in Sri Lanka.

Keywords: Residential buildings, Sri Lanka, Sustainability, Sustainability index, Wall materials

Incorporation of Polymer Material to Enhance Properties of Traditional Asphalt: A Review

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Sustainability and green concepts are currently acknowledged throughout the global construction industry. The present study is focussed to review the effects of polymer incorporated traditional asphalt. Besides, wearing of roads due to the melting of near-surface tar has become a critical issue in road construction. The traditional material used in road construction is a mixture of rock aggregates with bitumen. However, the introduction of waste plastics such as polythene bags, cups, bottles, and polyethylene terephthalate (PET) is highly appreciated. Since the plastics and polythene are non-biodegradable, these have become the major environmental pollutants around the World. However, these have been effectively incorporated in the asphalt mixture to be used in the construction of roads. According to literature, various polymer materials have been pre-heated at 150°C-200°C until the melt is well liquefied. The well-heated aggregates have then been added to the polymer melt. Thereafter, the plastic-coated aggregates have been mixed with bitumen to produce the polymer mixed asphalt composite (Plastiphalt). The mechanical properties of the composite have shown excellent strength values. Further, this composite has shown higher wear resistance and the melting of bitumen during exposure to sunlight has also reduced. Thereby, the durability of plastiphalt has been concluded to be much higher than the traditional asphalt material. Moreover, the dark black colour has also been reduced, thus minimizing heat absorbance to the inner material. The surficial oil formation of newly paved roads has also reduced. Consequently, road safety has been increased with a reduced number of accidents during rainy seasons. Therefore, the utilization of abundantly available waste plastics in road construction is highly recommended to developing countries such as Sri Lanka.

Keywords: Plastic waste, Eco-friendly, Roads, Asphalt, Durability

Fuzzy Logic Based Motor Speed Controlling System for Automobile Industry

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Road safety is becoming an important case in all over the world today. The number of deaths is increasing day by day inroads, due to the uncontrollable speed of drivers and accidental sleepiness while driving. The objective of this project is to develop a system to protect both vehicles and passengers on the road. The main aim of this project is to control the speed of a vehicle automatically by controlling the speed of the motor using fuzzy logic. Which reduces the driver's task for adjusting the gas pedal and checking the speedometer frequently. The research introduced the Fuzzy Logic for speed controlling instead of the commonly used methods such as RF signal controlling method; because Fuzzy logic controllers (FLC) can be used to utilize the human expertise and experience for design controllers. The purpose of using a fuzzy logic-based speed controller is to regulate vehicle speed according to the current speed of the vehicle and the distance between the vehicle and the object in front of the vehicle. The fuzzy controller has developed under three main parts as Fuzzification, Rule base, and Defuzzification. Two inputs were taken to the FLC as 'Speed error' and the 'Distance between vehicle and object Infront'. 49 Fuzzy rules were designed for the fuzzy logic controller in the rule base. The 'Centroid method' was used as the defuzzification method. The 'Mamdani' system which employs fuzzy sets in the consequent part was used in the Fuzzy logic controller. When the speed and the distance were given, the Fuzzy Inference system gives the best matching fuzzified values as the output value. Then it sends to the motor controller. The results show that the fuzzy logic has minimum transient and steady-state parameters, which show that FLC is more efficient. Finally, the Fuzzy controller produces the responses with little high rise-time, but it offers a high percentage exceed and peak amplitude which can result in poor performance of the system.

Keywords: Fuzzy logic, Fuzzy Logic controller (FLC), Rule base, Fuzzification, Defuzzification

Design & Control of A Dual Wheel Self Balancing Robot

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The field of robotics is a playground of creative minds in the modern age. In this research, it designed and controlled a two-wheel self-balancing robot within a low cost and efficient manner. Two-wheel robots can easily be controlled, spin on the spot, or turn around in small places faster than four wheels robots. The main objective of this project is it has a small footprint to navigate nicely through doors and tight spaces and made within low cost. Another specialty of this robot is it acquires it's balanced even within some fluctuations (around 0.35 rad) around its mean position. The angle of the robot relative to the ground will be sensed from the gyroscope. H-bridge motor driver was used to control the motors and two DC gear motors gave force to stable the robot. ATmega microcontroller used to control and connect the modules, sensors. The system is kept balanced in a straight position in the presence of disturbances forces applied by calculating the PID controller. The robot can guide to its destination within an application with a cloud-based platform, through Wi-Fi with the use of Nodemcu. The gyroscope, motors, and control boards were selected by considering both accuracy and cost. The structure of the robot made by low-cost materials. Kalman filter used to eliminate the noise of the gyroscope value. It helps to filter and avoid noises of the robot and get precise angle values to stable the robot smoothly. The fraction of the floor and tires, weight, and height of the robot are the most important factors to calculate the PID values (K_p , K_i , K_d) for the stabilization of the robot. Finally, the self-balancing robot can be made as a very user-friendly, cost-effective, faster, and small size of the product that can be used to carry or send things easily. And also, it can be modified by adding stages with a camera, IR sensor, etc. because wheeled robots can handle higher payload capability and can control the balance by varying the PID values.

Keywords: PID controller, Self-balancing, cost effective, Kalman Filter, Gyroscope

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Feeding Ecology and Avifaunal Distribution at Henarathgoda Botanical Garden, Sri Lanka

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Botanical gardens play a major role in providing habitats and niches to many species. Among the species groups, avifaunal distribution and feeding ecology can be observed simply. Therefore, a study was conducted to assess the avifaunal diversity distribution and feeding ecology at Henarathgoda botanical garden from February 2019 to February 2020. Data were collected in the morning (6:00 a.m. to 8:00 a.m.) and evening (3:30 p.m. to 5:30 p.m.) in different habitats using 7 transect lines of 150 m for 10 minutes in each transect. As a percentage around 17% of the total number of bird species in the country was recorded in the study area. During the study, 6395 individuals belonging to 81 species were recorded (42 families and 16 orders) including 07 endemics and 06 migratory species. The Shannon Weiner diversity, Shannon evenness, Simpson's, Brillouin, Margalef, and Menhinick indexes indicated 3.32, 0.34, 0.94, 3.29, 9.13, and 1.01, respectively. The highest percentage of feeding ecology was indicated by Insectivores (33.33%) bird species while Carnivores, Granivores, Frugivores, Nectivores, Omnivores, and Herbivores were 28.03, 16.67, 12.88, 5.30, 3.03, and 0.76% respectively. The transect which comprises of Paddy field, Aquatic habitat, and Garden had the highest number of individuals (1545) and species (68). Avifaunal distribution on the terrestrial habitats of the understory layer, sub-canopy, canopy, emergent layer, and the ground was 21.37, 17.56, 14.50, 12.98 and 11.45% respectively and 22.14% of the species were aquatic species. According to the study, distribution and feeding ecology of avifauna at Henarathgoda Botanical Garden represent relatively wide-ranging variability while having a considerable avifaunal diversity. Therefore, Botanical gardens' services can be extended to places for biodiversity education/awareness and nature tourism in addition to the ex-situ conservation of flora and recreation.

Keywords: Feeding ecology, Avifauna, Henarathgoda, Botanical garden

Development of a Compact Aerobic and Anaerobic Digestion Wastewater Treatment System for a Broiler Processing Plant

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The present study was conducted to develop a compact aerobic and anaerobic wastewater treatment system for a meat processing industry. Through this novel system, it was expected to increase the efficiency of wastewater treatment while reducing the land area utilized for the wastewater treatment plant. The treatment system was aligned vertically and consisted of four different units accordingly rotating drum bioreactor, aeration unit, screening unit, and anaerobic digester unit. The structure of the prototype was built mainly using high-density polyethylene drums. As the influent, wastewater generated at a commercial broiler processing industry was used. The experiment was consisted of 2 treatments: existing wastewater treatment plant (screening, aeration, dissolved air floatation, chemical treatment), and novel compact wastewater treatment system. Influent wastewater and the treated effluent from both treatments were analysed for Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, nitrate content, nitrite content, ammonium content, and Total Suspended Solids (TSS) levels. Surface area utilized for two treatments were compared. The BOD, COD, pH and nitrate values of the treated effluent from the novel system was significantly lower than those of treated effluent from the existing system. However, NH₃ content of the treated effluent from the novel system was significantly higher than that of treated effluent from the existing system which indicated incomplete anaerobic digestion in the novel system. When comparing the land area utilization of two treatments, the novel treatment system utilized less land area for wastewater treatment (163.75 L/m² vs. 3.09 L/m²). According to the results, it could be concluded that the novel wastewater treatment system is highly efficient in reducing organic load in wastewater and land area utilization. Further studies are recommended to optimize the system for the reduction of NH₃ generated during the anaerobic digestion of the waste.

Keywords: Chemical oxygen demand, Biological oxygen demand, Rotating drum bio reactor

Preliminary Survey on Avifaunal Diversity in a Suburban Ecosystem: Nadeniya Estate, Kandy, Sri Lanka

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The rapidly expanding human population in Sri Lanka has ensued in the reduction of natural habitats which have been converted to human settlements such as industrial sites, agricultural lands, and other infrastructure development. In consequence of these events, the avifauna is forced to ensure their survival by adapting themselves to human-altered settlements like home gardens, plantations, and estates. Therefore, a study was designed to ascertain the avifaunal diversity and abundance: Nadeniya Estate alias Yakange Watta (3.237km²) situated at Kiriwaula of Udunuwara in the Kandy district, Central Province (N 7°15'19" E 80°32'41"), to assess the contribution of suburban habitats for the conservation of avifaunal species. Two different habitat types' viz. Tea plantation habitat and home garden habitat were studied using 600 m transects, and bird species within 50 m either side were recorded two times per day, in the morning (6.00-09.00 h) and the evening (16.00-18.00 h), within a period of 5 months from August to December 2019. A total of 480 birds belonging to 33 species, 25 families, and 9 orders were recorded within the area. The Simpson's index and Shannon diversity index were 0.97/2.61, and 0.99/2.78 in the tea plantation habitat and home garden habitat respectively. The most dominant species recorded were the House crow (*Corvus splendens*), Common Myna (*Acridotheres tristis*), and Red-vented Bulbul (*Pycnonotus cafer cafer*), with a relative abundance of 10.81, 11.52, and 11.24% respectively. The least recorded species was the Velvet-fronted Nuthatch (*Sitta frontalis*) with a relative abundance of 0.22%. According to the results, it is evident that more anthropogenic activities have influenced the avifaunal diversity. Alternatively, garden and forest birds were also recorded in the area. Therefore, proper management of the land use is recommended for sustainable conservation of the suburban ecosystems.

Keywords: Avifauna, Diversity, Ecosystem, Suburban, Nadeniya Estate

Assessment of Avifaunal Diversity in a Municipal Waste dumping site: A case study from Karadiyana, Sri Lanka

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Waste disposal sites have become factitious feeding sites for some avifauna, especially in the urban and suburban ecosystems. Tentatively these sites are assumed not only to provide the organic food sources but also refuge to different prey species such as invertebrates and small mammals for the avifauna composed of different feeding requirements. As a consequence of this rich and easy food availability, a significant number of bird species are assumed to be allured to these dumping grounds. On account of this phenomenon, a study was designed to ascertain the bird species diversity at Karadiyana in the Colombo District, of the western province of Sri Lanka to assess the overall avifaunal diversity and abundance. Two different habitat types viz. Drainage channel along with terrestrial land habitat and dumping area habitat were studied using variable plot count method. Two plots were allocated to each of the habitats with equal intervals between the two stations respectively. Bird species were observed within 50 m either side were recorded twice per day, 6.30-8.30 h and 15.00- 17.00 h., from January to May 2019. A total of 2586 individuals belonging to 18 species, 14 families, and 8 orders were recorded in an area of 10.12 ha. For the Simpson's index and Shannon diversity index, 0.86/2.08 and 0.74/1.44 were obtained for the two habitats respectively. The most dominant bird species recorded were the House Crow (*Corvus splendens*) and Black-headed ibis (*Threskiornis melanocephalus*) with relative abundances of 34.1% and 28.5%. The least abundant bird species recorded was Common Sandpiper (*Actitis hypoleucos*). The abundance of certain bird species is very high and therefore causes overpopulation, which causes a threat to other avifauna in the area. Therefore, proper management practices should be implemented on direct and open dumping of waste in urban ecosystems to control the indirect impacts of the adjacent wildlife communities.

Keywords: Karadiyana, Avifauna, Waste dumping, Diversity, Shannon diversity

Shoreline Changes along the Western and North-Western Coast of Sri Lanka over the Past 15 Years

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Coastal Zone of a country is a very important interface, through which land connects the ocean. Monitoring the coastal zone of Sri Lanka is an important task in terms of sustainable development and environmental protection. As a result of natural phenomena and anthropogenic activities coastal zone is subjected to major changes. Therefore, it is necessary to identify the temporal dynamics of shoreline around the country for effective coastal zone management. Remote sensing and GIS methods can be efficiently used to determine the temporal and spatial variations of the coastal zones quantitatively and qualitatively. In this study, Google Earth satellite images have been used to analyse shoreline changes in the Western and North-Western provincial coast during the last 15 years. To estimate the accuracy of results, the ground-truthing field survey was conducted. The shorelines were delineated in Google Earth Pro 7.3 software. Tidal variation and geometric errors were considered to calculate the uncertainty to eliminate the errors in the analysis. Digital Shoreline Analysis System in ArcGIS was then used to detect the shoreline change over the period by calculating End Point Rate, Net Shoreline Movement and Shoreline Change Envelope means as the key statistics. The results show that the average erosion rates as; -1.21 ± 0.04 m yr⁻¹ in Kaluthara, -0.54 ± 0.63 m yr⁻¹ in Colombo, and -0.7 ± 0.58 m yr⁻¹ in Gampaha districts. However, Puttalam district shows a 0.26 ± 0.07 m yr⁻¹ average accretion rate while the highest accretion rate 0.95 ± 0.58 m yr⁻¹ shows in the Wilpattu region. 75.6% of coasts in Kaluthara and around 65% of coasts in Colombo & Gampaha have been subjected to erosion. Coasts of Puttalam have been eroded by 28.1% and accreted by 71.9%. This study revealed that the Western province coastal belt had subjected to coastal erosion than the North-Western province of Sri Lanka. Thus, identification of the dynamic nature of shoreline helps to enhance coastal zone management.

Keywords: Shoreline, Remote sensing, Dynamic, Erosion, Coastal changes

Abundance and Diversity of Reef Associated Fish Species in the Eastern Coast of Sri Lanka

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Reef fishes are important marine fauna that provides benefits to reef ecosystems. Although their ecological role is extremely important for the healthiness of the coral reef ecosystem, marine ornamental fishing industry, coastal food fish industry, tourism industry, and lack of monitoring and caring, severely degrade reef fish stocks in the eastern coast of Sri Lanka. Since it is highly important to keep up to date scientific records, a survey was conducted in the final quarter of 2019 using fish belt transect method by snorkeling and/or diving over five selected sites; Passikudah, Kayankerni, Adukkuparu, Parrot rock, and Pigeon island as major and most important reefs in Eastern coast. Threats on sites were identified by visual observation and questioner surveying. 289 reef fish species belonging to 41 families were recorded from all five sites. Reef fish species of each site recorded as 41, 131, 31, 103, and 156 respectively. The highest abundance of fish was recorded in the Kayankerni reef, with a greater number of Damselfish and their abundance was increased from shallow (1 m) to deeper (5 m) area while the lowest abundance was recorded in the Adukkuparu reef. The highest biodiversity (0.96), species richness (103), and evenness (0.65) were recorded in the Parrot rock which may due to the highest recorded coral diversity (0.93) and live coral cover (70%) of the reef. Lowest reef fish diversity (0.68) was recorded in the Passikudah reef which may due to the low coral diversity of the reef (21% live coral cover) but with the highest (51%) algae cover. Marine ornamental fish trade, tourist attraction, invasive species, and pollution were the majorly identified threats to reef fish stocks in the eastern coast of Sri Lanka. *Acanthaster planci* and *Halimeda* sp. are the identified invasive species. Reef fish species and Coral reefs on the eastern coast are in highly threaten level and the Parrot rock and the Kayankerni reefs are recommended to declare as marine national parks.

Keywords: Reef fish, Coral reefs, Eastern coast of Sri Lanka, Kayankerni and Pigeon Island

Diversity and the Current Status of Coral Reefs in Eastern Coast of Sri Lanka

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Coral reefs are highly diverse ecosystems and biodiversity hotspots in the world consisting also of Sri Lankan continental shelf. However, coral reef ecosystems have been changing for the last decades due to natural and human impacts. Therefore, it is important to monitor their current status for conservation and management purposes. Thus, Kayankerni, Passikudah, Pigeon island, Adukkuparu, and Parrot rock reefs which considered major reefs on the Eastern coast of Sri Lanka were surveyed in the final quarter of 2019 by using line intercept transect method. Data were taken by snorkeling or diving over 30 x 50 m transects per site. Threats were quantified by visual observations, water quality analysis, and questionnaire surveying. Live corals at each site were 38%, 21, 59, 12 and 70% respectively. A total of 104 species that belong to 19 coral families were recorded from the Eastern coast while family Acroporidae and Faviidae were dominating. Biodiversity and species richness were highest in Parrot rock reef and lowest in Adukkuparu reef. Massive hard corals which belong to family Poritidae and Muscidae, as well as soft coral family Alcyonidae, were dominated in the Parrot rock reef. The highest percentage of dead coral was in Passikudah reef (79%) and Adukkuparu reef (88%) due to excessive pollution, sedimentation, destructive fishing practices, and overgrowth of *Halimeda sp.* Pigeon Island, Kayankerni, and Parrot rock reefs are also in danger due to destructive fishing, tourism, and invasive species *Acanthaster planci*. Marine ornamental fish trade, dynamite fishing, and tourism activities were the identified major human threats for coral reefs in the Eastern coast. Therefore, it is highly recommended that Parrot rock and Kayankerni reefs should be declared as marine national parks, and coral restoration initiatives have to be taken for all the reefs. These reef ecosystems must be regulated from adverse human activities for long term conservation and management.

Keywords: Coral Reef Ecosystems, Eastern Coast, Conservation, Pollution

Study on Removal Efficiency of Fluoride in Water using Environmentally Friendly, Low Cost Filter System

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Water sources in specific regions of dry zone in Sri Lanka naturally contain high fluoride level than the maximum requirement level of drinking water. The intake of excessive amounts of fluoride in water causes different human health issues. This study was intended to identify the potential of using the biomaterials for an integrated water filtration system to improve the water quality. Based on the literature records, production cost and availability of biomaterials, Areca nut (*Areca catechu*) husk fiber, Coconut (*Cocos nucifera*) spathe charcoal and Snake Cucumber (*Cucumis melo*) seeds were used to identify the fluoride removal rate in water. Fluoride rich natural water was subjected to different biomaterial weight and treatment time combinations during preliminary trials. Based on the results of preliminary trials, the final experiment was conducted in the column systems using four types of integrated water filter setups at different weight ratios between areca nut husk fiber: coconut spathe charcoal {Experimental setups: A (1:1, 25g:25g), B (1:2, 25g:50g), C (1:1, 50g:50g), D (2:1, 50g:25g)} with 3 layers of sand. Equal treatment period (1½ hrs) was used for all 4 column experimental setups since the adsorption capacity of biomaterials depends on the contact time. Fluoride removal efficiency and other water quality parameters were measured in each filter setup. Biomaterials amount in the filter setups had a significant effect on the fluoride level, pH, and Total Dissolved Solids in water ($p < 0.05$). The fluoride removal rate of filter setups was 27.90%, 28.80%, 34.49%, and 43.15% in the A, B, C, and D systems respectively. Although the same biomaterial ratio (1:1) had for the A and C experimental setups, the fluoride removal efficiency was significantly different due to the variations of biomaterials dose in two systems (A: 25g, C: 50g). The most effective filter setup was identified as the integrated system with 50g of areca nut husk fiber and 25g of coconut spathe charcoal considering Sri Lanka Standards for potable water (SLS 614:2013). Turbidity, nitrate, nitrite, phosphate, sulphate, iron, and chloride level of water had recorded the acceptable levels as meeting with drinking water standards after 1½ hrs of the treatment period. The pH of all the filter setup was recorded at the range of 7.1-8.1 within the permissible level for drinking water. In conclusion, areca nut husk fiber and coconut spathe charcoal act as effective, low-cost biomaterials in removing the fluoride from water while maintaining the quality of water.

Keywords: Water quality, Biomaterials, Integrated water filter system, Fluoride removal rate, Fluorosis

Soil Characteristics of Turtle Nesting Beaches in Southern Coast of Sri Lanka

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There are seven species of marine turtles living in the world and five of them are occurring in Sri Lanka. All those five species: Green Turtle (*Chelonia mydas*), Olive Ridley (*Lepidochelys olivacea*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*) and Leatherback (*Dermochelys coriacea*) are nesting on Southern coastal belt of Sri Lanka and it comprises with largest marine turtle rookeries. Although, many characteristics of beaches are affecting turtle nesting; sand composition, sand porosity, vegetation cover, debris composition, soil temperature and soil pH level are considered as majors. Here eight most prominent turtle nesting beaches on the Southern coast: Yala, Bundala, Rekawa, Kalamatiya, Ussangoda, Habaraduwa, Mirissa, and Kosgoda were selected to study the sand characteristics since there is a lack of studies regarding this. The studied characteristics are sand porosity, sorting coefficient ($S\phi$) and mean diameter ($Mn \phi$) and sorting level of beaches by collecting sand samples using piston core sampler up to 50cm depth level. Average sand porosities of different sites were as 28.67, 43.86, 40.77, 50.56, 30.32, 42.51, 55.23 and 21.43% while average sorting coefficient were as 0.56mm, 0.45mm, 0.60mm, 0.60mm, 0.77mm, 0.33mm, 0.95mm and 0.32mm respectively. Average mean diameters of sands of different sites were as 0.45mm, 0.34mm, 0.48mm, 0.50mm, 0.70mm, 0.24mm, 0.97mm and 0.23mm while average sorting levels were as 1.09, 0.85, 0.91, 1.02, 0.97, 0.71, 0.87 and 0.69 respectively. Among these sites, Mirissa has the highest porosity, sorting coefficient and mean diameter of sands. Yala and Kalamatiya have poorly sorted soil and other sites have moderately sorted soil. According to the literature, Kosgoda and Rekawa have the highest turtle nesting frequency. However, other characteristics of beaches and different turtle populations have to be incorporated by conducting more researches to afford strong inference on turtle nesting.

Keywords: Species, Coastal characteristics, Sand, Rekawa, Turtle population of Sri Lanka

Study on the Potential Usage of *Hygrophila schulli* (Neeramulliya) for Removal of Water Hardness as a Method of Phytoremediation

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A high level of water hardness in drinking water is a serious problem in different regions of Sri Lanka. Phytoremediation acts as an effective, environmentally friendly, and low-cost technology for the removal of water hardness. Therefore, the current study was intended to identify the potential usage of *Hygrophila schulli* (Neeramulliya) for the removal of water hardness using a hydroponic system. This plant was selected for the current study based on traditional beliefs, literature records, and availability in the natural environment. Preliminary trials were conducted to identify the appropriate maturity stage of plants, the number of plants, treatment time, and growth medium of hydroponic system. Based on the above results, final experiments were conducted in two hydroponic systems (Treatment 01: 4 plants, Treatment 02: 5 plants) with 16 L of natural hard water (Initial hardness: 300 mg L⁻¹ CaCO₃) in the growth medium of 1:1 ratio of coconut coir: sand using one-month-old *H. schulli* plants. Three replicates for each of the systems were used during the final experiment. Temperature, pH, Electrical Conductivity, Dissolved Oxygen, and Hardness level of water were measured every 12 hours for 36 hours of the experimental period. According to the results, the number of plants and treatment time had a significant effect on the removal rate of water hardness ($p < 0.05$). The hardness removal efficiency of 2 treatment systems ranges at an average of 3.85-21.25% within 36 hours. This explains the capacity of *H. schulli* plants in absorbing causative ions responsible for water hardness during the phytoremediation process. The hydroponic system with 5 plants per unit was recorded average 250 mg L⁻¹ of hardness which satisfies the standard level permissible for drinking water after 36 hours of the time. Accordingly, the absorbance level of Ca²⁺ ions had recorded 10 mg L⁻¹ per single plant of *H. schulli*. Consequently, the treatment system having 5 plants acts as the most effective hydroponic unit in the removal of water hardness. There was no significant difference between pH, Dissolved Oxygen, Electrical Conductivity level in each experimental system, and treatment time ($p > 0.05$). The current study recommends identifying the applicability of similar hydroponic units for removal of extremely high hardness levels from natural water which is over 500 mg L⁻¹ in certain areas of Sri Lanka. In conclusion, this study reveals the appropriateness of *H. schulli* for the reduction of hardness level (300 mg L⁻¹ CaCO₃) during the water treatment process.

Keywords: Hardness Removal Rate, Phytoremediation, Hydroponic system, Water quality parameters, Water treatment

Assessment of Coral Health along the Eastern Coast of Sri Lanka

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Corals are called as most diverse and valuable ecosystems on the earth, disclose their productivity and ecological benefits. Today coral community is degraded and diseases are the distinguishing factor that affects coral health conditions. Absence of the proper health level with any kind of abnormalities called as a disease. In the sense of the view, some are infectious and others are not (genetically-based or toxicant-induced disorders). Lesions or mutations and significant color changes occur due to disease of the coral reefs. Since there is no scientific health assessment on reefs in Sri Lanka has been undertaken to this date, a study was carried out in the final quarter of 2019, using visual observation method by snorkeling and diving over transect lines of most significant & prime fringing coral reefs; Passikudha, Kayenkerni, Adukkuparu, Parrot rock and Pigeon Island reefs of the Eastern coast. 30 transect lines consisted of 50 m length were surveyed per site. The result of the study showed that 07 coral diseases from the Eastern coast were identified under Tissue Loss, Tissue Discoloration, Growth Anomalies and Compromised Health disease categories. 104 of coral species were recorded under 13 families and 65 species out of them were possessed any kind of diseases. All coral reefs were highly threatened due to “compromised health problems and tissue discoloration (white; bleaching) diseases. Most disease vulnerable coral families were, Acroporidae, Agariciidae, and Pocilloporidae. *Acropora valenciennesi*, *Coeloseris mayeri*, and *Pocillopora damicornis* from each family encounter the higher correlation with disease vulnerability. Adukkuparu and Parrot rock reefs were respectively the most and least diseased sites. Considerable natural and disagreeable anthropogenic effects may be the reason for these utmost outbreed health problems. Augmentation of ecosystem management and conservation plans with more researches on health issues may help to protect above coral communities.

Keywords: Coral diseases, Tissue loss, Tissue discoloration, Compromised health problems, Natural and anthropogenic effects

Identification of Thermal Hot Spots in Urban Areas through Establishing Heat Index in Support of Mitigation Plans to Counteract Urban Heat Island (UHI): A Case Study in Colombo Urban Area – Sri Lanka

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The creation of thermally comfortable microclimates in urban environments is very essential for human well-being. This study was conducted to assess the outdoor thermal comfort by establishing Heat Index (HI) values and identifying thermal hot spots in Colombo urban city of Sri Lanka. Fourteen sites (14) with different urban designs were selected purposively which were highly populated during daytime. Daytime temperature and humidity values of selected locations were collected to calculate HI values. Further, questionnaire surveys were conducted among 168 individuals purposively to evaluate the thermal perception of people who exposed to outdoor thermal conditions. Five study sites (Borella, Colombo Fort, Maradana, Wellawaththa, Liberty junction) out of 14 selected study sites were identified as thermal hotspots in Colombo. The average day time HI value for Colombo city was 37.36°C during the study period. The observed HI values were varied between 40.35°C-33.82°C. The highest average day time HI value was observed at Maradana (40.35°C) and lowest HI at Thummulla (33.82°C). The questionnaire survey was revealed most of the study sites consisted of uncomfortable outdoor thermal conditions and people prefer windier, shady, and low temperature outdoor micro climatic conditions in Colombo. The study was revealed that the most important feature of public spaces is the availability of shade due to the intense solar radiation. It is important to promote an urban design that creates shade and ventilation.

Keywords: Heat index; Outdoor thermal comfort; Thermal hotspot; Urban micro-climate

Screening of Plastic Pollution Effects in Madu-ganga Estuarine Ecosystem in Southern Province, Sri Lanka: An Approach toward the Coastal Zone Management

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Plastic pollutants act as the emerging contaminant with possible threats to aquatic ecosystems. The present study attempts to assess microplastic (MP) content in surface water and sediments of Madu-Ganga estuary which is one of the ecologically and commercially important Ramsar wetlands in Sri Lanka. Manta net (380 μm) was employed to collect surface water samples by towing net horizontally along water surface for 10 m with 1.8 ms^{-1} of average flow rate, while Ekman grab was used for sampling sediments from 4 study sites during October 2019 to January 2020. Wet Peroxide Oxidation (WPO) protocol was applied after subjecting both water and sediment samples to the wet sieving process. Fourier Transform Infrared Radiation (FTIR) analysis was used to confirm polymer types of extracted MPs in samples. MPs in digested samples were enumerated and categorized microscopically according to their size, shape, and color. One Way Analysis of Variance (ANOVA) was applied to identify the differences of MPs density with sampling location ($p < 0.05$). According to the results, both surface water and sediment layers had contaminated by MPs accumulation. Sampling location had not significant ($p > 0.05$) effect on the MP content of surface water and sediment samples. Average MPs accumulation rate of surface water and sediment samples were recorded as $40.06 \pm 1.84 \text{ items/m}^3$ and $5.88 \pm 1.33 \text{ items/100g}$ respectively. White-transparent, blue, black, and red were major color categories observed in MPs, while white-transparent color was dominant MP type of water and sediment samples. Most of the accumulated MPs were at the 0.50-1.00 mm of long-range. Fiber, sheet, and fragment shape MPs were commonly found in water and sediment samples. According to FTIR analysis, polypropylene (Characteristic absorption bands: 2950 cm^{-1} , 2915 cm^{-1} , 2838 cm^{-1} , 1455 cm^{-1} , 1377 cm^{-1}) was abundant polymer type in surface water, while sediment contains polypropylene and polyvinyl chloride (Characteristic absorption bands: 1427 cm^{-1} , 1331 cm^{-1} , 1255 cm^{-1} , 1099 cm^{-1} , 966 cm^{-1}). As per the preliminary survey, two major anthropogenic activities: commercial fishery and tourism were identified as the main point and non-point pollution sources in this ecosystem. In conclusion, this study emphasizes the growing risk of plastic pollution and the urgent need for a sustainable management plan to reduce plastic pollution in the Madu-Ganga estuary ecosystem.

Keywords: Plastic contamination, Microplastics, Coastal ecosystem, Surface water, Benthic sediments, Anthropogenic factors

Current Status of Coastal Debris Accumulation along Beach Ecosystems in Southern Province of Sri Lanka

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Coastal debris accumulation in coastal and marine ecosystems is considered one of the serious, the emerging environmental problem in several countries including Sri Lanka. This study aims to identify the current status of debris accumulation in the coastal zone of Southern province in Sri Lanka. The 180 stakeholders were interviewed to collect data using a pre-tested questionnaire survey through 15 open-ended and rank order closed-ended questions (maximum 1-10 of scale) as a convenience sampling method. Based on the estimated median rank data, the majority of waste types were plastic (991.5), followed by glass (819.5) and papers (768.5) in the Southern coastal zone. Soft drink/water bottles (1264) were recorded as the major disposal items followed by food wrappings (1225) and Styrofoam food containers (1146) considering rank scores. Burning or collecting wastes (32.09%), handing over the garbage to the municipal council (25.5%), usage of public garbage bins (25.11%) are common waste disposal methods along the southern coast. The highest percentage of waste separation practices were recorded from Hikkaduwa (81.81%), Galle fort (60%), and Polhena (61.11%) regions. Hambantota and Tangalle beaches have regular waste collection services (100%) to a satisfactory level. Rekawa and Godawaya regional coasts had not recorded any frequent waste collection mechanism. Tourism and recreational activities (86.36-52.94%) and fisheries and harbor operations (93.33-60%) are major waste accumulation sources in study sites. Coastal debris is also accumulated by residential and household activities and unsustainable constructions to a lesser extent. Thus, unsustainable anthropogenic activities are major sources of coastal debris accumulation. The majority of fishermen and coastal residents did not adequately aware of the ecological and commercial impacts of coastal debris. This study suggests implementing integrated coastal management programs focusing on plastic debris accumulating sources. In conclusion, this study provides a basic platform on the issue of coastal debris deposition on the southern coast of Sri Lanka.

Keywords: Plastic pollution, Coastal debris accumulation, Coastal environment, Pollution sources, Anthropogenic activities

A Study on Identification of a Suitable Alternative for Asbestos Fibers

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Asbestos is a widely used roofing material in the construction field all over the world. In Sri Lanka, 85% of people use asbestos as a roofing material. According to the World Health Organization, fibers including in asbestos is one of the most harmful occupational carcinogens. Therefore, the government of Sri Lanka wanted to ban asbestos roofing sheets from 2018 in Sri Lanka which has not been successful. The main objective of this study was to find out the suitable alternative for asbestos fibers. Fibers of coir, bamboo, corn skin and polythene of rice sacks were considered as alternative materials that can be collected easily. Two samples were taken for each fiber type by changing fiber proportion and testing was carried out to check the breaking load, density, water absorption, and resistance to acidified water of the sheet. All the testing procedures were carried out according to the Sri Lanka Standards Institute specifications on corrugated asbestos sheets. This study indicated that the polythene of rice sacks has reached the breaking load up to 7.51 kN m^{-1} while the density of is 2946.6 kg m^{-3} . The water absorption percentage was 12.9% and resistance to acidified water was 0.024 kg m^{-2} . According to the Sri Lanka Standards Institute, even asbestos sheets also have a breaking load of 5 kN m^{-1} while the density of the sheet should not less than 1200 kg m^{-3} . Water absorption should not exceed 28% of the dry mass and resistance to acidified water test should not be more than 1.15 kg m^{-2} . The above results narrate that the polythene from rice sacks can be utilized as a good substitute for asbestos fibers which meets Sri Lanka Standards Institute standards. This study furthermore indicated that all test specimens except polythene fiber failed the breaking load test due to shorter fibers length. Shorter length fibers reduce the bonding between quarry dust, cement, and fibers. With the use of micro and lengthy fibers, these alternatives can be developed in the future.

Keywords: Asbestos, Alternative, Fibers, Corn, Bamboo

Phenanthrene Degradation Ability of *Bacillus* sp. Phyllosphere Bacteria Inhabiting the Urban Areas in Sri Lanka

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Remediation of phenanthrene from the environment is essential since its toxic effect. Out of many remediation methods, bioremediation is the most eco-friendly and effective method which can be used to convert toxic substances to nontoxic. There are many phyllosphere microorganisms which have the capability in phenanthrene like polyaromatic air pollutant degradation. This attempt is to isolate, select, and identify the efficient phenanthrene degrading bacteria. Bacteria were isolated using specific leaf samples collected from Panchikawatta, Orugodawatta, Pettah, Maradana, Colombo Fort, and Sapugaskanda in Sri Lanka. Phenanthrene degradation ability of isolated bacteria was screened using plate assay. Phenanthrene degradation ability of each bacterial species was analysed using the UV-Vis spectrophotometer and HPLC. The selected bacterial isolates were identified up to species level by PCR amplification of a fragment of 16S rRNA gene and sequencing the amplified fragments using the primers 1492R and 27F. Four *Bacillus* species *Bacillus* sp. P₂B-02, *Bacillus velezensis*, *Bacillus* sp.1, and *Bacillus megaterium* were able to degrade more than 40% of phenanthrene. Out of these bacteria, *Bacillus* sp.1 (MN190173) was the most efficient bacterial species which was highly capable of degradation of phenanthrene. The *Bacillus* sp. could be useful as a potential biological agent in bioremediation for polluted environments with phenanthrene like polyaromatic hydrocarbons.

Keywords: Phyllosphere, Aromatic hydrocarbon, Bioremediation, Phenanthrene

Antimicrobial Activities of Different Microbial Consortia Developed from Endophytic Fungi and Soil Bacteria

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Microbial combinations are a major source of novel and diverse bioactive compounds with a variety of biotechnological potentials. The present study aimed at developing fungal-bacterial biofilm and evaluating the antimicrobial effect of the biofilm combinations. Nine endophytic fungi were isolated from the leaf section of *Murraya koengii* plant and sixteen soil bacteria were isolated from local forest reserve soil. Antagonistic activity of isolations was evaluated against *Escherichia coli* and *Cladosporium cladosporioides* separately under dual culture technique. Antibacterial and antifungal effects of ethyl acetate extracts of the selected isolates were performed using the disk diffusion method against *Staphylococcus aureus* and *C. cladosporioides*. The best bacterial and fungal isolates, having high antimicrobial activities from disk diffusion assay were combined to develop initial 6 biofilms namely BF1 to BF6. The ethyl acetate extracts of the best attachment biofilms (BF1, BF2, BF5, BF6) were evaluated for their antimicrobial activities and compared with their mono-cultures. Out of all isolates, three bacterial (B1, B2, and B3) and two fungal (F1 and F2) isolates showed higher responses for the antagonistic activity. Out of five microbial extracts, two bacterial (B1 and B2) and all fungal extracts showed positive responses for the antimicrobial assays. Microscopic observations confirmed the successful formation of four biofilms (BF1, BF2, BF5, BF6) and three biofilm extracts showed positive responses for antibacterial activity through disk diffusion assay. Out of all biofilm combinations, BF6 showed the highest antibacterial and antifungal effects. B2 bacterial extract showed the highest significant ($p < 0.05$) antibacterial activity and the F1 fungal extract showed the highest significant ($p < 0.05$) antifungal activity. Therefore, these findings conclude that the biofilms are a potential source for bioactive compounds and may find the potential to use as antimicrobial compounds.

Keywords: Antibacterial activity, Antifungal activity, Microbial biofilm, Endophytic fungi, Soil bacteria

Phytoplankton Diversity in Six Major Reservoirs of Badulla District, Uva Province, Sri Lanka

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Phytoplanktons are major primary producers and act as a bioindicator in inland waters. The present study investigated the phytoplankton species composition of six reservoirs (Ulhitiya, Rathkinda, Mapakada, Nagadeepa, Dambarawa, and Sorabora) with highest inland fish production in Badulla district. Samples were collected using a plankton net (60 µm mesh size) from five sampling points of each reservoir during November 2019-January 2020. The taxonomical status of collected samples was identified using previous literature records, standard pictorial guides (The Genera of the Freshwater Algae of Sri Lanka). Biodiversity indices were calculated to identify the variations of phytoplankton diversity among sampling points and reservoirs. Total of 41 phytoplankton species belonging nine major taxonomic classes; Bacillariophyceae (10), Chlorophyceae (10), Cyanophyceae (08), Zygnemaphyceae (06), Euglenophyceae (02), Fragilariophyceae (02), Chrytophyceae (01), Xanthophyceae (01), Dinophyceae (01) were recorded. Diatoms (Bacillariophyceae) recorded the highest relative abundance (61.57%) from selected reservoirs. Sampling points of each reservoir had no significant effect ($p>0.05$) on the phytoplankton diversity while it showed a significant effect ($p>0.05$) on phytoplankton diversity among reservoirs. The highest Shannon-Wiener index (1.61 ± 0.06), Simpson's Index (0.71 ± 0.01), evenness (0.52 ± 0.024) and richness (21 ± 1.62) were reported from Dambarawa, while lowest Shannon-wiener index (1.25 ± 0.19), Simpson's index (0.59 ± 0.08), evenness (0.42 ± 0.19) and richness (19 ± 0.89) resulted for Ulhitiya Reservoir. The current study reveals that *Aulacoseira* sp, *Microcystis* sp, *Pediastrum* sp, *Staurostrum* sp, *Arthrospira* sp shows the highest abundance in all six reservoirs. Dominant species play a vital role as primary producers, bioindicators (*Aulacoseira* sp, *Microcystis* sp), and feed (*Staurostrum* sp, *Arthrospira* sp) for fish. Due to the high abundance of *Microcystis* sp. (51.58%) in the Ulhitiya reservoir, the potential to generate toxic algal blooms was identified by the current study. In conclusion, this study identified the dynamic phytoplankton community and dominant species which act as the major autotrophs in studied reservoirs. Further, data collected could be used as the baseline information for the aquatic ecological studies and inland fishery enhancement programs

Keywords: Shannon-Wiener index, Simpson's index, Biodiversity, Inland fishery, Primary producers/autotrophs

Assessment of Macroalgae Diversity along the Economically Important Southern Coastal Zone of Sri Lanka during North East (NE) Monsoon Period

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Southern coastal zone acts as a highly productive ecosystem with rich macroalgae diversity. However, limited scientific studies have been conducted on macroalgae diversity in the southern coastal belt of Sri Lanka. The current study is focused on the assessment of the intertidal, macroalgae diversity along this coastal belt. This study was conducted using systematic sampling technique along the intertidal zone at 12 selected regional coasts (Hambantota, Godawaya, Rekawa, Tangalle, Dickwella, Polhena, Mirissa, Weligama, Unawatuna, Galle Fort, Dodanduwa and Hikkaduwa) representing three districts (Hambantota, Matara, Galle) of the southern province during NE monsoon period (December 2019 to February 2020). NE monsoon period was selected to minimize the climatic effects during sampling in different seasons. Macroalgae species were taxonomically identified using the recommended pictorial guides and literature records. Oneway Analysis of Variance (ANOVA) was employed to identify the variations of macroalgae diversity with sampling location ($p < 0.05$). According to the results, a total of 26 macroalgae species (10 belong to Chlorophyta: >38% richness, 10 in Rhodophyta: >38% richness, and 6 from Phaeophyta: >23 % richness) were identified in this coastal belt. Ecologically dominant species belong to division Chlorophyta out of all the sampling sites. Shannon-Wiener biodiversity index (H') of the macroalgae in respective ecosystems significantly changed with sampling locations ($p < 0.05$). The spatial variation pattern of biodiversity is correlated with unsustainable anthropogenic activities and natural factors. Shannon-Wiener biodiversity index (H') ranged at 0.67-2.59 in the study sites. The highest composition of macroalgal species (20) was recorded from the Godawaya site due to the minimum anthropogenic effect. Mirissa (02) and Dodanduwa (01) regions had the lowest macroalgae species richness and commercial activities were relatively higher along these coastal zones compared to all other sites. Accordingly, macroalgae act as the biological indicators reflecting the health status of respective ecosystems. So, the findings of this study would be important to identify the quality of the coastal zones and apply appropriate coastal conservation and management measures in the future. Also, the commonly recorded macroalgae species which belong to Chlorophyta and Rhodophyta can be sustainably utilized in processing value-added foods and other products. In conclusion, this study reveals the current status of macroalgae diversity on the southern coast during the NE monsoon period and detailed investigation of species composition is strongly recommended throughout the year.

Keywords: Biodiversity assessment, North east monsoon, Macroalgae, Intertidal zone, Coastal ecosystems

Variability of Unsaturated Hydraulic Conductivities of Landslide Risky Soils in Uva Province of Sri Lanka

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Localized slope failures resulting in massive landslides can occur during the rainy season in the central highlands of Sri Lanka. The objective of this research was to measure and assess the variability of the field hydraulic conductivities using a minidisk tension infiltrometer. The selected sites were located in Uva Wellassa University of Sri Lanka, *Haputale*, *Haldummulla*, and *Meegahakiula* which are located in the Uva province of Sri Lanka. Using the minidisk infiltrometer, infiltration rates were measured for soil depths of 0-5, 30-35, and 60-65 cm under suction levels of -3, -2, -1, and -0.5 cm. Soil core samples were collected to measure bulk densities of respective soil depths while the soil textural class was identified using the simple method of feeling by hand. The field moisture content was measured using the oven-dry method. Sieve analysis was performed to identify particle size distribution and coefficient of uniformity. Field hydraulic conductivity values were calculated using infiltrometer readings with respect to each suction rate and soil texture class for all three depths. Textural classes of tested soils were identified as clay loam to sandy clay loam and the coefficient of uniformity value is ranging from 4.4 to 6.8. The gravimetric moisture content of soil samples ranged from 0.021 to 0.233 g g⁻¹ for all sites and bulk density ranged from 1.0 g cm⁻³ to 1.5 g cm⁻³. The highest unsaturated hydraulic conductivity $6.9 \times 10^{-5} \text{ m s}^{-1}$ was observed in *Meegahakiula* soil at -0.5 cm suction at a gravimetric moisture content of 0.212 g g⁻¹ for 60-65 cm depth. The lowest hydraulic conductivity $1.0 \times 10^{-6} \text{ m s}^{-1}$ was observed in the Uva Wellassa University site at -3 cm suction at a gravimetric moisture content of 0.040 g g⁻¹ for 0-5 cm depth. Identifying relationships between hydraulic conductivity and the soil properties individually and developing prediction equations to demarcate landslide risky areas are expected to be done in the future.

Keywords: Slope failure, Hydraulic conductivity, Suction, Minidisk infiltrometer

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Effect of α -pinene on the Soil Bacterial and Fungal Population and Soil Organic Carbon and its Variation with the Stand Age of *Eucalyptus grandis* Plantations.

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Eucalyptus is one of the most commonly established plantation forests in the world. However, they emit α -pinene which is known to have allelopathic characteristics that suppress the microbial activities. Therefore, organic matter decomposition rates could be affected by α -pinene in plantation soil which may lead to higher carbon sequestration in soil. Further emission of α -pinene could be affected by the stand age of the plantation. To investigate these the present study of the relationship between soil α -pinene content, microorganisms, and organic carbon (OC) content in 30,13 and 4 -year-old *Eucalyptus grandis* plantations were studied. As the control plantation, an adjacent Patana grassland (previous land-use before afforestation) was used. Three plots (20 × 20 m) were established within each site and 12 soil samples from each site were collected from 30 cm depth. Soil OC content was measured using the Walkley-Black method and microbial counts were taken using the pour plate method. The α -pinene in soil samples were analyzed using GC-MS. The highest OC content was observed in 30-year-old *E. grandis* plantation (3327.09 Kg) and interestingly the lowest bacterial and fungal populations (2.15×10^3 CFU mL⁻¹ and 1.07×10^3 CFU mL⁻¹) and the highest α -pinene content ($(0.47\% \pm 0.09)$) were recorded in the same. There were significant positive relationships between stand age and α -pinene and OC in soil (Pearson correlation value 0.982, 0.913; $p < 0.05$). The OC had shown a significant negative relationship with the bacterial and fungal population (Person correlation 0.669, 0.653, $p < 0.05$). The results showed that with the stand age, α -pinene content in soil increases and affects negatively on microbial populations which results in higher OC content in the soil. Therefore, we can conclude that as *Eucalyptus grandis* plantations ages they support soil carbon sequestration and the findings could be useful in promoting the minimizing of atmospheric CO₂ level.

Keywords: *Eucalyptus grandis*, Stand age, α -pinene, Organic carbon, Carbon sequestration

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Performance Evaluation of Electro-Coagulation Process Using Different Electrodes for Removing Hardness from Drinking Water

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The presence of hardness in water is problematic when it comes to water treatment. Many different removal methods are in use for removing hardness from the water. However, each has its advantages and disadvantages. Amongst those, electrocoagulation has gained much attention as it outperforms other methods due to its simple and fast process. This study aims to investigate optimum pH and retention time to achieve maximum removal of hardness using the Electrocoagulation process using an aluminum anode and an iron cathode. The electrode area, the distance between two electrodes, and potential differences in the Electrocoagulation process were kept constant during all the experiments as in 30 cm², 5 mm, 20 V respectively. The concentration of hard water, 500 ppm was synthetically prepared to mimic the concentration of hardness in groundwater in the Jaffna peninsula. The prepared solution was filled into the container and the Electrocoagulation process was run with changing initial pH and retention time. At the end of the experiments, the hardness of the water samples was measured by using EDTA titrimetric method. Experimental results showed a maximum hardness removal efficiency of 84% at initial pH 8.5 during 60 minutes retention time.

Keywords: Hardness, Electrocoagulation, Aluminum anode, Iron cathode, Jaffna Peninsula

Diversity, Stand Density and Structure of Mangroves in Panama Lagoon, Sri Lanka

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This study was undertaken to estimate the diversity, stand density, and structure of mangrove flora in Panama lagoon which has identified as a location with rich mangrove vegetation in Ampara district, Sri Lanka. Six sites covering the whole lagoon were assessed using the transect line plots method by laying three transect lines perpendicular to the shoreline at each site which was varying from 10 m to 40 m in length. The number of mangrove species with the distance from the shore including their diameter (cm) and height (m) were recorded. The individuals were categorized as trees, saplings, and seedlings based on their diameter. The in-situ parameters of soil pH, temperature, and salinity were measured. Five true mangrove species belong to families of Avicenniaceae (*Avicennia marina*), Rhizophoraceae (*Rhizophora mucronata*, and *Bruguiera sexangula*), Combretaceae (*Lumnitzera racemosa*) and Euphorbiaceae (*Excoecaria agallocha*) were recorded. *Avicennia marina* was the most dominant species with the Importance Value of 68.65. The stand density of 475 individuals/ha represented 56% of tree density, 19% of sapling density, and 25% of seedling density. The greatest Shannon-Weiner diversity (1.79) was recorded in site 03 while site 06 recorded the highest Simpson's Diversity Index (0.83) and Pielou's Evenness Index (0.98). Site 05 obtained the highest Margalef's Species Richness (1.83). Highest Basal Area of 70.28m²/ha in site 01 confirmed the undisturbed nature of mangroves. There was a negative linear relationship between distance from the shore and average salinity ($p < 0.05$) and a positive linear relationship between salinity and mangrove abundance ($p < 0.05$). The cluster analysis depicted the highest similarity of 90.81 for site 03 and 06 based on diversity. *Lumnitzera racemosa* and *Excoecaria agallocha* showed the highest similarity (84.14) based on dominance and density. The results indicated the pristine nature of Panama lagoon with high biological diversity of mangrove flora.

Keywords: Panama lagoon, Mangrove flora, Dominance, Stand basal area

Comparative Assessment on Non-Indigenous Biofouling Species in Colombo Harbour Basin with Ships Arrive to the Colombo Harbour

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Introduction of non-indigenous aquatic organisms to the new environments through ships biofouling has been identified as a major threat to world oceans and for the conservation of biodiversity. As an island nation with intensive shipping activities, there is a high possibility to introduce invasive species into Sri Lanka through ships biofouling. It is imperative to identify and assess the fouling related invasions in Sri Lankan waters to adopt necessary control measures. This study examined the biofouling related invasion in Colombo port with a view of adopting control measures. The study was undertaken between October 2019 to January 2020 in Colombo port. The hard substrate samples were collected monthly basis from eight sampling locations. The artificial settlement plates were deployed to collect benthic fouling samples. Samples were collected from the ship's hull which arrived at the Colombo port from various regions of the world. 93 biofouling creatures were identified up to their family level and 83 up to their species level. 51% nonindigenous, 35% native, and 4% cryptogenic fouling species were detected. 33 native fouling organisms were detected from all samples. Relative abundance, diversity indices, species richness, and evenness were calculated. Mean relative abundance varied with 0.0169 to 0.0579. *Amphibalanus ampurite* the most abundant species on ship's hull while *Saccostrea cucullata* was the most common species at harbour sites. The exotic species of *Chathamalus montagui* was recorded for the first time in Colombo harbour. The five globally known invasive alien species introduced through ships were recorded. Results imply that some invasive biofouling species had already settled in the harbour basin area and ships arrive in Colombo port poses a risk of introducing invasive species into Sri Lanka waters. This study suggests that it is exigent to adopt relevant international guidelines to mitigate the threat of introducing invasive species through ship biofouling.

Keywords: Invasive alien species, Biofouling, Colombo port, Ship's hull, Introducing

The Effectiveness of the Particle Sizes of Rice Husk Powder and Clearing Nut Seed Powder for Removal Efficiency of Cd (II) from Wastewater

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Biomaterials are considered as efficient removers of heavy metals from wastewater through biosorption. The main goal of this study was to investigate the effect of particle sizes of Rice Husk Powder (RHP) and Clearing Nut Seed (*Strychnos potatorum*) Powder (CNSP) for the removal efficiency of Cd (II) in synthetic wastewater. Rice husks collected from the Badulla area were thermally treated at 200°C for 3 hours and clearing nut seeds collected from the same area were dried at room temperature for 7 days and powdered. Batch experiments were conducted to study the effect of particle sizes of biomaterials (0.5-1.0 mm, 150-500 µm, <63 µm) and contact time (2, 4, 6 hours) in removal efficiency by keeping other factors at constant (Adsorbent dosage = 1.5 g, pH = 5, Cd(II) initial concentration = 100 ppm, Cd(II) volume = 50 ml, Temperature = 25±2°C, Agitation speed = 150 rpm). The characterization of the materials before and after treating with Cd (II) was analyzed using SEM, FT-IR, XRD, and XRF. The characterization analysis revealed that both are fibrous in nature and rich in SiO₂. The results of the study showed a linear positive strong correlation between removal efficiency and reducing particle size for both materials ($p < 0.05$). The lowest particle size (<63 µm) of RHP and CNSP showed higher removal efficiency except for the mixture of materials and they were 84.12% & 78.74% respectively. The highest removal efficiency (85.12%) was obtained for 1:1 mixture of the materials with the particle size <63 µm at the contact time of 4 hours. The reduction of FT-IR peak intensity for Si-O after the treatment confirms the participation of functional groups in metal binding. SEM images confirmed the changes in surface morphology of materials after the treatment. In conclusion, a decrease in particle size causes an elevation in removal efficiency of Cd (II) due to the presence of large surface area for biosorption and 1:1 mixture of RHP and CNSP is an efficient biomaterial for Cd (II) removal.

Keywords: Rice husk powder, Clearing nut seed powder, Particle size, Cadmium, Removal efficiency

Designing a Wastewater Treatment Plant for the Wastewater Discharge from Seafood Market

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Seafood is the main interest in the coastal areas; hence seafood markets are centralized towards the city and highly crowded place. A seafood market includes many varieties of fishes, crabs, clams, prawns, lobsters, cuttlefish, etc. from saltwater as well as from freshwater. In general, wastewater generation from the seafood market is not given much attention and thus, lack of awareness about the problematic factors associated with that. The wastewater from this mainly contains blood, shells, fines, fish heads, offal products, and detergents used for cleaning and washing. In this study, the wastewater generated from the seafood market in Trincomalee was investigated. The wastewater characterization was done for 5 months. The results of the wastewater characterization showed that the average value of pH, Total Suspended Solids (TSS), Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) were 7.62, 195.2 mg L⁻¹, 870.20 mg L⁻¹, and 88.20 mg L⁻¹, respectively which are exceeding the tolerance limit set by Central Environmental Authority of Sri Lanka. The oil and grease, nitrate, and phosphate are within the tolerance limit set by the Central Environmental Authority of Sri Lanka. The BOD: COD ratio was 0.1, which implies that the wastewater is less biodegradable, and biological treatment is not suitable in this case. The design of the wastewater treatment plant was proposed with chemical coagulation as a pre-treatment. Bar rack was placed as a preliminary treatment, then equalization tank was designed to control the flow variation, next the coagulation tank was followed by a clariflocculator. Finally, the design of the wetland with aerated Hyacinth system with recycle was proposed. Additionally, COD removal efficiency was checked with bio sorbents prepared using Water Hyacinth and Rice husk.

Keywords: Sea food market wastewater, Wastewater characterization, Designing wastewater treatment plant

Effect of Contact Time and Adsorbent Dose on Limestone for Removal of Total Dissolved Solids from Industrial Wastewater

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Commonly the food processing industry consumes a huge amount of water. Food industry effluent characterizes high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), fats, nutrients, oil, and grease. Fish processing wastewater mainly shows high TDS due to releasing of blood, small pieces of fishes, and chemicals at the filtering, cooling, washing, cooking, pre-cooking, and thawing steps. High TDS can be interference for wastewater treatment steps like biological treatment and this situation, a cost-effective pre-treatment is suitable. Adsorption theory has also been used in previous researches to remove TDS, and in this research, the effect of contact time and adsorbent dose were investigated to remove TDS from fish processing wastewater. A batch test was performed using limestone as an adsorbent. Wastewater samples were kept at pH 7 using 0.1 N HNO₃ and 0.1 N NaOH. Using sieve shaker, ≥ 0.063 mm, ≥ 0.125 mm, ≥ 0.15 mm, ≥ 0.5 mm, ≥ 1 mm, ≥ 2 mm and ≥ 3.14 mm particle sizes were separated. As ≥ 1 mm particle recorded highest removal efficiency as 83.85% (adsorption capacity 1297.5 mgg⁻¹). ≥ 1 mm particle was used for remaining experiments. When increasing contact time, the highest removal efficiency was recorded at 5-hour contact time as 72.55%. When increasing adsorbent dose, the maximum removal efficiency was recorded at 4 g L⁻¹ as 79.64%. The results indicated that the removal efficiency of TDS depends on the adsorbent dose and contact time. Though, limestone is an alkaline material because of containing CaCO₃ as a predominant material, with no high increment of pH in the wastewater sample after adsorption. Adsorption data also fitted with Langmuir Isotherm and according to results, this can be indicated as favourable adsorption.

Keywords: Food processing industry wastewater, Limestone, TDS, Adsorption

Applicability of Grumusol Soil to Remove Cadmium from Textile Wastewater through Adsorption

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Heavy metals are well-known environmental pollutants. Today, it has become a serious problem in most of the countries in the world including Sri Lanka. The industrial sector can be considered as the major source of heavy metal pollution and in Sri Lanka, the textile industry has received a significant place. The processes like dyeing and finishing in textile manufacturing result in adding heavy metals into its wastewater. This generated wastewater typically contains environmentally harmful heavy metals like Cadmium. Failing to remove them properly will lead to accumulating them in surface water bodies and ultimately causing severe problems for human and aquatic ecosystems. Different methods have been tested for their suitability in removing heavy metals from wastewater amongst adsorption that has received much attention. For a country like Sri Lanka however, investigation of an economical, inexpensive, and safe method with having higher removal efficiencies is an essential and timely matter. The grumusol soil which can be easily found in Jaffna and Mannar districts in Sri Lanka has shown some special characteristics of a good adsorbent. The high cation exchange capacity, high clay fraction, high organic matter content, swelling and shrinkage properties, and the 2:1 clay mineral type bear evidence that it is worth to investigate the adsorption ability of grumusol soil. The primary objective of this study was to investigate the applicability of grumusol soil in removing heavy metals from aqueous solutions. In this study, cadmium (Cd^{2+}) ion was used as the selected heavy metal and the textile wastewater was used to check the adsorption ability of grumusol soil to remove Cd^{2+} . The equilibrium time and effect of pH were investigated using the batch method. The results indicated that grumusol soil can adsorb cadmium ions with higher efficiency. The reaction is pH-dependent and the adsorption capacity of the grumusol soil increases with the increment of pH from 2 to 7 and maximizes at pH 10. The highest removal efficiency of 97.66% was recorded at pH 10 during the optimum equilibrium time of 6 hours.

Keywords: Grumusol soil, Heavy metal pollution, Cadmium, Adsorption, Textile wastewater

Analysis of Quality of Water in Sludge Drying Bed and Reusing Sludge Generated in Bandarapura Water Treatment Plant in Brick Manufacturing

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The generation of large quantities of Aluminium rich sludge in the treatment process of Water Treatment Plants is an unavoidable problem all over the world. Aluminum sulphate and Aluminium chloride used as the coagulants in the water treatment process mainly cause for the sludge formation. Disposal of this Aluminium rich sludge in an economically and environmentally sustainable way is a major challenge faced by Water Treatment Plants. In Bandarapura Water Treatment Plant, after the dewatering process, dried sludge is being loaded on the ground beside the drying beds due to the lack of proper disposal facilities. This openly disposed of Aluminium rich sludge can cause hazardous effects to the environment as well as to the people. Hence, this urgently requires for a proper sludge disposal method to be in place and also for a feasible option for reusing the waste sludge. Studies have stated of reusing this waste sludge for brick manufacturing by combining with clay mixture after characterizing the sludge properties. Thus, the possibility of using sludge generated in Bandarapura Water Treatment Plants in Badulla in brick manufacturing was investigated in this study. Sludge percentages were increased from 0% to 20% with increments of 5%. Clay sludge mixing and brick preparation were done by hand pressing. Bricks were fired at two temperature batches as 850 and 1000 °C. Brick strength of 0.15 N mm⁻², water absorption of 13.06%, and Shrinkage of 0.4 cm were monitored. The bricks used for construction purposes require minimum brick strength of 2.0 N mm⁻² which is not achieved by the prepared brick in this study. Nevertheless, the prepared brick can be used as a substitute for Interlocks.

Keywords: Water treatment plant, Aluminium rich - sludge, Sludge disposal, Reusing sludge, Brick Manufacturing

Determination of Pectinase and Cellulase Activity of Fungi Species Isolated from Unsanitary Landfill in Badulla

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Municipal solid waste is one of the major sources for microbes having potent enzymatic activities. The positive impacts of such microbes could use for finding a suitable solution to overcome waste-related problems. The present study aimed at isolating and determining pectinase and cellulase activity of fungal strains living in unsanitary landfills. Fungi species were isolated in Potato Dextrose Agar medium. The isolated fungal strains were distinguished from each other by examining their morphological features through the light microscope after culturing them in slides. All fungal isolates were tested for cellulase and pectinase activities by using Carboxymethylcellulose and Vincent's agar plates respectively. The good diffusion method was used in both assays. The diameter of the clearance zone around the wells was measured after the incubation. Data were analysed by ANOVA in Minitab 17.1. According to the results, a total of 29 fungal species were isolated and coded from F1-F29. Among them, 21 species were positive for pectinase activity whereas 20 species were positive for cellulase activity. The significant ($p < 0.05$) mean diameter for pectinase activity was given by F22 (40 mm) and for cellulase activity by F9 (19 mm). Eight fungi isolates (F22, F16, F23, F9, F24, F25, F15, and F2) were shown both pectinase and cellulase activities. Thus, such cultures having positive pectinase and cellulase activities could be useful in organic waste management in unsanitary landfills. The fungal species having pectinase and cellulase activities yet to be identified.

Keywords: Unsanitary landfill, Fungi, Pectinase, Cellulase

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Proposing an Economical and Effective Treatment Process for Reverse Osmosis Concentrate in Brackish Water Desalination Using *Chlorella sp.*

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Currently, brackish water desalination is practiced through reverse osmosis technology as it utilizes lower energy for high and stable quality water products. Though it produces high-quality water, around 15-35% of raw water is discharged as a waste concentrate which is problematic in terms of environmental and economic aspects. This study is to propose a cost-effective as well as efficient method to treat Brackish Water Reverse Osmosis (BWRO) concentrate through exploiting *Chlorella sp.* Isolated *Chlorella sp.* was grown in photobioreactor where sunlight was used as a light source and concentrate was used as an inorganic carbon source. *Chlorella sp.* were inoculated at 15% (v: v) in 250 mL Erlenmeyer flasks and kept in rotation at 250 rpm without aeration. Algae were grown in three different concentrates separately in the batch model. The retention time of the batch model was 9 days in which on the last day maximal of 1.16 g L⁻¹ of biomass was produced. Total dissolved solids, electrical conductivity, alkalinity, total hardness, nitrate, and phosphate were able to remove with efficiencies up to 63.07, 63.42, 80.39, 74.36, 88.28, and 88.79% respectively. 1 m³ of concentrate was effectively treated in a surface area of 0.12 m² of the photobioreactor. Due to the lack of discharge standards for reverse osmosis concentrate, the treated water quality of concentrate was compared with its feed water to check whether discharging in to surface water bodies and recycling is possible. The comparison studies showed that concentrate with high salinity, hardness, and alkalinity approximately met its feed water quality after batch model treatment which is harmless on discharge.

Keywords: *Chlorella sp.*, Brackish water reverse osmosis concentrate, Inorganic ion removal, Nutrient removal

Understanding the Effect of Unsaturated Hydraulic Conductivity of Surface Soils on Landslide Triggering: A Case Study in *Yahalabedda* Landslide Risky Area, Sri Lanka

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Hydraulic conductivity (K) is one of the most important soil properties for rainfall-induced landslide triggering. *Yahalabedda* receives higher rainfalls in Northeast and Southwest monsoon seasons and considered a potential landslide risky area in Sri Lanka. The objective of this study was to evaluate the unsaturated K (K_{unsat}) of surface colluvium soils using a minidisk tension infiltrometer together with relevant basic soil properties. Field investigations were conducted at three soil depths; 0, 30, and 60 cm of a prepared soil profile in September 2019. The infiltration test was conducted at each soil depth using three tension levels of -0.03, -0.02, and -0.01 m. The K_{unsat} has been calculated using the $K_{unsat} = C_I/A$, where C_I is the slope of the curve of the cumulative infiltration versus the square root of time, and A is a value relating the van Genuchten parameters for a given soil type to the suction rate and radius of the infiltrometer disk. K_{unsat} increased with the soil profile depth for each tension value. K_{unsat} values for -0.03 m tension, are 1.35×10^{-6} , 2.62×10^{-6} and $7.77 \times 10^{-6} \text{ m s}^{-1}$; for -0.02 m tension, are 2.13×10^{-6} , 3.91×10^{-6} and $1.02 \times 10^{-5} \text{ m s}^{-1}$ and for -0.01 m tension, are 4.23×10^{-6} , 7.86×10^{-6} and $1.42 \times 10^{-5} \text{ m s}^{-1}$ for 0, 30 and 60 cm depths, respectively. K_{unsat} increases with decreasing the tension values at each depth as expected. 0 and 30 cm depths show nearly the same bulk density (1.0 g cm^{-3}), while the 60 cm depth shows higher bulk density (1.1 g cm^{-3}). The soil texture is clay loam for the entire soil profile while the uniformity coefficient (C_u) is higher (6.8) in upper soil resulting in a lower chance to interlock between soil particles and higher pore spaces. As the K_{unsat} increases with the depth, more water will be percolated to deeper soils resulting in the increasing soil weight in deeper soils and the landslide risk. The study reveals that *the Yahalabedda* area has a threat to landslide triggering in rainy seasons.

Keywords: Minidisk tension infiltrometer, Hydraulic conductivity, Infiltration, Landslide risky soils

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Isotherm Models for Aqueous Manganese (II) Adsorption by Bamboo Wood Based Activated Carbon

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The adsorption is considered the most effective technology for the removal of contaminants from water. The production of low cost, efficient and eco-friendly adsorbents is a growing concern, and activated carbon is considered a viable solution. In this study, bamboo which is an abundant and inexpensive material was used to prepare activated carbon, and adsorption of Mn (II) onto bamboo wood activated carbon (BAC) was investigated. BAC was prepared by chemical impregnation with KOH at a 1:1 ratio followed by pyrolysis at 800 °C for 2 hours. Adsorption isotherm of the Mn (II) onto BAC was determined and correlated with Langmuir and Freundlich isotherms. A Commercial Activated Carbon (CAC) was used as a reference. The experimental data at optimum conditions (pH=6-7, adsorbent dose = 5g/L, contact time - 5 hours) for BAC shows a better fit with Langmuir model ($R^2=0.9960$) than Freundlich model ($R^2=0.9740$), whereas CAC shows a better fit with Freundlich model ($R^2=0.9815$) than Langmuir model ($R^2 = 0.9720$). The Langmuir constant (KL) and adsorption capacity (Qm) were calculated with graphical data. KL is 0.2940 mg⁻¹ for BAC and 0.7740 mg⁻¹ for CAC, which implies BAC has a higher affinity than CAC between adsorbent and adsorbate. Qm was 0.9620 mg g⁻¹ for BAC and 2.259 mg g⁻¹ for CAC. For Freundlich model experimental data, the Freundlich constant (KF) and adsorption intensity (1/n) was calculated and it results in KF of 0.5350 mg g⁻¹ for BAC and 2.929 mg g⁻¹ for CAC. The 1/n values are 0.4358 and 1.162 for BAC and CAC respectively which BAC indicates more favourable adsorption than CAC. Mn (II) is found to adsorb strongly on the surface of activated carbon and adsorption behavior is described by a monolayer, homogeneous Langmuir type isotherm. The present investigation showed that bamboo can be effectively used as a raw material for the preparation of activated carbon for the removal of Mn (II) from aqueous solutions.

Keywords: Bamboo, Activated Carbon, Langmuir, Freundlich, Manganese

Isolation of Fenobucarb Resistant Bacteria from Agricultural Soils in Belihuloya, Sri Lanka

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Pesticides are extensively used in controlling pests globally as well as in Sri Lanka, and many of these pesticidal compounds are nuisances of the natural ecosystem. But, some soil microbes immensely help in biodegrading the pesticide residues, enabling the pesticides to be less harmful. Fenobucarb is one of the extensively used carbamate insecticides in Sri Lanka. The objective of this study was to isolate resistant soil bacteria against Fenobucarb in agricultural soils. Three pooled soil samples were collected from three selected farming lands located in the Belihuloya area where Fenobucarb is used continuously in crop cycles. Each sample was grown on M9 minimal salt medium supplemented with 100 ppm Fenobucarb at 28 °C for 2-3 days. Seven well-grown single colonies were isolated and subcultured on the same medium supplemented with 100, 150, 200, 300 ppm Fenobucarb separately. Four out of the seven isolates were able to grow in all the concentrations of the pesticide. From the other three isolates, one was able to grow in 100 and 150 ppm while the other two showed their growth only in 100 ppm concentration of the pesticide. One out of four isolates that grew in all the pesticide concentrations didn't show any growth on control (M9 minimal salt medium without the pesticide). One out of two isolates that grew only in 100 ppm concentration also did not show any growth in control. However, the other five isolates exhibited very small colonies on control as well. These results support the fact that some soil bacteria can utilize pesticides as their sole carbon source. According to the above results, the study concludes that some isolated soil bacteria can resist up to the concentration of 300 ppm Fenobucarb being potential bioremediation agents for decontaminating the polluted sites.

Keywords: Fenobucarb, Bioremediation, Soil Bacteria, M9 minimal salt medium

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Applicability of Using Rice Husk for Fluoride Removal from Drinking Water in Anuradhapura, Sri Lanka

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Finding low cost, environmentally friendly adsorbents with having higher removal efficiencies are vital to improve the quality of drinking water in the regions where groundwater is contaminated with fluorides. In Sri Lanka, this problem is apparent and has been prevailing especially in the north-central province. Rice husk is claimed to have better fluoride removal when used as an adsorbent. As a country known for its paddy cultivation, the waste material of it, the rice husk would be cheaper if can be used as a filter material. Therefore, this study was sought at investigating the efficiency of rice husk as a filter material in removing fluoride from groundwater. For that, bio-waste rice husk was converted to activated carbon by thermal activation and through merely treating with H_3PO_4 . Characterization of Rice Husk Activated Carbon (RHAC) was carried out using the following methods: Fourier Transform Infra-Red (FT-IR), physical properties such as moisture content, ash content, and bulk density were also determined. FT-IR analysis showed the presence of various functional groups such as $C=O$, $C=C$, $-OH$, and $C-H$ on the surface of the adsorbent. Moisture content, ash content and bulk density were found to be $5.32 \pm 0.06 \%$, $15.28 \pm 0.22\%$, $535 \pm 0.51 \text{ kg m}^{-3}$ respectively. The effect of contact time and initial concentration were studied. Fluoride equilibrium time was found to be 120 minutes. Adsorption of Fluoride fits the Langmuir isotherm. Fluoride adsorption experiments were performed on the laboratory-scale column. The parameters obtained from the laboratory scale column were used to build the packed bed column using a scale-up approach. 10.0 g of RHAC has the capacity of attaining 83% of fluoride removal for the initial concentration of 10 mg L^{-1} .

Keywords: Rice husk activated carbon, Fluoride, Langmuir isotherm, Packed bed column

Development of a Fluorescent *in situ* hybridization assay (FISH) for the diagnosis of Velocardiofacial Syndrome (VCFS) in Sri Lanka

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Velocardiofacial Syndrome is associated with orofacial clefting, congenital heart defects, and developmental delay. It is caused by a 3Mb deletion of chromosome 22q11.2. The gold standard test is FISH but using commercial probes incurs high costs which are beyond the means of most patients. This study was aimed at developing a FISH based assay. Bacterial Artificial Chromosome (BAC) clones (FISH mapped and end-sequenced) spanning a region within the deleted and control regions were identified using publicly available databases and obtained from BACPAC Resource Center, Children's Hospital Oklahoma, USA. Bacterial cultures of the BAC clones, RP11-1057H19 (173,947bp) for the target region (22q11.2), and CH17-338N2 (205,938bp) for the control region (22q13.3) were grown and plasmid DNA was prepared using optimized methods. The isolated BAC DNA was further confirmed by PCR using 3 sets of primers spanning the two regions. BAC DNA (target and control) were fluorescently labelled by degenerate oligonucleotide PCR (DOP-PCR) using Fluorescein-12-dUTP (Green) and Chroma Tide Alexa Fluor 546-14-dUTP (Orange) respectively. The labeled DNA was purified by size exclusion chromatography and a small aliquot run on an agarose gel and visualized. If necessary, the labeled DNA fragments were DNase treated using an optimized protocol to obtain labeled fragments in the range of 200-500bp. The labeled DNA probes were used to perform FISH analysis of prepared metaphase spreads from three patients whose samples had already been tested using a validated, commercial probe. One patient had a deletion in the target region while two were negative. These results were in agreement with those obtained using commercial probes. The developed FISH probe can distinguish deleted from non-deleted cases. The preliminary data supports this as a useful diagnostic test for VCFS. Analysis of more samples is ongoing.

Keywords: Fluorescent in situ Hybridization, Velocardiofacial syndrome.

Modification of Nutrient Agar Medium to Culture Un-culturable Bacterial Strains Living in Unsanitary Landfills

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The decomposition of municipal solid waste is mediated by native microorganisms and it is essential to estimate the participating microorganisms to accelerate the decomposition of waste material. However, 99% of bacterial species remain unculturable in the standard Nutrient Agar (NA) medium. This research was focused on the modification of the NA medium to mimic the composition of the natural substrate where they live. Conventional NA medium was modified by adding separately 40% (M1), 32% (M2), 24% (M3), 16% (M4), 8% (M5) (v/v) of soil extracts obtained from the dumpsite. The Conventional NA medium was the control. Random soil samples were collected from the garbage dump and bacterial species were isolated in each modified medium. The isolated bacterial cultures were air-dried under aseptic conditions and powdered. To characterize them, Fourier Transform Infrared (FTIR) spectra were recorded for all bacterial samples in the 500 - 4000 cm⁻¹ region at 4 cm⁻¹ resolution by scanning 120 times. The average of the absorbance of each FTIR spectrum was used as variables of the distance matrix of the cluster analysis (Minitab 19). A total of 103 bacterial strains were isolated and 9 bacteria samples showed a similarity level of more than 98%. The 20, 14, 16, 16, 18, and 19 bacteria species were isolated from the modified media M1, M2, M3, M4, M5, and the control, respectively. According to the cluster analysis, six clusters were obtained. Cluster 1 was the largest and it consisted of 45.63% of the total bacterial isolates from M1, M2, and the control. Cluster 2 consisted of 30.10% of total isolates from M4-M5. All the other isolates were clustered in clusters 3, 4, and 5. The separate clustering of the isolated bacteria in the modified media showed dissimilarity among them, thus indicating the potential of the soil extracts to modify NA to culture un-culturable bacterial strains living in unsanitary landfills.

Keywords: Unculturable bacteria, Soil extracts, FTIR

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The Potential Use of Reverse Osmosis Concentrate as Water Source for Irrigation

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Reverse Osmosis (RO) membrane technology is one of the promising techniques used to provide safe drinking water to the community, particularly chronic kidney disease of unknown etiology (CKDu) affected areas in the dry zone of Sri Lanka. The rejected water from the RO plant is known as the RO concentrate, which is generally released to the environment without any beneficial use. The main objective of this study was to identify the potential use of RO concentrate as irrigation source water. Therefore, water samples were collected from different capacities of RO plants varying from household to commercial, and the selected area was the North Central province and North Western province, the total number of RO plants were fifty. The essential irrigation water quality parameters for agriculture were tested to determine the characteristics of RO concentrate. pH, electrical conductivity, total dissolved solids, alkalinity, carbonate, bicarbonate, nitrate, and phosphate were measured. Furthermore, the concentration variation maps were plotted (using ArcGIS 10.5) to identify the spatial variation of RO concentrate. Finally, the findings were compared with existing irrigation water quality standards provided by the United States Food and Agriculture Organization (FAO), and Agriculture Department of Sri Lanka. As the obtained results average values of, pH was 7.25, electrical conductivity was 1.48 dS m^{-1} , total dissolved solid was 725.4 mg L^{-1} , alkalinity was 104.66 mg L^{-1} as CaCO_3 , bicarbonate was 1.05 meq L^{-1} , nitrate was 1.78 mg L^{-1} , phosphate was 0.96 mg L^{-1} and carbonate was not identified. According to the results, this study revealed that RO concentrate water quality complies with the requirement of both water quality standards for agriculture, and there is a potential of using the RO concentrate as a water source for irrigation.

Keywords: Reverse osmosis, RO concentrate, Irrigation, Agricultural water

Case Study on Waste Water Management Systems Adopted by Different Industries

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Different industries discharge wastewater with different contaminants in the production process. The heavy metals and other inert materials present in wastewater will contaminate the environment by causing normal drainage systems and natural water resources polluted. Therefore, it is a timely need to study detail on potential industries that generate wastewater and their adoption measures at present to treat the wastewater. With that objective twenty companies that represent eight different industries were identified using secondary data and a structured questionnaire was used to collect data in this study. Data were analysed by descriptive analysis method using Minitab 17 software. The findings of this study emphasized that different industries have adopted different wastewater management systems and analysis methods, however, their wastewater treatment methods at present are of very expensive. Further cost for water consumption by eight different industries is significantly different every month and recorded an average of Rs. 4,700,000.00 per month. Among the eight different industries and the highest cost recorded in the glove industry that costs about Rs. 5,000,000.00 per month. Moreover, 98% of industries prefer to implement a cost-effective wastewater treatment method in which each industry would be able to reuse the water and enhance the efficiency of water usage in a sustainable way.

Keywords: Waste water treatments, Heavy metals, Industries, Water reuse

Diurnal Avifaunal Diversity at Pallemalala, Bundala, Sri Lanka

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In a world of rapid development influences such as anthropogenic land use, effects of invasive fauna and flora, suburbanization, and pollution are major causes for declining of biodiversity and it is needed to understand the state of biodiversity to aid management and conservation. To successfully manage land use in ways that are least harmful to biodiversity it is vital to be able to identify habitats that are of most important for biodiversity beyond the protected areas. In this study diurnal avifaunal diversity was studied at unprotected natural habitat (Pallemalala, Bundala) adjacent to Bundala National Park, during two months (from March to April 2018), using the fixed distance line transect method. A total number of 2540 of individuals belonging to 52 species, 34 families and 13 orders were recorded during the study period. The relative abundance of each bird species indicates that the Black-winged stilt (*Himantopus himantopus*) was the most common bird (7.40) followed by Yellow wattled lapwing (*Vanellus malabaricus*) (7.25) and Yellow billed Babbler (*Turdoides affinis*) (6.50). Yellow Bittern (*Ixobrychus sinensis*), Pied kingfisher (*Ceryle rudis*), Indian paradise flycatcher (*Terpsiphone paradisi*), Grey heron (*Ardea cinerea*) and White-bellied Sea Eagle (*Haliastur leucogaster*) were the least observed birds. The Shanon diversity index was 3.5106. Even though the study site is close to populated residential areas; it still provides vital habitat to a large number of bird species. However, due to the increasing number of invasive species and pollution around the area, there is a potential increasing threat to the avifaunal composition in the non-protected area natural habitats outside the Bundala National Park. In conclusion, the unprotected habitat at Pallemalala, Bundala can be considered as an important habitat for avifaunal diversity thus suitable integrated measurements should be implemented with the help of residents to conserve biodiversity in the area.

Keywords: Avifauna, Bundala, Diversity

Diversity of Mangrove Associated Brachyuran Fauna in Panama Lagoon, Eastern Coastal of Sri Lanka

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Mangroves are salt-tolerant plant communities that provide unique habitats for a wide range of faunal communities. Panama lagoon is pristine with rich mangrove coverage. The present study was carried out to investigate the diversity of mangrove associated brachyuran fauna in the Panama lagoon, on the East coast of Sri Lanka. Field sampling was conducted in six sampling sites, covering the entire lagoon from November 2019 to January 2020. In each site, three belt transects were laid perpendicular to the lagoon. The belt transects were 10 m to 30 m depending on the length of the mangrove patch. It was subdivided into 10 m×10 m plots and which had six 1 m×1 m randomly selected sampling units. The sampling area was dug into the water level until the crabs were caught and picked by hand. Several crabs from different species were recorded. Crabs were identified up to species level using external morphological characters. Salinity, temperature, and pH of mangrove soil were measured. Seven species of brachyuran crabs belonging to four families were identified up to the species level. They were *Parasesarma plicatum*, *Metopograpsus thukuhar*, *Metasesarma obesum*, *Episesarma mederi*, *Episesarma versicolor*, *Cardisoma armatum*, and *Varuna litterata*. The *Parasesarma plicatum* was recorded as the most dominant species due to it was recorded in whole sites of the lagoon. The lower and middle areas of the lagoon recorded 1.51 and 1.13 for the Shannon wiener indexes and no species found in the upper area of the lagoon. The distribution pattern of dominant species up to 10 m, 20 m, 30m level. The salinity showed a negative correlation ($p < 0.01$) with the increasing distance from the lagoon. The distribution of *Cardisoma armatum* showed a positive correlation ($p < 0.01$) with the soil salinity. Panama lagoon consists of rich brachyuran fauna diversity and it plays a virtual role in the ecological process and must be conserved for the future generation.

Keywords: Brachyuran crabs, Fauna, Mangrove, Panama lagoon, Shannon wiener indexes

Assessment of Nitrate and Phosphate Levels in Natural Water Bodies in Badulla District

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Water plays a significant role in human life and the environment. Due to the application of pesticides and weedicides in agricultural activities and dumping of solid wastes on open dumpsites, water resources are now in danger near urban and also rural areas of *Badulla* district. With the rainfall and widely spanned streams, it is very easy to contaminate the water resources in some areas of *the Badulla* district. The objective of this study was to identify the NO_3^- and PO_4^{3-} concentrations of selected natural water bodies in *the Badulla* district. Water samples were collected from natural water bodies located in all 13 divisional secretariat divisions including *Haldummulla, Haputhale, Bandarawela, Ella, Welimada, Uva-Paranagama, Soranathota, Hali-Ela, Lunugala, Passara, Meegahakiula, Kandaketiya*, and *Badulla* during the period from January to December 2019. Onsite measurements of temperature, pH, conductivity, and dissolved oxygen were measured using portable pH, Dissolved Oxygen (DO), and conductivity meters respectively. Laboratory analysis was conducted to determine NO_3^- and PO_4^{3-} concentrations using a UV spectrophotometer. The results were compared with the Sri Lanka Standards (SLS 614:2013) for potable water. The results revealed that NO_3^- concentrations of all water samples were lying under the SLS potable water quality standards. PO_4^{3-} concentrations of many water samples exceed the maximum permissible level of 2 mg L^{-1} for potable water. The water sample collected from “*Narangahakiula*” in *Meegahakiula* division showed the highest PO_4^{3-} concentration value of 17.6 mg L^{-1} and all the water samples collected from *Soranathota, Ella, Bandarawela, Welimada, Uva Paranagama Meegahakiula, Kandaketiya* and some other water samples collected from *Haldummulla* and *Passara* showed higher PO_4^{3-} concentration values more than the permissible level. The study indicates that the pollution potential of downstream areas where the catchment is disturbed by human activities.

Keywords: Physico-chemical parameter, PO_4^{3-} , NO_3^- , Water quality, Water pollution

Acknowledgement: *Uva Wellassa University for providing the research funds (UWU/RG/ST/2019/011)*

Correlation of Ground Water Fluoride with Total Hardness and Total Alkalinity in CKDu Prevalent areas in Uva Province

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Chronic Kidney Disease of unknown etiology (CKDu) describes as a multifactorial effect. Thus, postulates on CKDu focus on the cumulative effect of nephrotoxic contaminants which deteriorate the kidney function progressively. This study aimed to determine the influence of total hardness (TH) and total alkalinity (TA) on fluoride (F-) content of groundwater in CKDu prevailing areas in Uva Province. Divisional secretariats of Mahiyangana (MDS), Rideemaliyadda (RDS), Wellawaya (WDS), and Siyambalanduwa (SDS) were selected as CKDu prevailing areas for sample collection. Water samples from 45 dug wells were collected by following a simple random sampling method and the samples were triplicated. Samples were analysed by standard methods of water analysis (APHA 1985). Statistical data analysis was carried out using IBM SPSS 21.0 software. The range of F- contents in MDS (n= 17), RDS (n= 8), WDS (n= 11) and SDS (n=9) were 0.01– 1.80±0.08 mg L⁻¹, 0.02 – 0.61±0.13 mg L⁻¹, 0.01±0.01– 5.8±0.1 mg L⁻¹ and 0.17±0.02– 1.42±0.11 mg L⁻¹ respectively. The highest mean value for TH was observed from WDS (156.44±21.53 mg L⁻¹) and the least was observed from RDS (116.36±21.95 mg L⁻¹). All the mean values for TA were recorded within the permissible level according to WHO guidelines for drinking water and the highest was observed from WDS (336.36±117.58 mg L⁻¹). Results of the linear regression analysis on the dependence of F- on TH indicated a positive correlation in MDS, WDS, and SDS as well as a negative correlation (r= - 0.33) in RDS. All the test areas were observed with positive correlations between F- content, and TA. Among the selected DS areas, 44% of the water samples in SDS, 36% of the water samples in WDS, 12% of the water samples in MDS, and 0% of the water samples in RDS exceeded the maximum permissible level for F- defined by WHO. The influence of total hardness and total alkalinity on Fluoride content in groundwater is required to be studied further.

Keywords: Fluoride, Total Hardness, Total Alkalinity, CKDu, Uva Province

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Synthesis, Characterization and Swelling Studies of Methotrexate Incorporated Hydrogels Using Natural Polymers and a Cross Linker; Preliminary Study to a Nano-hydrogel

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The hydrogel can be defined as a three-dimensional polymer/s network with cross-linker/s which able to absorb and retain water or biological fluid. This water retention does not dissolve or disturb the basic structure. They are more potent to use in medicine as they can mimic the properties and composition of biological tissues/ cells and as they can carry drugs. Rapid release of drugs from hydrogels is an issue and to address it, nano-hydrogels are developed. Typically pore sizes range from 1nm to 100nm in nano-hydrogels. The primary objective of this study was to develop a hydrogel to transport drug methotrexate (MTX) via the oral route and to advance it to a nano-hydrogel using the results. Characterization, swelling studies, and *in-vitro* drug release are secondary objectives of the study. Two natural polymers; Carboxymethyl Cellulose (CMC) and Chitosan (CHN), and one natural cross-linker; Citric Acid (CA) were used in this study as natural substances exert minimum adverse effect to the environment and human. Three hydrogels were prepared as (1) CMC+CA+MTX, (2) CMC+CHN+MTX, and (3) CMC+CHN+CA+MTX in distilled water. Freeze drying was done to obtain dry samples. Based on Scanning Electron Microscope (SEM) images, the pore size of hydrogel 1 varied between 6-9 μm and hydrogel 2 varied between 6-8 μm . Hydrogel 3 showed special pocket like features other than its pores where size ranged from 200nm-1.6 μm . Swelling studies were done at 37 °C in pH 2.2 and pH 7.4 using phosphate buffers separately for all three hydrogels. Results showed that hydrogel 1 was swollen up to 642% at pH 2.2 and up to 924% at pH 7.4. Hydrogel 2 swollen up to 590% at pH 2.2 and 462% at pH 7.4. Hydrogel 3 swollen up to 430% at pH 2.2 and up to 404% at pH 7.4. *In-vitro* release studies are being carried out at the moment. According to the results, prepared hydrogels showed different swelling behaviours at different pH values. The highest swelling was for hydrogel 1 at pH 7.4 and the lowest was for hydrogel 3 at pH 7.4. Hydrogel 3 showed the lowest swelling behaviour in both pH values and it can be due to the highest crosslinking nature compared to others. Therefore, it can be concluded that hydrogel 3 is more potent to develop a nano-hydrogel as it is more cross-linked and it has folded pocket like structures where size is near to nano level.

Keywords: Nano-hydrogel, Hydrogel, Methotrexate

Does *Clidemia hirta* (L.) D. Don Affect Natural Regeneration from Soil Seed Bank in Halgolla Forest, Sri Lanka?

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Invasive plant species exert a significant impact on natural regeneration of tropical forests causing drastic changes in the future stand composition. Small isolated forest fragments surrounded by human habitation are more prone to plant invasions. Halgolla Forest Reserve (7018'N; 80031'E) is an isolated tropical lowland rainforest fragment in central Sri Lanka which is highly disturbed due to logging and illegal land encroachment. *Clidemia hirta* (L.) D. Don has established densely at the forest edges of this lowland forest fragment. Although, many studies have investigated the effect of this invasive species on standing vegetation, its effect on soil seed banks is poorly understood. Thus, this study investigated the impact of *C. hirta* on a seed bank in three habitat types in the forest; highly disturbed forest edge, less disturbed riverine area, and undisturbed forest interior. In each habitat type, 30 soil samples ($10 \times 62.8 \text{ cm}^3$) were collected using stratified random sampling during dry and wet seasons. The seed bank was estimated by the germination method. Out of all emerged seedlings, 40.7% was represented by *C. hirta* seedlings while identified native seedlings represented 35.7%. The highest seedling density of *C. hirta* in the dry and wet season was recorded in riverine and edge habitats, respectively, though the values were not statistically significant between habitats. Species diversity and evenness were lower in highly disturbed forest edge in which the highest relative abundance of *C. hirta* was observed. The percentage emergence of native seedlings was negatively correlated with the emergence of *C. hirta* seedlings during both seasons. Low representativeness of native plant species in seed banks compared to *C. hirta* indicates the threat exerted by this invasive species on the natural regeneration of tropical lowland forests. Thus, it is crucial to eradicating this species to conserve the biodiversity of Halgolla Forest Reserve.

Keywords: *Clidemia hirta*, Invasive species, Regeneration, Soil seed bank, Tropical lowland rainforest

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Variation of Slope Environmental Lapse Rate (SELR) in the Western and Eastern Slopes of the Central Highland in Sri Lanka

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The average temperature decrease ($6.5^{\circ}\text{C km}^{-1}$) with increasing elevation in the free atmosphere is generally called as Environmental Lapse Rate (ELR). The Temperature Lapse Rate (TLR) along the mountain slopes significantly differs from the free atmosphere ELR. The TLR along a mountain slope is here termed as the Slope Environmental Lapse Rate (SELR). The main objective of this study was to identify the variation of the SELR in the Western and Eastern slopes of the Central Highland in Sri Lanka during the South-West Monsoon and North-East Monsoon seasons. The seasonal average temperature has been calculated from 2008 to 2017 from three Meteorological stations; Nuwaraeliya (1895 m), Ratnapura-Western slope station (34 m), and Badulla-Eastern slope station (670 m). Elevation and temperature of the Nuwaraeliya were taken as the base location and calculated the SELR by $((T_1 - T_2) / (H_2 - H_1) * 1000)$ for Ratnapura and Badulla. The result revealed that the SELR is $5.9^{\circ}\text{C km}^{-1}$ in the Western slope and $6.5^{\circ}\text{C km}^{-1}$ in the Eastern slope of the Central Highland during the South-West monsoon season. The Western side of Central Highland receives more rainfall than the Eastern side when South-West monsoon occurs. During this season the entire area of Eastern slope in the Central Highland gets dry due to the inverse direction of the monsoon with the effect of orography rainfall. During the North-East monsoon season, the SELR is $6.4^{\circ}\text{C km}^{-1}$ in the Western slope and $4.9^{\circ}\text{C km}^{-1}$ in the Eastern slope due to the stimulating of North-East monsoon on the Eastern side. Considerable spatial differences have been noticed during two seasons. The seasonal monsoon rainfall patterns are highly affected for variation of the Slope Environmental Lapse Rate in the Western and Eastern slopes of the Central Highland in Sri Lanka.

Keywords: Central Highland, Eastern slope, Seasons, Slope Environmental Lapse Rate, Western Slope

Food Science & Technology

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Selection and Comparison of Two Wood Smoke and Fruit Juices as Flavorings on the Physiochemical and Sensory Qualities of Catla (*Catla catla*)

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Fish is a highly nutritious food and preserved in many ways. Preservation affects the physical and nutritional composition of fish. Smoking improves the colour and flavour of fish while extending the shelf life. Catla (*Catla catla*) is an exotic fish species currently harvested from reservoirs in Sri Lanka. It contains major and minor nutrients but poor preference among consumers due to the muddy taste and unpleasant odour. This study was conducted to identify specific wood smoking conditions while comparing the physiochemical and sensory qualities of smoked Catla flavored with pineapple and orange juice stored under chill (4°C) and frozen (-18°C) conditions. Frozen Catla was thawed, made into steak, and washed. Pre trials were conducted to find out the best brining time, brining concentration, smoking agent, and smoke level. Accordingly, wood-smoked (1Cinnamon: 1Mahogany) Catla flavored with pineapple juice and orange juice were produced. The steaks were immersed in brine containing 10% (w/v) NaCl (dip and allow to drain) and smoked at 107°C for 40 minutes along with pineapple and orange juice separately. Final products were vacuum-packed and stored at 4°C and -1°C for analysis. Microbial quality (*Escherichia coli*, *Salmonella* sp. and Total plate count), TBARS, pH, colour, and texture were detected during 21 days of storage, and proximate analysis was conducted for the raw fish and the final products. Microbial count and lipid oxidation were within the permitted levels in both fruits flavored smoked fish compared under two storage conditions for 14 days. Frozen storage was better in extending the shelflife for the lower microbial counts and lipid oxidation when compared to the chill storage. In conclusion, immersing Catla steaks in 10% (w/v) NaCl followed by smoking at 107°C for 40 minutes with pineapple juice or orange juice using 1:1 combination of cinnamon: mahogany can be considered as the best conditions to produce smoked Catla.

Keywords: *Catla catla*, Wood smoking, Sensory qualities, Physiochemical properties

A Study on Sensory Attributes of White Wine from Jack Fruit (*Artocarpus heterophyllus*) Seed Flour with Incorporation of Bitter Gourd (*Mormodica charantia* L.) and Cinnamon (*Cinnamomum zeylanicum* Blume) Powder

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Jack fruit (*Artocarpus heterophyllus*) seeds are discarded as the fruit waste due to the lack of preservation and processing techniques. As an ingredient, jack seed flour in new product development helps in effective utilization. The present study aimed to assess and compare sensory attributes of white wine from jack fruit (*Artocarpus heterophyllus*) seed flour with the incorporation of bitter gourd (*Mormodica charantia* L.) and cinnamon (*Cinnamomum zeylanicum* Blume) powder. Jack fruit seed flour was hydrolyzed by using 0.5% citric acid. Cinnamon powder at 1% and crushed bitter gourd at 5% were added to hydrolyzed jackfruit seed flour. The mixture was inoculated with 0.1% *Saccharomyces cerevisiae* and allowed to ferment for two weeks. Wine samples were prepared with 2% and 4% jack fruit seed flour. The coded transparent cups were served with control to 32 un-trained panelists. The commercially available chardonnay white wine was served as the control. Samples were assessed for color, aroma, mouthfeel, taste, and overall acceptability using duo-trio method in the 5th week of fermentation. Data from the sensory evaluation were analysed using the Kruskal-Wallis non-parametric test in Minitab 17®. All the sensory attributes were showed a significant difference ($p < 0.05$) amongst two wine samples. The highest preference for the color (38.5), taste (37.5), and overall acceptability (38.5) were obtained by the 2% jack fruit seed flour incorporated wine to sample. Least acceptance for color (26.5), taste (27.5), overall acceptability (26.5), and highest acceptance for aroma (37.5) and mouthfeel (36.5) were recorded from the 4% jack fruit seed flour incorporated wine to sample. In conclusion, the 2% jack fruit seed flour incorporated wine is the best amongst the treatments which were highly preferred by the panelists.

Keywords: White wine, Jack seed, Bitter gourd, Cinnamon powder, Sensory attributes

Egg Based Mousse Ice Cream Incorporated with Lavulu [*Pouteria campechiana* (Kunth) Baehni] Flour as a Colorant and an Antioxidant

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This study aimed to produce egg-based mousse ice cream and to promote the food value of underutilized Lavulu fruit. Lavulu flour was prepared by oven drying of the ripened Lavulu fruit slices along with the peel at 60°C for 26 hours (until moisture content reach 5%) and ground to a fine powder. Ice cream mix was prepared with constant levels of egg white foams (45%), whipped dairy cream (33%), sugar (18%), and varying levels of Lavulu flour (0, 0.2, 0.4, and 0.6 w/w %). Lavulu flour (LF) was analyzed for total phenolics content (colorimetric method), total flavonoids content (colorimetric method), color (colorimeter), carotenoid profile (UV spectrophotometer), radical scavenging activity (DPPH), pH, water holding capacity, oil holding capacity, emulsifying activity, foaming activity, and proximate composition. The melting ratio, complete melting time, overrun, viscosity, hardness, total flavonoids content, total phenolics content, and sensory properties of ice cream samples were analyzed at day 2 of the frozen storage (-18°C). Radical scavenging activity (RSA), pH, color and microbial examinations of ice cream samples were carried out weekly during 1 month of frozen storage (-18°C). TOPSIS technique was used to determine optimum Lavulu flour incorporation level using sensory, RSA, and colour data. Proximate analysis was carried out for the selected treatment (0.4 w/w% Lavulu flour). Sixteen carotenoid types were identified quantitatively and qualitatively in LF. Total carotenoid content and RSA of LF was 21.98 mg/g and 82.55±0.784 %, respectively. Increasing Lavulu flour percentage increased the viscosity, L* value, and complete melting time of ice cream significantly. Total phenolic content, total flavonoid content, and RSA were significantly higher in LF incorporated samples compared to the control. Results of the study revealed that Lavulu flour can be incorporated in ice cream as a rich source of antioxidants, along with colour, flavor and texture enhancement properties.

Keywords: Antioxidant, Carotenoid profile, Colorant, Ice cream, *Pouteria campechiana* (Kunth) Baehni

Development of a Low Cost Cheese Analogue Using Sweet Potato (*Ipomoea batatas*), Wheat Flour and Fresh Cow Milk

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The demand for cheese analogues is being increased due to the low cost of production, simplicity of manufacturing, and diverse use of ingredients. Hence, this research was conducted to develop a low-cost cheese analogue. Series of preliminary trials were done to develop a method for manufacturing a suitable cheese analogue. A gel was prepared using wheat flour, butter, and fresh cow milk. A mixture was prepared using the best combinations of gel and boiled sweet potato. Vinegar was added to fresh cow milk for curd preparation. The best curd and mixture (gel and sweet potato mixture) combination was selected by sensory evaluation using a nine-point hedonic scale. The organoleptic properties were evaluated using a sensory panel comprised of 37 untrained individuals and data were analyzed by the Friedman non-parametric test. As chemical properties pH, titratable acidity and peroxide value were determined during five weeks of storage period (4 °C) and data were analyzed using one-way ANOVA. *E.coli*, yeast and mold and total plate count were analyzed as microbiological analysis. Further, colour and hardness of the product were measured. Moisture content, ash content, fat content and protein content were determined as proximate analysis. Cost analysis was done for the final product and it was Rs.75.09 for 100 g of cheese analogue. Curd at 66.7% (w/w) and 33.3% (w/w) of the mixture (gel and sweet potato mixture) was selected as the final product among four treatments according to the highest preference of panelists. Salt at 1.5% (w/w), 0.1% (w/w) Potassium sorbate and 0.05% (w/w) soy lecithin were added to finalize the product. All the physicochemical and microbiological results were in acceptable limits according to Sri Lanka Standards during the five weeks of storage period at 4 °C. This method is a simple and low cost to produce a cheese analogue.

Keywords: Cheese substitute, Low cost, Cheese analogues, Catering purpose, Dairy

Enzymatic Hydrolysis of Ovotransferrin and the Functional Properties of Its Hydrolysates

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With the increase of human health concerns, egg white protein-derived bioactive peptides have great potential applications as nutraceuticals and pharmaceuticals. Ovotransferrin (OT) is a major egg white protein, which can be used to produce bioactive peptides. The objectives of this research were to produce functional peptides from OT using single enzyme treatments and to analyse the antioxidant and antimicrobial properties of the hydrolysates produced. Lyophilized OT was dissolved in distilled water at 20 mg mL⁻¹ concentration, treated with protease, elastase, papain, trypsin, or α -chymotrypsin separately at 1% level and incubated for 0-24 hr with the optimal temperature and pH of each enzyme. The 15% SDS-PAGE images indicated that OT was completely hydrolyzed with protease, papain, trypsin, and α -chymotrypsin after 3 hrs, whereas elastase produced partially hydrolyzed products even after 24 hrs of incubation. Thus, hydrolysates obtained by incubating OT + protease (OTPro), OT + papain (OTPap), OT + trypsin (OTTrp) and OT + α -chymotrypsin (OTChy) for 3 hrs and OT + elastase (OTEla) for 24 hrs were selected as the best to analyse the functional properties. None of the OT hydrolysates exhibited antioxidant properties in oil emulsion. However, OTChy and ETEla had higher Fe³⁺-chelating activities (1.06±0.88%, 1.25±0.24%, respectively) than the native OT (0.46±0.60%), but no significant difference was observed among the treatments. Although OT was reported to possess a strong antimicrobial property, the hydrolyzed products did not show any clear inhibition against bacteria at 20 mg mL⁻¹ concentration. Therefore, overall results indicated that the investigated single-enzyme treatments were not effective to produce peptides with antioxidant and antibacterial activities from OT. Hence, further research is needed to produce peptides with different functions from OT using single enzymes or their combinations.

Keywords: Antioxidant, Bioactive peptides, Fe³⁺-chelating activity, Lyophilization, Protease

Development of a Herbal Jelly Using *Cissampelos pareira* and *Aloe vera* blend

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Jelly is a product with a semi-solid texture and is characterized by the concentration of plant components and sugars. The use of chemicals and artificial ingredients in the preparation of jelly products is a major concern related to health issues. Hence, this study was aimed to develop herbal jelly from velvet leaf (*Cissampelos pareira*) and Aloe (*Aloe vera*) blend with natural flavors. Three jelly samples were prepared by varying the flavors of sugar cane, kithul treacle, and bee honey. Sensory evaluation was conducted and results were analysed by Freedman non-parametric test using (MINITAB). Herbal jelly prepared with bee honey, *Cissampelos pareira*, and *Aloe vera* plant blend were selected as the most preferable herbal jelly sample. The selected sample was analysed for proximate composition and it contained 0.2% of ash, 0.6% of crude protein, 0.2% of moisture, 80.9% crude fiber, 47.4% of pectin, and 31.2% of sugar by mass. Phytochemical tests revealed the presence of glycosides, flavonoids, alkaloids, and steroids which functionally beneficial for humans. Total soluble solids (TSS) value of 6.9% is compatible with Sri Lankan Standard Institution (SLSI). Alcohol test confirmed that the absence of alcohol in the herbal jelly product. The David person's chemical analysis on food test revealed that the developed herbal jelly contained 76.9 kcal per 100g of the sample. Analysis of microbial parameters (aerobic plate count, *E. coli*, yeast, and mold count) results in the count which compares with the SLS standards and shelf-life attributes for six weeks suggesting that herbal jelly product as a stable for a shelflife of six weeks hopefully beyond. According to the tests results provide evidence that this newly developed jelly product can be used as a healthy dessert.

Keywords: *Aloe vera*, Bee honey, *Cissampelos pareira*, Jelly

Assessment of Bioactive Compounds in Seedlac Extract and Exploration of Film Forming Properties of Seedlac Resin

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Seedlac is one of the important natural, animal, and plant-based resins that have applications mainly in food, and pharmaceutical industries. This study aimed to analyse the proximate composition of raw Seedlac resin and to study the bioactive compounds (alkaloids, glycosides, saponins, phenolic compounds, anthocyanin, flavonoids, and terpenoids), antioxidant activity, total phenolic content, total flavonoid content and reducing power in Seedlac resin extracted by ultrasound-assisted extraction method. Seedlac and the gelatin-based composite film was developed and evaluated for its physical and tensile properties. Results indicated that raw Seedlac resin consisted of 0.72% ash, 4.06% protein, 2.5% fat, and 2.08% moisture. The maximum extraction yield was obtained for the sample extracted with 80% ethanol for 30 minutes. The samples extracted with 60% ethanol concentration showed the highest values for antioxidant activity (DPPH inhibition 38.54%), phenolic content (82.36 mg GAE/g of extract), flavonoid content (75.47 mg QE/g of extract) and reducing power (24.8 mg ascorbic acid equivalent/g of extract). Samples extracted with 80% ethanol gave lower values for antioxidant activity than those extracted with 60% ethanol probably due to denaturation of the extract at the higher ethanol concentration decreasing its scavenging ability. Composite film prepared with 1:1 ratio of gelatin to Seedlac showed the highest values for thickness (0.19 mm), moisture content (18.27%), water solubility (76.91%), water swelling (93.60%), tensile strength (13.72 MPa) and the highest percent elongation (29.57%). Higher gelatin content results in higher elongation because gelatin can capture water molecules increasing the polarity of the film and that water molecules could act as a plasticizer which would increase the flexibility of the film. It is concluded that Seedlac films can be improved by incorporating a suitable composition of gelatin, which would make beneficial contributions to many industries.

Keywords: Seedlac, Bioactive Compounds, Composite Film

Development of Fruit Incorporated Paneer Based Dairy Snack Bar

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Dairy based snack bars which can be used as “on-the-go” products are currently rare in the market. Paneer is an un-ripened soft cheese variety obtained by acid and heat coagulation. This study was conducted to develop a fruit incorporated paneer based dairy snack bar. Citric acid and vinegar (1:3), a 2% solution was used to coagulate the cow milk. Mango pieces were osmotically dehydrated using 50% of sugar and drying at 60°C for 30 minutes. Paneer snack bars were formulated using different stabilizers (corn flour, tylose powder®, guar gum, and xanthan gum) at different incorporation levels, while chocolate coated and non-coated. The best stabilizer for the product was selected using 4 sensory evaluations with 30 untrained panelists according to the 9-point hedonic scale. Proximate analysis (AOAC, 2016) and antioxidant properties (DPPH radical scavenging activity) were measured. Sensory attributes, microbial analysis, color (colorimeter), texture (texture analyzer), pH, titratable acidity, and peroxide values were evaluated at a 7-day interval for 28 days of refrigerated storage (4±1°C) for the finalized product. The guar gum incorporated snack bars gave the highest notes for sensory attributes (above 7). Results revealed that the non-coated sample had the highest protein content of 14.83±0.31%, while the coated sample had 12.37±0.42%. Ash, moisture and fiber contents were significantly higher ($p < 0.05$) in non-coated samples as 1.05±0.04%, 34.40±2.08%, 42.07±1.53%, respectively. Fat content was higher in the coated sample as 37.12±1.64%. The hardness of the coated samples was slightly decreased by 0.97±0.03 N within the storage time. Acidity, pH, and peroxide values of the coated and non-coated samples were significantly altered ($p < 0.05$). In conclusion, a fruit incorporated paneer snack bar can be successfully formulated, which indicates a possibility to develop a novel dairy product with enhanced nutritive properties with one month of shelf life using the guar gum as the stabilizer.

Keywords: Paneer, Snack bar, Guar gum, Mango incorporated, Coated

Evaluation of Chemical and Sensory Acceptability of *Kappaphycus alvarezii* Powder Incorporated Functional Processed Cheese

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Kappaphycus alvarezii is a red algae, which is mainly cultivated for carrageenan extraction. It can act as a functional food ingredient due to the presence of antioxidants and phenolic compounds. In this study, the chemical and sensory properties of *K. alvarezii* seaweed powder (SWP) incorporated processed cheese were evaluated. Fresh seaweed was cleaned, blanched, oven dried (60°C for 18 hrs), and pulverized to prepare SWP. Chemical properties of the SWP, including moisture content (Moisture analyzer), antioxidant activity (DPPH), total phenolics (Folin-Ciocalteu method), and total flavonoids (AlCl₃ colorimetric method) were evaluated. Natural Caerphilly cheese was prepared using fresh cow milk, incorporating rennet (0.03%), single strain *Lactobacillus helveticus* culture, and ripened at 10 for 2 weeks at 80% RH. Ripened cheese was melted and incorporated with different w/w levels of SWP (0, 1, 2, and 3%) to prepare final processed cheese and stored in the refrigerator (4 °C). Antioxidant activity (AOA), pH, microbial qualities of the cheese were evaluated at 1,7,14 and 21 days while total phenolics (TP) and total flavonoids (TF) were analysed at 7th day of refrigerated storage (4 °C). Sensory evaluation was done using the 9-point hedonic scale at 7 days of storage (4 °C). SWP contained 4.77 0.16% of moisture, 22.53 2.09% of AOA, 5.18 0.04 mg GAE/100g of TP and 5.37 0.24 mg QE/g of TF. Increasing the level of SWP significantly increased the AOA, TP, and TF in cheese. Three percent of SWP incorporated cheese showed significantly higher AOA (16.47 0.26%), TP (2.82 0.029 GAE/100g) and TF (2.59 0.37 mg QE/g) compared to control (0% SWP) which showed 4.82 0.02% AOA, 1.24 0.01 GAE/100g TP and 0.10 0.04 mg QE/g TF. The sensory properties were not significantly different between treatments. *K. alvarezii* SWP can be successfully incorporated into the processed cheese at the 3% level to develop potentially functional processed cheese with acceptable sensory properties.

Keywords: Seaweed powder, Antioxidant activity

Extension of Shelf Life in Set Yoghurt by Altering the Starter Culture

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Shelflife of currently available yoghurts in the market is relatively low. The present study was done to develop set yoghurts with extended shelf life by incorporating a novel starter culture, AiBi 22.50 LOW which contains *Streptococcus salivarius* ssp., *thermophiles*, *Lactobacillus delbrueckii* ssp., *bulgaricus* and examined its quality attributes while gaining a better insight into the relationship between, storage temperature and the shelflife. A preliminary trial was conducted to determine the suitable incorporation level of the culture. Yoghurts were prepared using two commercial starter cultures, Yoflex and AiBi 22.50 LOW followed by incubation at 42°C until pH reached 4.6 and stored at storage temperatures of 4°C and 28°C. Four treatments (0.004% Yoflex/4°C, 0.004% Yoflex/28°C, 0.005% AiBi/4°C and 0.005% AiBi/28°C) were evaluated for pH, titratable acidity, texture profile, microbial count and keeping quality at 7 days interval for 42 days. Results further revealed that set yoghurt with the two cultures was not significantly different in chemical composition. Although, at the initial stage of storage, set yoghurts stored at 4°C with 0.005% AiBi culture had the highest pH value (4.61) and the lowest acidity value (0.57). Yoflex & AiBi culture incorporated yoghurt samples stored at 28°C had the lowest hardness compared with yoghurts stored at 4°C. 0.005% AiBi culture sample had shown a decrement of pH values while an increment of acidity at the period of 4°C storage compared to other treatments. The hardness of yoghurt increased within the period of storage till 4th week. Further, all microbial parameters (coliform, yeast & mold) were found to be below the standard levels of SLS within the storage of six weeks. Set yoghurts having 0.005% AiBi culture which was stored at 4°C exhibited higher mouth feel. Hence, 0.005% AiBi culture added yoghurt stored at 4°C can be introduced as extended shelf life yoghurt with adequate nutritional and sensory properties.

Keywords: Set yoghurt, Shelf life, Starter culture, Texture

Extraction of Crude Proteins from Black Tea and Green Tea of Uva Region in Sri Lanka & Determination of its Antioxidant Properties

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The consumption of tea has gained much attention due to its antioxidant potential. Tea polyphenols are believed to be the major contributor. However, proteins can also act as powerful antioxidants and there are few scientific reports on crude tea proteins' antioxidant properties. Tea proteins contribute around 21-28% dry weight of tea. Uva is one of the most top tea growing regions in Sri Lanka with distinguishable flavour characteristics. This study was focused on the investigation of antioxidant properties of crude tea extract of green and black tea collected from the Uva region. Black and green tea samples were collected from selected tea factories representing Uva high and Uva mid regions. The crude extract was obtained using hot water treatment with different temperatures (30°C and 40°C) in 2 hrs followed with lyophilisation. Extracted crude was elucidated using 15% SDS-PAGE and quantification was done using the Lowry method for proteins. The lyophilized crude extract was tested for antioxidant activity using DPPH and Fe²⁺ chelating assays. According to protein yield analysis, approximately 40% in green tea and 30% in black tea was observed (40°C series) in lyophilised powder. As with the assays Uva teas have a maximum of 95.33% inhibition of DPPH radical at 10 mg/ml solution which is obtained by 1g of made tea, using the water extraction method. It shows a significant difference in protein concentration between black and green teas in prepared 30°C and 40°C series ($p < 0.05$). There is no difference between crude extract powder yield between the temperatures used for the extraction procedure ($p > 0.05$). Uva teas showed antioxidant properties in DPPH assay but negative results in Fe chelating assay. However, there is no significant difference in levels of elevation, type of tea, and temperature in % inhibition of DPPH radicals in Uva teas. Further studies need to be done with other antioxidant assays to determine the antioxidant property of Uva tea.

Keywords: Uva tea, Green tea, Black tea, Crude protein, Antioxidant activity

Effect of Marination with Fruit Juices and Vacuum Packaging on Sensory and Physicochemical Characteristics of Chicken Wings under Frozen Storage

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Antioxidants naturally present in fruits and vegetables have the potential to increase the shelf life of foods by reducing lipid oxidation. The effect of marination with fruit juices rich in antioxidants including Pineapple juice (PJ), Mango juice (MJ), and June plum juice (JJ) on sensory and physicochemical characteristics of chicken wing meat under vacuum packaging at frozen storage was examined in this study. Chicken wings were marinated separately with respective fruit juices for 12 hrs and 24 hrs, vacuum packed and stored under frozen storage (-18°C). A sensory analysis was conducted and three samples were selected (MJ, PJ, and JJ marinated for 24, 24, and 12 hrs, respectively). Selected samples were vacuum packed and kept under freezing conditions. pH, water holding capacity (WHC), colour, texture, moisture content, fat content, ash content, protein content, and microbial counts of samples were evaluated. Antioxidant activity (AOA) and total phenolic content of fruit juices and samples were measured using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and Folin-Ciocalteu colorimetric method. Sample marinated with PJ for 24 hrs showed better sensorial properties ($p < 0.05$). Marinade uptake was higher in the sample marinated with MJ for 24 hrs and marinade loss was higher in samples treated with JJ for 12 hours ($p < 0.05$). MJ was observed with a higher AOA followed by PJ and JJ ($p < 0.05$). Control had the highest pH value and the PJ sample had the highest WHC ($p < 0.05$). Samples marinated using fruit juices had higher ash contents than the control sample ($p < 0.05$). Vacuumed packed samples marinated with MJ had the lowest TBARS value and microbial count ($p < 0.05$). TBARS and total plate count values of vacuum-packed chicken wings with fruit juices were within the permitted limits at 5 weeks of storage. Therefore, it can be concluded that marination with Mango juice and vacuum packaging increased meat quality traits and shelf life of chicken wings.

Keywords: Antioxidants, DPPH radical scavenging assay, Total phenolic content, Marinade uptake, Mango juice

Inhibitory Effects of *Andrographis paniculata* Water Extracts against Glycation-Induced Cross-Linking

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Diabetes mellitus is a metabolic disorder that causes an increase in blood glucose level, which can lead to the acceleration of glycation-induced protein cross-linking and associated complications. It has been a major health issue worldwide affecting over 400 million people. In Sri Lanka, one in twelve adults suffers from diabetes. Past studies have shown that Ayurvedic medicine can be used for the treatment of diabetes. A study was designed to investigate the anti-glycation effects of water extracts of *Andrographis paniculata* (AP). Sonicated (APS) and boiled (APB) samples of AP leaves were prepared by sonicating for 1 hr and boiling for 1 hr respectively. Extracts at concentrations of 0.02%, 0.1% and 0.2% (w/v) were incubated with lysozyme and fructose at 37°C and pH 7.4 for 7 days. Incubation was also done with standard glycation inhibitor aminoguanidine (AG) as a positive control and other controls in replace of extracts. After 7 days, products of protein cross-linking in the incubation mixtures were detected using Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE). High molecular weight products representing dimer, trimer, and tetramer were observed in the negative control containing fructose but no AG and extract, indicating the occurrence of protein cross-linking. Such products were not observed in the positive control (AG), confirming the inhibition of glycation. Similarly, APS and APB showed dose-dependent inhibition of protein cross-linking at all three concentrations, with a complete protein cross-linking inhibition observed at a concentration of 0.2%. Despite being to a slightly lesser degree than APS, the presence of glycation inhibition in APB indicates good thermal stability of AP. In conclusion, AP water extracts can be used to prevent diabetic complications and due to its thermal stability, can be used as a home remedy.

Keywords: Glycation, Cross-linking, Antidiabetic, *Andrographis paniculata*

Development of an Edible Packaging Material Using Jack Fruit (*Artocarpus heterophyllus*) Seeds and ‘Kohila’ (*Lasia spinosa*)

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Currently, increasing worldwide annual plastic production and improper handling of plastic waste leads to higher environmental pollution. Therefore, the present study was focus to develop a packaging material with edible properties. Edible packages are beneficial rather than bioplastics because it does not exist in the environment as waste. Jackfruit (*Artocarpus heterophyllus*) seeds that are underutilized contain about 24% of amylose and Kohila (*Lasia spinosa*) rhizomes are under-utilized marshy herb with anti-oxidant properties, which imparts good health effects. Therefore, this edible package consists of Jackfruit (*Artocarpus heterophyllus*) seed powder, Kohila (*Lasia spinosa*) rhizomes powder, Tylo powder, Salt, Sorbitol, Cooking Oil and Water. All materials were used according to a finalized recipe, mixed, prepared a thin film, and molded up. Treatments were prepared by varying Kohila Rhizome powder (KRp) at 0%, 2%, 8%, and 12%. Treatment with 0% KRp was served as the control. Based on sensory evaluation, treatment with an 8% KRp added sample was selected. Physiochemical properties, Water Vapor Permeability (WVP), Microbial analysis, DPPH Scavenging Activity, FTIR analysis, and proximate analysis were carried out to the best treatment. The fiber level was higher (7% on a dry basis) in treatment with 8% KRp. WVP was decreased in the 8% KRp treatment ($p < 0.05$) during storing conditions at temperature $25 \pm 0.5^{\circ}\text{C}$ and humidity $50 \pm 2\%$ RH. FTIR analysis showed that there was no effect on the addition of Kohila bonds within the film and hydroxyl (OH) groups are present which causes solubility in water. There was no effect on Total Plate Count addition of KRp. DPPH Scavenging Activity was high and hardness was low. In conclusion, an edible cup developed with 30 - 35% of Jackfruit seed powder and 8-10% Of KRp has good antioxidant activity and barrier properties and it would be a better alternative for the single-use synthetic cup.

Keywords: *Lasia spinosa*, Antioxidant, Jackfruit seeds, Edible cup, Dietary fiber

Assessment of Quality Parameters of Strained Yoghurt Incorporated with Germinated Mung Bean (*Vigna radiata*) Powder

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The present research was aimed to study the effects of germinated mung bean (*Vigna radiata*) powder on the physicochemical characteristics of strained yoghurt. The strained yoghurt was prepared according to the commercial guidelines by incorporating germinated mung bean powder and without germinated mung bean powder (control). A sensory evaluation was conducted to determine the suitable level of germinated mung bean powder from 1%, 1.5%, 2%, and 2.5% (w/w) using 30 untrained panelists. The control and the selected sample were tested for protein, fat, total ash, fiber, moisture, pH, titratable acidity (TA), Brix value, microbial quality for one month in seven days interval at refrigerated condition (4°C). Based on the results of sensory evaluation, strained yoghurt with 2% (w/w) germinated mung bean powder was chosen as the best treatment. Results revealed that strained yoghurt with 2% germinated mung bean powder had the highest fat ($3.46 \pm 0.07\%$) and protein ($7.48 \pm 0.11\%$) contents compared to that of the control. Results showed that strained yoghurt with 2% germinated mung bean powder had the highest pH (4.59) during 4 weeks of the storage. Similarly, incorporation of germinated mung bean powder into strained yoghurts increased the TA compared to that of the control sample while a 2% germinated mung bean flour incorporated sample had the highest Brix value (18.66). The pH of strained yoghurt samples was decreased ($p > 0.05$) during storage. TA and Brix values were increased ($p > 0.05$) during the storage. Total plate count and yeast and mold counts in strained yoghurts were increased ($p > 0.05$) with the incorporation of germinated mung bean powder during storage, however, the values did not exceed the permitted levels (SLS 824:2). Coliform was absent in all samples. In conclusion, germinated mung bean powder enhances the nutritional value and the sensory properties of strained yoghurts.

Keywords: Strained yoghurt, Titratable acidity, Germinated mung bean powder, Brix value

Effect of Different Levels of Soy Flour in Batter on Quality Parameters of Crispy Chicken

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Crispy chicken is a battered and fried meat product. Soy flour is a good protein source having high viscosity and film-forming ability. Therefore, the current research was aimed to study the effect of different levels of soy flour as a component of the batter on crispiness and other quality characteristics of crispy chicken. The crispy chicken was prepared according to the commercial guidelines by incorporating soy flour at 0%, 5%, 10%, and 15% (w/w) and wheat flour and corn flour making the balance in the batter mixture. A sensory evaluation was conducted using a 7-point hedonic scale and 30 untrained panelists to select two best crispy chicken samples incorporated with soy flour. The control and two selected samples were tested for proximate composition, pH, colour, water holding capacity, microbial quality, and TBARS value over a one-month storage period. Crispy chicken with 10% and 15% soy flour levels in batter was chosen as the best treatment ($p < 0.05$) during the sensory evaluation. Results further revealed that crispy chicken with 15% soy flour had the highest fat (17.1%) and protein (24.3%) contents compared to other treatments ($p < 0.05$). At the initial stage of the storage, crispy chicken with 15% soy flour had the highest pH (8.84) value ($p > 0.05$) and that with 10% soy flour had the highest water holding capacity (93.33%) ($p < 0.05$). Besides, crispy chicken with 10% soy flour had the highest crispiness followed by control and 15% incorporated level ($p < 0.05$). The pH values and water holding capacity of crispy chicken samples decreased ($p > 0.05$) during storage. Furthermore, TBARS and total plate count values increased in control and other treatments with the storage, but within the permitted levels. *Salmonella* and *Escherichia coli* were absent in all samples. In conclusion, soy flour in the batter enhanced the crispiness and sensory properties of crispy chicken at a 10% level in an economical and sensory perspective.

Keywords: Crispiness, *Salmonella*, *Escherichia coli*, Sensory, TBARS value

Study on Palmyrah Toddy Sediments as a Leavening Agent for Bakery Products

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Palmyrah toddy is a unique palm product that generates more income for Palmyrah dependents. Yeast sediments can be observed in bottled toddy production and most of the time they are discarded during the process. The main objective of this study is to convert these fresh sediments into a leavening agent suitable for domestic bakery production. Pooled Palmyrah toddy obtained from palm development corporative societies was used for the isolation of yeast. Among the 13 isolated yeast strains best yeast were selected based on the Leavening Index (LI) as commercial yeast (IY), mixed yeast (MY) and isolated yeast (N10) were selected and showed LI value of 1.3, 1.2 and 1.2 respectively. Killer toxicity was tested with peptone dextrose methylene blue agar plate and no toxicity was observed. Mixed yeast culture was showed growth at 45°C, pH 5 to 6, and tolerance to alcohol (5-10%) and salt (4-8%). Medium optimization was done by using general full factorial design and the best treatment having yeast extract (2 g/l), peptone (1 g/l), and glucose (1 g/l) was selected and it showed 0.857 optical density at 5th day of fermentation. Yeast was dried at different treatments such as sundry, shade dry, and oven-dry at 50, 55, and 60°C. The best treatment (55°C) showed the corresponding LI, dry weight (g/100 ml) and viability (%) were 18.45(±0.46), 1.6, and 98.85(± 0.85) respectively. Wheat flour was selected for the bun preparation based on the LI (1.4), bun prepared by using MY, IY and N10 showed significant (p<0.05) difference in sensory characteristics, while there was no significant difference in nutritional characteristics as a percentage of moisture (6.7), fat (3.8), protein (0.9), ash (1.1) and total sugar (73.2) of the bun with MY and IY. Therefore, yeast obtained from the palmyrah toddy sediment could be used as a leavening agent in bakery products.

Keywords: Palmyrah toddy sediment, yeast, leavening agent, bun

Determination of Sucrose, Glucose and Fructose Levels in Low Grown Black Tea Using High Performance Liquid Chromatography Technique

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No extraneous matters are allowed to add during tea manufacture. Nevertheless, some of the manufacturers add sugar to withered tea leaves to develop better appearance in black tea. Sugar adulteration adversely affects the reputation of Ceylon Black Tea. As stipulated by the Tea Research Institute of Sri Lanka, maximum permissible levels of fructose, glucose, and sucrose for low grown black teas are 25 mg/g, 20 mg/g, and 35 mg/g respectively. The present study was conducted to determine whether the black tea manufactured in the low country in Sri Lanka was adulterated with sugar. Sample collection was done according to stratified random sampling keeping administrative districts; Galle, Matara, and Rathnapura as strata. Sixty-three black tea samples (Dust 1 grade) were collected during three consecutive weeks. Coldwater extracts of samples were prepared and their sugar levels were determined using a High-Performance Liquid Chromatograph fixed with a Zorbax NH₂ column and a RI detector. The mobile phase comprised of 75% Acetonitrile and 25% de-ionized water. The average fructose, glucose, and sucrose contents of low grown tea were 6.3±2.7, 6.1±3.1, and 7.3±5.5 mg/g respectively. Fructose, glucose, and sucrose contents of all tea samples collected from Matara and Rathnapura districts were below the maximum permissible limits. Further, fructose and sucrose contents of Galle district's black tea samples were also below the maximum permissible limits. The highest fructose, glucose, and sucrose contents were detected from the Rathnapura district's black tea samples. It can be concluded that Matara and Rathnapura Districts' black tea samples comply with the stipulated maximum permissible levels of fructose, glucose, and sucrose whereas Galle District's black tea samples comply with the maximum permissible levels of fructose and sucrose.

Keywords: Black tea, Fructose, Glucose, Sucrose, Adulteration

Comparison of Dressing Percentage and Meat Quality Traits of Broilers Reared under Different Housing Systems

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At present, open house and closed house systems take a major position for broiler production and no scientific studies have been conducted on dressing percentage and meat quality traits of broilers reared under these housing systems in Sri Lankan context. Therefore, this study was performed to compare the dressing percentage and meat quality traits of broilers reared under the open house and closed house systems. Ten birds from each housing system were selected randomly at the slaughtering line in a commercial broiler processing plant. Dressing percentages and physicochemical and sensory quality traits were determined. Sensory evaluation was conducted using a 7-point hedonic scale and 30 untrained panelists for appearance, color, flavor, aroma, juiciness, texture, mouthfeel, and overall acceptability. Results showed that broilers from the closed house had a significantly higher dressing percentage (82.95%) than those from open houses (79.50%) ($p < 0.05$). Higher protein content (23.08%), pH value (6.62), cooking loss (32.12%), hardness, gumminess, and chewiness while a lower water holding capacity (75.80%) were observed in meat from open house system compared to that from closed house system ($p < 0.05$). Further, thigh meat showed significantly higher moisture content (77.27%), fat content (3.37%), a^* value (11.52), pH value (6.65), and cooking loss (31.93%) and lower protein content (19.16%) and L^* value (58.13) than breast meat ($p < 0.05$). Sensory evaluation results showed no significant difference between meat from the two systems ($P > 0.05$). In conclusion, dressing percentage and physicochemical properties were affected by the housing system and the anatomical location of meat. But, the sensory properties of both breast and thigh meat were not affected by housing systems.

Keywords: Open house, Closed house, Sensory, Cooking loss

Effect of Different Marinades with Bee Honey and Pineapple on Quality Attributes of Smoked Chicken Jerky

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This study was carried out to investigate the effect of different marinades made with bee honey, pineapple, and their combination of physicochemical and sensory attributes of smoked chicken jerky (SCJ). As the marinade solution, different levels of bee honey (5%, 10%, 15%) and pineapple (5, 10, and 15%), and combinations of bee honey and pineapple (2.5%+2.5%, 5%+5%, 7.5%+7.5%) and for the control sample water (20%) with spice mixture was used. Preliminary trials were conducted to determine the best recipe for SCJ. A sensory evaluation was conducted by using 30 untrained panelists according to the 7-point hedonic scale to select the best treatments for further analysis. Selected SCJ treatments were tested for marinade uptake, cooking loss, proximate composition, pH, colour, water holding capacity, texture, microbiological analysis, and TBARS value for 4 weeks of storage. Based on sensory evaluation, SCJ with 5% and 15% bee honey were selected as the best treatments ($p < 0.05$). Results further revealed that 15% of bee honey had the highest amount of protein and lower ash. The highest moisture (66.87%) content and cooking loss (54.55%) have resulted in SCJ with 5% bee honey. During the storage, pH was decreased and TBARS values increased within the permitted levels. There is no significant difference in the hardness and fat content between the samples ($p > 0.05$). However, the highest gumminess and chewiness values have resulted in SCJ with 15% bee honey ($p < 0.05$). Total plate count increased during the refrigerated (0-4°C) storage within the permitted levels. The treatments kept under refrigerated (0-4°C) condition extended the shelf life up to 4 weeks while the shelf life of those kept at room temperature (27-28°C) was limited to 2 weeks. *Salmonella* and *Escherichia coli* were absent in all treatments. In conclusion, bee honey enhanced the physicochemical and sensory attributes of SCJ at a 15% level at refrigerated (0-4°C) storage.

Keywords: Bee honey, Marination, TBARS value, Jerky, Chewiness

Effect of Guar Gum and Carboxymethyl Cellulose on Heating Behavior of Coconut (*Cocos nucifera*) Milk

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Thermal processing is used to destroy *Clostridium botulinum* in low acid canned foods such as coconut milk (CM) and thereby, extend the shelf life. The length of the thermal treatment is established based on the targeted thermal destruction (12D destruction) of *C. botulinum*. at 121.1°C in the container cold point. Typically, the addition of stabilizers into CM is performed to increase the emulsion stability and to alter the heat transfer behavior. Therefore, the main objective of this study was to investigate how the heating behavior of CM could be changed with the addition of different stabilizers. During the study, heating behavior and heat-sensitive properties of CM were studied at three different temperatures (30, 50 and 80°C) against the separate addition of Guar Gum (GG) and Carboxymethyl Cellulose (CMC), that were incorporated at levels of 0.05, 0.1 and 0.5%. Extracted fresh CM was standardized for 17% fat and homogenized at 894 g for 5 min. Homogenized samples having different levels of GG and CMC were prepared from standardized CM. Specific gravity and viscosity of prepared samples at 30, 50, and 80°C were determined using the gravimetric method and viscometer, respectively. Cold point and the length of thermal processing to achieve target thermal death time (*F*₀) of *C. botulinum* (2.52 min) were determined for prepared CM in aluminum cans. It was found that the specific gravity of samples at 30-80°C was in the range of 0.9778±0.05-1.0176±0.01 for GG and 0.9957±0.00-1.0164±0.03 for CMC and that did not significantly differ (*p*>0.05) and viscosity was in the range of 9.98±3.31-126.70±0.00 for GG and 9.98±3.31- 40.00±3.30 for CMC. The cold point of canned CM was found to be the center of the can which was above 3 cm from the bottom. The addition of stabilizers did not affect the cold point of canned CM. Incorporation of GG and CMC into CM had no significant effect (*p*>0.05) on the processing time (80.2-88.8 min. for GG and 86.8-88.8 min. for CMC). In conclusion, the heating behavior of canned CM was not affected by the addition of GG and CMC.

Keywords: Coconut Milk, *F*₀, Cold point, Viscosity, Specific gravity

Development of Madan (*Syzygium cumuni* L.) Incorporated Novel Yoghurt

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Madan (*Syzygium cumuni* L.) is an underutilized fruit crop grown in Sri Lanka with promising functional properties. In this study, well ripen Madan fruits were used to develop fruit incorporated set yoghurt. Yoghurts were prepared with different sugar (0, 5 and 10% w/v) and gelatin (0.6, 0.7 and 0.8% w/v) levels to select the best combination. Pasteurized fruit pulp was added at the levels of 7.5, 10, 12.5, and 15% w/v with a pre-selected level of sugar and gelatin. Based on sensory evaluation (9-point hedonic test), selected treatment was tested against the control (set yoghurt without added fruits) for physicochemical and phytochemical properties. Shelf life and microbial analysis were carried out in three days intervals for 18-days. Based on the results of sensory analysis, it was revealed that 10% sugar, 0.8% gelatin, and 10% of fruit pulp were the best combination for the production of fruit yoghurt. Addition of Madan increased ($p < 0.05$) the phenolic content (3.04 ± 0.1 mg GAE 100 g^{-1} yoghurt), monomeric anthocyanin (4.42 ± 0.4 mg L^{-1}) and antioxidant activity (Ferric reducing power assay: 0.14 ± 0.0 $\mu\text{mol Fe}^{+2}$ 100 g^{-1} ; IC₅₀: 331.08 ± 1.5 ppm) of fruit yoghurt compared to that of the control. Storage of the yoghurt samples for 18-days under refrigerated condition ($< 5^{\circ}\text{C}$), increased ($p < 0.05$) the acidity while decreased ($p < 0.05$) the pH. Syneresis increased ($p < 0.05$) with the storage period in the control sample while fruit yoghurt exhibited the decreasing ($p < 0.05$) pattern with the time. Yeast and mold, *Staphylococci* spp, and *Escherichia coli* did not exceed the Sri Lankan Standard Institute recommendation during the 15 days of refrigerated storage ($< 5^{\circ}\text{C}$). In conclusion, 10% fruit pulp was the best level for the production of Madan incorporated set yoghurt with promising antioxidant properties which have 15 days of shelf life at refrigerated conditions ($< 5^{\circ}\text{C}$).

Keywords: Anthocyanin, Antioxidant activity, Total phenol, Yoghurt, Madan

Microbial Deterioration of Stored Banana Varieties (Embul Kesel: Sour Banana and Kolikuttu: Silk Banana) and Determination of Their Best Storage Conditions

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The present study was focused to determine the best storage conditions and to assess microbial and nutritional variation of stored sour banana and silk banana during storage. Fresh and green samples of banana varieties were picked from a farm in the Badulla area. After surface sterilization, bananas were stored in four storage conditions; refrigerator (4°C), wet saw dust, dry sawdust, and room temperature which were served as treatments of the study. The content of protein, crude fat, sugar, moisture, and microbial counts was assessed in three-day until the bananas were over-ripened. Microorganisms were isolated and identification was done. *Fusarium* spp. and *Aspergillus* spp. were the dominating fungal species while *Alcaligenes* spp. and *Xanthomonas* spp. were the tentatively identified dominant bacteria in sour banana and silk banana respectively. But the best storage condition for both varieties was refrigeration (sour banana 13 days, silk banana 20 days). When considering the nutrient profile sour banana contained high protein percentage and low-fat percentage while silk banana contained low protein percentage and high-fat percentage throughout the ripening process. When ripening protein content has increased while fat content has decreased in both varieties. However, both moisture and sugar content increased and were almost similar in both varieties. Therefore, high protein and low-fat content could have led to faster ripening and microbial deterioration of sour banana. Protein and fat content play a major role in shelflife of studied banana varieties and the best storage condition for the selected varieties was refrigeration.

Keywords: Sour Banana, Silk banana, Storage condition

Evaluation of Defatted Coconut Testa Flour Formulation for Selected Sri Lankan Traditional Foods

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Coconut testa is the major by-product of Virgin coconut oil and DC processing. The dried brown testa was gone through the cold press extraction process to collect the defatted residue and it ground into fine flour. This research aimed to evaluate the best testa flour formulation for two Sri Lankan traditional food items, *roti* and *pittu* and to determine their nutritional properties. Food items were made incorporating 10%, 20%, and 30% of testa flour (TF), and their sensory properties were evaluated using 25 untrained panelists through a five-point hedonic scale. Proximate qualities of selected *roti* samples, functional properties of selected flour blend were compared with control treatment (100% wheat flour). The moisture content (4.04 ± 0.12 %) and free fatty acid content (1.33 ± 0.018) of testa flour were the initial quality TF. All sensory attributes (taste, texture, appearance, smell, overall acceptance) were affected significantly ($p < 0.05$) for testa flour incorporation into the wheat flour-based *roti*. There was no significant difference ($P > 0.05$) between 10% and 20% TF incorporation for all sensory attributes. Testa flour incorporation (10% and 20%) were affected significantly ($p < 0.05$) for the taste and texture of *pittu*. The testa flour can be successfully incorporated into refined wheat flour to make *roti* and *pittu* up to a level of 20% to enhance nutritional qualities with acceptable sensory attributes. Proximate composition of selected (20%) testa flour incorporated *roti* and control *roti* (wheat flour 100%) not showed significant difference ($p > 0.05$) in moisture (Oven dry method), fat (Soxhlet), carbohydrate and ash content between testa flour *roti* and wheat flour *roti*. Incorporation of 20% of testa flour affected significantly ($p < 0.05$) for the fiber (Weende) and protein content (kjeldahl), of two treatments. The 20% TF incorporation has increased the fiber level of *roti* $1.81 \pm \%$ to $7.04 \pm \%$ with the quality of proteins from $12.43 \pm \%$ to $16.06 \pm \%$ compared to the control.

Keywords: Testa flour, Wheat flour, Sri Lankan traditional foods, Dietary fiber, Gluten

Determination of Acrylamide Formation with Different Frying Temperatures in Potato (*Solanum tuberosum*), Cassava (*Manihot esculenta*) and Sweet Potato (*Ipomoea batatas*)

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Acrylamide is a carcinogenic toxic compound formed during the frying process at high temperatures by the reaction of asparagine and reducing sugars. Due to the high consumption of fried tubers in the world, it is worthwhile to detect and quantify the acrylamide in fried foods to reduce the detrimental effects on human health. This study aimed to analyze the effect of temperature and the available nutrient content on the formation of acrylamide in three selected tuber species named as potato (*Solanum tuberosum*), cassava (*Manihot esculenta*) and sweet potato (*Ipomoea batatas*). Fried tuber samples were prepared by deep frying at 160°C, 180°C and 200°C separately using coconut oil until they reach the standard colour based on the colour chart recommended by the United States Department of Agriculture. Proximate analysis was carried out to determine the nutrient content of raw and fried tubers before analyzing the acrylamide. Gas Chromatography-Mass Spectrometry (GC-MS) was used to detect the acrylamide and quantification was proceeded according to a calibration curve of acrylamide standard ($R^2 = 0.8535$). Among the varieties, the potato was recorded the longest frying time and sweet potato was recorded the shortest time duration in all three different temperatures to obtain the recommended colour. Further, the highest amount of protein content was observed in potato and the lowest protein content was observed in sweet potato in raw form and the protein content reduced in all varieties dramatically with the increment of temperature. Similarly, the highest acrylamide concentration was found in potato ($1125.65 \mu\text{gkg}^{-1}$) fried at 200°C and lowest acrylamide concentration was detected in sweet potatoes fried at 180°C which was $84.36 \mu\text{gkg}^{-1}$. Acrylamide was not detected in raw samples. Results revealed that acrylamide formation was increased with the increment of temperature and there is a significant effect of the protein content of tubers on the development of acrylamide ($P < 0.05$).

Keywords: Acrylamide, Frying temperatures, Tubers, GC-MS

Development of Finger Food Incorporated with Rathu Heenati Rice (*Oryza sativa* L.) Flour, Chickpea (*Cicer arietinum* L.) Flour and Mung Bean (*Vigna radiata* L.) Flour for Toddlers

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In the Sri Lankan context, proper nutrition among toddlers is a very crucial problem due to less consumption of nutritious foods. Therefore, finger foods with high nutritional composition and acceptable sensory attributes can be introduced to increase their consumption. Legumes such as; mung bean (*Vigna radiata* L.) and chickpea (*Cicer arietinum* L.) are rich sources of protein. Rathu heenati rice (*Oryza sativa* L.) is a traditional rice variety that contains a high nutritional and medicinal value. The main objective of this study was to develop value-added finger food which can fulfill the nutritional requirements of toddlers to a considerable level. Finger food was prepared by changing the levels of rathu heenati rice flour, germinated chickpea, and mung bean flour in the percentages of 60:10:30, 60:25:15, 60:30:10, 60:15:25 and 60:20:20, respectively. Treatments were subjected to sensory analysis to select the best finger food formulation. Finger food formulated with 60 of wheat flour: 20 of mung bean: 20 chickpea flour served as control. Finger food with rathu heenati rice flour, chickpea flour and mung bean flour in 60:25:15 treatment was chosen as the best sample ($p < 0.05$) and tested for proximate composition (protein, fat, ash, fiber and moisture), colour, texture, pH, Brix value and TPC over one month in seven days interval. Results showed that selected finger food sample had the highest protein (21.85%), fat (22.11%) and ash (3.27%) content compared to the control which showed protein (16.52%), fat (19.83%) and ash (1.84%) content, ($p < 0.05$). During the storage, pH was decreased while TPC values were increased in both samples. The hardness of both samples was decreased within the storage. *E. coli* was absent in both samples. In conclusion, finger food incorporated with rathu heenati rice flour, chickpea flour, and mung bean flour at 60:25:15, showed high nutritional composition as well as acceptable sensory attributes for toddlers.

Keywords: Rathu heenati rice, Mung bean, Chickpea, Finger food, Toddlers

Development of Palmyrah Tuber Flour Incorporated Noodles and Analysis of its Physicochemical and Sensory Properties

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Noodles is one of the popular fast food items having good market demand. Palmyrah tuber flour with numerous health benefits can thus be a better option than wheat flour to make healthy noodles. The objective of this study was to develop palmyrah tuber flour (PTF) incorporated noodles and compare with wheat flour noodles (control). Five different ratios of wheat flour: PTF (45: 55, 55: 45, 65: 35, 75: 25, 100:00) were tested. Other ingredients used were salt (1.75%), carboxymethyl cellulose (0.30%), sodium bicarbonate (0.60%), coconut oil (7%) and water (35%). The best formulation was selected via sensory evaluation by 30 untrained panelists using a 9-point Hedonic scale. Noodles containing wheat flour: PTF in 35:65 ratio was chosen as the best formulation according to the sensory analysis. The selected noodles were compared with the control in terms of cooking quality, pH, moisture, nutritional composition, calorific value, total phenolic content, and yeast and mold count. Total phenolic content was in 2-fold greater abundance in PTF noodles (1.35 ± 0.07 mg/ g), indicating greater antioxidant capacity. Additionally, the PTF noodles contained calcium (0.01 mg/g) and magnesium (0.13mg/g) 3 times and 10 times greater abundance respectively as determined by titrimetric analysis. Yeast and mold count in both noodles complied with Sri Lanka Standard requirement for noodles. Fat (6.27%) and sugar (1.65%) contents of the PTF noodles satisfied the Food Act requirement, whereas the salt content (3.46%) exceeded the preferred limit. The PTF noodles were found to be inferior to the control noodles, in terms of cooking quality. The incorporation of PTF had increased the health values of the noodles as PTF has higher mineral (calcium and magnesium) and total phenolic content

Keywords: Food act, Noodles, Nutrients, Palmyrah tuber flour, Sri Lanka Standard

Effect of Potassium Sorbate and Thickness of Packaging Material on Shelf Life of Coconut Fingers

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Coconut finger is a product made from coconut kernel and sugar which is more susceptible to mold growth and rancidity development. Hence it has a very short shelflife; it is restricted generally for one month. This research was conducted to investigate the effect of potassium sorbate concentration and thickness of packaging material on the shelflife of coconut fingers. Prepared coconut finger samples were treated with 0.20% and 0.27% Potassium sorbate levels separately. Each sample (30 g) of each level were packed in Low-Density Polyethylene (LDPE) package with the dimensions of 15 cm length, 15 cm width and thickness of 500 Gauge, 600 Gauge and 700 Gauge, accordingly and stored at 27 °C and 65% relative humidity along with a control. Samples were periodically withdrawn to monitor changes in physical, chemical, and microbiological qualities. According to chemical analysis, concerning peroxide value and free fatty acid values, Potassium sorbate treated samples showed greater oxidative stability than the control sample throughout the study. When considering microbial colony counts, potassium sorbate treated samples showed less Total plate counts and yeast and mold counts than control. Based on moisture contents potassium sorbate treated samples showed low moisture contents than the control sample. Color measurements revealed that color of potassium sorbate treated samples was better than control. This study concludes that there is an effect of potassium sorbate and no effect from the gauge of polyethylene on the shelf life of coconut fingers. According to the physical, chemical, microbiological, and statistical results obtained, the best potassium sorbate level was 0.27% and according to the cost analysis, the effective gauge of LDPE was 500-gauge.

Keywords: Coconut Fingers, Polyethylene gauge, Potassium sorbate, Shelflife

Effect of Gamma Irradiation on Microbiological and Physicochemical Properties of Dehydrated Carrot (*Daucus carota* L.) and Dehydrated Ripe Jackfruit (Waraka) (*Artocarpus heterophyllus* L.)

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Dehydrated ripe Jackfruit (waraka) and carrot have a high demand in the local and export market due to their health benefits and the use as ingredients for the food industry. The study was carried out to evaluate the effect of different gamma irradiation doses on physicochemical parameters and microbial quality of dehydrated waraka and carrot in Sri Lanka. Dehydrated waraka and carrot samples were collected and irradiated at doses of 0 kGy, 2 kGy, 4 kGy, 6 kGy, 8 kGy, and 10 kGy by industrial Co-60 gamma irradiator at dose rate 5.3 of Gy min⁻¹. Under physical parameters, water activity and moisture content were measured for each of the treatments. Total plate count, yeast, and mold count and coliform counts were determined by using ISO modified method. Antioxidant content by following DPPH free radical scavenging method, total phenolic content by following Folin- Ciocalteu (FC) method, and beta carotene content by using AOAC 1980 method was analyzed in all the irradiated samples and non-irradiated samples and all physicochemical and microbial treatments were replicated in three times. The average moisture content of irradiated waraka and carrot samples was 97.04±0.09% and 96.37±0.09% respectively. The average water activity of irradiated waraka and carrot samples was 0.49±0.00 and 0.50±0.00 respectively. Antioxidant activity and total phenolic content of the waraka and carrot samples showed no significant difference (P>0.05) among different-irradiation doses. However, the content of beta carotene has been reduced (P<0.05) with the increase of irradiation-dose. Both irradiated waraka samples and carrot samples showed a reduction (P<0.05) of total plate count with the increase of irradiation dose. There was no growth of yeast and mold and *Escherichia coli* in all the gamma-irradiated samples. It was concluded that the most preferable irradiation doses for preserving the physical and nutritional quality and microbial safety of dehydrated waraka and dehydrated carrot were 2 kGy and 4 kGy.

Keywords: Dehydration, Waraka, Carrot, Gamma irradiation, Dose

Comparison of Antimicrobial, Antioxidant and Total Phenolic Content of Leaves of *Solanum torvum*, *Solanum incanum*, *Solanum violaceum* Grown in Two Different Areas of Sri Lanka

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The present study was carried out to compare the antioxidant activity, antibacterial activity, and total phenolic content of the leaf extracts of *Solanum torvum*, *Solanum incanum*, and *Solanum violaceum* and to identify the effect of geographical area on the selected chemical properties to utilize them in medicinal purposes effectively. Three mature leaf samples for each variety were taken from three different locations of Badulla and Puttalam district and Methanolic extracts of shade-dried leaf powder were prepared. The antioxidant activity was determined using DPPH spectrometric assay. The antibacterial activity was investigated using agar disk diffusion assay against *Escherichia coli* and *Staphylococcus aureus* with Gentamicin as positive control and Methanol as the negative control. Folin Ceocalteu method was used to determine the total phenolic content of selected plants. *S. torvum* growing in Badulla district has shown the highest total phenolic content (163.4 GAE/g) and highest antioxidant activity (IC 50 value, 0.72 ppm). All the extracts tested were not active against *E. coli*. However, extracts of *S. torvum* in Badulla district were active against *S. aureus* (Average Inhibition Diameter, 7.33 mm; Positive Control, 24 mm; Negative control, 0 mm). According to statistical analysis, there is no significant difference in antioxidant activity and total phenolic content of the studied varieties and no significant effect from geological area to any of the studied properties (Two-way ANOVA, $p > 0.05$). Since *S. torvum* of Badulla district has shown comparatively higher antioxidant activity, antibacterial activity, and total phenolic content, it could be more effective in the production of various medical commodities. However, further studies should be done for *S. torvum* growing in other areas as well.

Keywords: *Solanum* sp., Antioxidant activity, Anti-bacterial activity, Total phenolic content, Geographical area

Estimation of Benzoic Acid in Commercially Available Fruit Juices and Nectars in Anuradhapura City Area

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Benzoic acid is a commonly used chemical preservative for processed foods in the form of benzoate. In the presence of sunlight, benzoate reacts with ascorbic acid and can produce benzene which is a known carcinogen. In most retail outlets in Sri Lanka, fruit beverages are stored exposing to sunlight. Considering the importance of this subject, this study was aimed to estimate the benzoic acid content in selected commercially available fruit juices and nectars stored exposed to sunlight and without exposure to sunlight. Through a pre-validated questionnaire, commonly available brands of fruit juices [Mixed Fruit Juice (MFJ) and Mango Juice (MJ)] and nectars [Mixed Fruit Nectar (MFN) and Mango Nectar (MN)] in Anuradhapura city were selected. The amount of benzoic acid was estimated according to the method described by Williams *et al.*, (1998). Benzoic acid was detected in 3 brands of MFN and MN and 2 brands of MFJ and MJ, although it was not indicated on the labels. The maximum permitted level of benzoic acid in fruit nectars is 120mg/L and benzoic acid is not permitted to be used in fruit juices (SLS 1328: 2008). Mean benzoic acid concentration in MFN and MN without exposing to sunlight were 88.33±68.93mg/L and 72.56±50.06 mg/L while samples exposed to sunlight showed mean benzoic acid levels of 16.41±12.60 mg/L and 20.35±17.93 mg/L respectively. Mean level of benzoic acid in MFJ and MJ without exposed to sunlight were 44.95±1.64 mg/L and 36.04±5.07 mg/L while samples exposed to sunlight showed mean benzoic acid levels of 5.66±7.81 mg/L and 1.80±8.63 mg/L respectively. Therefore, there was a significant difference ($p<0.05$) in the reduction of benzoic acid in MFN, MN, MJ, and MFJ samples exposed to sunlight. It can be concluded that the effect of sunlight during storage has a relationship with the marked reduction of benzoic acid contents in fruit juices and nectars. Further studies needed to be conducted to identify the presence of benzene in fruit drink samples.

Keywords: Benzoic acid, Fruit juices, Fruit nectar, Sunlight

Evaluation of Probiotic Activity of Drinking Yoghurt in the Presence of Two Natural Fruit Pulps

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Drinking yoghurt (DY) is one of the most popular fermented dairy products in the market which can be used as a carrier of probiotics and prebiotics. According to new findings, *Streptococcus thermophilus* (ST) can be considered as a probiotic microorganism. Fruits contain prebiotic carbohydrates such as oligosaccharides, antioxidants, and polyphenols. In this study, the changes of microbiological, chemical, and sensory properties of fruit pulps incorporated DY which produced using single strain ST culture was evaluated. DY was prepared using two levels of (5% and 10%) strawberry pulp or mixed berry pulp and with control. The control sample was prepared without adding fruit pulps. The viability of ST was evaluated for 28 days of refrigerated storage (4 °C) with 7 days interval using M17 agar with β -glycerophosphate. The sensory evaluation was conducted by using 30 untrained panelists according to the 9 points hedonic scale. The sensory evaluations showed that the DY, containing 5% strawberry and 10% mixed berry had better overall acceptability than other treatments. Fruit pulp incorporated DY showed a lower ($p < 0.05$) pH value and higher titratable acidity than that of the control during storage at 4. Strawberry 5% incorporated DY and mixed berry 5% incorporated DY showed higher ($p < 0.05$) ST counts throughout the storage period, compared to the 10% strawberry or mixed berry incorporated DY and that of the control. This may be due to the low initial pH and higher titratable acidity due to the addition of fruit pulps. The DY samples incorporated with 5% strawberry pulp showed higher ($p < 0.05$) ST counts (8.53 0.03) log cfu g⁻¹ at 28 days of refrigerated storage compared to the 5% mixed berry incorporated DY (8.44 0.01) log cfu g⁻¹ and that of the control (8.21 0.02) log cfu g⁻¹. These results revealed that the addition of fruit pulps increased the viability of ST during refrigerated storage.

Keywords: Drinking yoghurt, Microbiology, Probiotic, *Streptococcus thermophilus*

Extraction of Natural Food Colorant by using Bovitiya (*Osbeckia stellata*) and Evaluation of its Stability under Different Processing Conditions

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Numbers of phytochemicals have been derived directly or indirectly from natural sources in the form of food supplements, oil, nutraceuticals, and color pigments. Herbal medicines have been used for the treatment of various disorders in Ayurveda medicine and all over the world due to their numerous health benefits. Bovitiya (*Osbeckia stellata*) is a medicinal plant which contains Anthocyanins that is responsible for the various colors of the plant. Anthocyanins have a wide range of pharmacological properties and play a major role in the food industry as natural colorants due to its possible health benefits and safety issues compared to the synthetic dye. In this study, Bovitiya fruits were used to extract anthocyanin pigment. Weighted fruits were blanched to degrade the enzymes responsible for browning, before the extraction procedure. The experiment was carried out using only 50% ethanol solution, according to 1:5 (w/v) ratios. The total monomeric anthocyanin content was measured using a pH differential method. Physiochemical properties and stability under different processing conditions (temperature, pH) were estimated. The stability of color extract was evaluated for one week using standard color codes. The total anthocyanin contents were 62.20 mg kg⁻¹ under the optimum condition set at temperature 60°C, 300 rpm for 3 hours. The study demonstrated that the very dark purple extract of the fruits is stable under low pH values (≤ 4.7) and unstable under alkaline (≥ 7) conditions. Also found to be sensitive to high temperature were the conditions like 121°C for 10 sec. Microbiological stability was tested using the standard method. Total plate count was (3.23 \pm 0.2 CFU mL⁻¹) and yeast and mold count was (2.33 \pm 0.2 CFU mL⁻¹) and *Coliform*, *E. coli* was not detected. The study carried out on Bovitiya provides information to tap its potential as a colorant in acidic and neutral food.

Keywords: Food color, Bovitiya, Anthocyanin, pH differential method, Physiochemical

Effect of *Kappaphycus alvarezii* Seaweed Powder on Quality Parameters of Chicken Meat Spread

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A meat spread is a semi-liquid colloidal suspension used in food preparation or consumed directly. *Kappaphycus alvarezii* is a seaweed species widely used in the food industry, which has high antioxidant properties. Therefore, the present study was conducted to elucidate the effect of incorporating seaweed powder (*Kappaphycus alvarezii*) in chicken meat spread on its quality parameters. Preliminary trials were conducted to determine the suitable levels of vegetable fat spread (i.e. 20%, 30%, 40% [w/w]) and spices. Seaweeds were oven dried (60°C, time) and ground to prepare its powder. The control and four meat spread samples (seaweed powder percentage 0%, 1%, 2%, 3%, 4%) were then prepared according to the commercial guidelines. A sensory evaluation was conducted using a 7-point hedonic scale and 30 untrained panelists to select the best level of seaweed powder for the chicken meat spread. All samples were tested for proximate composition, pH, color, water holding capacity, microbial quality, and TBARS value over a one-month storage period at a temperature of 4°C. Accordingly, 30% fat spread and 1% and 2% seaweed powder levels were selected as the best levels during the sensory evaluation. Results further showed that meat spread with 2% seaweed had the highest hardness, ash content, and pH value ($p < 0.05$). The 1% sample had the highest water holding capacity, lightness, and fat content ($p < 0.05$). Furthermore, TBARS and total plate count values were decreased with the increasing levels of seaweed powder with storage ($p < 0.05$). *Salmonella* and *Escherichia coli* were absent in all samples. The addition of *Kappaphycus alvarezii* can potentially enhance the quality parameters of chicken meat spread and reduce the rate of lipid oxidation during storage.

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Keywords: Seaweeds, Antioxidant, TBARS value, *Salmonella*, Fat spread

Effect of Marination with Lime Juice, Papaya Juice and Sesame Oil on Meat Quality Characteristics of Chicken Wings

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As a result of consumer's attention towards health, it has become a trend to consume natural ingredients to improve the quality of the product. There is a high possibility to use natural ingredients in the meat industry to improve the quality parameters of chicken meat. This study was done to determine the meat quality parameters of marinated chicken wings with lime juice, papaya juice, and sesame oil. Chicken wings were marinated for three hours with spice mixture mixed with lime juice, papaya juice, and sesame oil separately and the control sample was marinated with spice mixture mixed with water. Marinade: meat ratio was 1:1. Marinade uptake, meat quality parameters, proximate analysis, microbiological parameters, and lipid oxidation level of marinated chicken wings were evaluated. Sensory analysis was performed using a 7-point hedonic scale. The results showed that papaya juice has improved the tenderness of chicken wings ($p < 0.05$). Flavor desirability and general acceptability were significantly higher in chicken wings marinated with sesame oil according to the sensory evaluation. Lime juice ensured microbiological safety as it showed the lowest total plate count (7.25 CFU mL^{-1}). TBARS value was higher ($p < 0.05$) in wings marinated with lime juice (0.73 mg kg^{-1}). The antioxidant activity was higher in sesame oil (72%). Marinade uptake, crude ash, crude protein, and crude fat content of three treatments were significantly different. Chicken wings marinated with sesame oil had higher ($p < 0.05$) marinade uptake ($3.18 \pm 0.53\%$), fat content ($8.30 \pm 0.17\%$) and protein content ($67.11 \pm 0.05\%$) while those marinated with lime juice obtained higher ($p < 0.05$) crude ash content ($1.63 \pm 0.01\%$). Meat quality parameters such as pH, color, and texture were significantly different ($p < 0.05$) among the treatments. Chicken wings marinated with sesame oil had the highest texture, pH, and color values. In conclusion, sesame oil was a better marinade ingredient compared to lime juice and papaya juice.

Keywords: Tenderness, Antioxidant activity, Marinade uptake

Pectinase and Cellulase Activity of Bacterial Strains Isolated from Unsanitary Landfills

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Cellulase and pectinase producing bacteria can bring a scientific solution to overcome the municipal solid waste problem by introducing them as organic waste decomposers. Such bacterial species can use to reduce the cost of industrial enzyme production. The study aimed to isolate the bacterial strains with good cellulase and pectinase producing capability from unsanitary landfill soil to be utilized in organic waste degradation and industrial enzyme production in the future. All 21 bacterial strains were isolated in Nutrient Agar plates using serial dilution, spread plate, and streak plate methods. Morphological characteristics of bacterial colonies were noted. Well, diffusion assay was used to screen the cellulase and pectinase activity using carboxymethylcellulose (CMC) and Pectinase Screening Agar Medium (PSAM) respectively. The positive results were evidenced by clear inhibition zones in CMC and PSAM. The diameters of the clear zones were measured. There were three replicates for each bacterial culture. The experimental design was Complete Randomized Design. Data were analyzed by ANOVA in Minitab 16. Out of 21 isolates, 62% presented at least one considerable enzymatic activity. Zones of hydrolysis produced by the bacterial strains were ranged from 1.4 - 3.2 cm for cellulase while it was 1.0 – 5.1 cm for pectinase. The bacterial culture B14 showed the significant ($p \leq 0.05$) halo zone diameter in the CMC medium over the tested species by proving the highest cellulase activity. The most potent pectinase producers were found to be the isolate B1 and B6 because such cultures showed the significant ($p \leq 0.05$) halo zone diameter over the other species in PSAM. Based on morphology B1 was a bacillus in shape whereas B6 and B14 were coccus in shape. As per the results, it can be concluded that unsanitary landfill soil is inhabited by cellulose and pectin degrading bacteria, hence can be utilized in enzyme production and organic waste treatments.

Keywords: Cellulase, Pectinase, Soil bacteria

Effect of Dried *Murraya koenigii* Leaf Powder on Quality Parameters of Chicken Meat Cracker

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There is huge consumer demand for pre-cooked and shelf-stable meat-based snack products. Dried *Murraya koenigii* leaf powder (DMLP) possesses antioxidant, antidiabetic, anticancer, anti-inflammatory, and antimicrobial properties. This study was conducted to develop a chicken meat cracker incorporated with DMLP and to determine the physicochemical and sensory properties. Preliminary trials were conducted to finalize the best ratio of wheat and corn flour. Chicken meat crackers were prepared separately from the dough incorporated with DMLP at 0% (control), 1%, and 2%. After baking at 180°C for 15 minutes, samples were vacuum-packed and stored at 27°C. Proximate composition, pH, colour, water holding capacity (WHC), texture, microbial quality, and TBARS value were tested during the storage period. Sensory evaluations showed that 1:1 ratio of wheat: corn flour with 1% and 2% DMLP incorporated samples were acceptable. The hardness of the samples was decreased ($P < 0.05$) over the storage period. When considering the colour, the highest L^* value ($P > 0.05$) and b^* value ($P < 0.05$) was from 2% DMLP incorporated to sample, and the highest a^* value was from the control. The pH value reduced and TBARS values of all the samples increased over the storage period. At the initial stage, the lowest pH (7.73) and lowest TBARS value (0.76) was from 2% DMLP incorporated sample. *Salmonella*, *Escherichia coli*, yeast, and mold were absent in all samples up to one month storage period. Total plate count (TPC) values increased by 1% and 2% DMLP incorporated samples up to a month storage period. The highest TPC value was recorded from the control up to one month storage period. The highest average moisture content and the lowest ash content were recorded from the 2% DMLP incorporated sample. Thus, the results showed the possibility of utilizing both 1% and 2% DMLP to improve the nutritional characteristics of chicken meat crackers in equal amounts.

Keywords: Total plate count, Sensory, TBARS value, Hardness, *Murraya koenigii*

Preservation and Quality Evaluation of *Elaeocarpus serratus* (Ceylon Olive) using Natural Preservatives

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Elaeocarpus serratus (Ceylon olive/ *Veralu*) is one of the underutilized fruit tree species indigenous to Sri Lanka. The edible flesh of fully matured or ripen fruits is rich in minerals and vitamin C. The postharvest losses during the season are substantially higher due to shorter shelf life of ripe fruits. The objective was to develop a value-added, preserved product using natural preservatives and Ceylon olives for the offseason. Based on the preliminary trials, the blanching of fruits in a salt solution (10% w/v) was the best pretreatment. Pretreated fruits were filled into sterile bottles with the filling medium of the hot water extracted filtrate (100 ml) of spice mixture (12-15g of red onion, garlic, white pepper, clove, mustard and curry leaves) with salt (10 g) and vinegar (20 mL). Then bottle exhausting and sealing were done. Preserved fruits and filling medium were subjected to chemical and microbiological tests just after bottling and during the storage, at ambient temperature ($28 \pm 2^{\circ}\text{C}$) of 14 weeks. Color, taste, texture and overall acceptability were evaluated by 34 untrained panelists with the hedonic scale (1: extremely dislike, 5: extremely like). Titrable acidity, pH, total soluble solids and Total Plate Count of the filling medium of the blanched fruits were recorded as $1.7 \pm 0.1\%$, 2.7 ± 0.1 , $12.9 \pm 0.1\%$, $344 \pm 10 \text{ cfu mL}^{-1}$ respectively, at 14th week storage. However, yeast & molds were not detected in the product containing blanched fruits, during the storage. All the tested sensory properties of both blanched and non-blanched fruits were evaluated above neither like nor dislike by the sensory panel. Preserved fruits in combination with blanching pretreatment were microbiologically safe for 14 weeks while the shelf life of the non-blanched fruits was 4 weeks. Therefore, natural preservatives can be used to preserve Ceylon olives up to 14 weeks with acceptable sensory properties and quality parameters in comparison with allied fruit product standards.

Keywords: Ceylon olive, *Elaeocarpus serratus*, Natural preservatives, Underutilized

Shelf Life Extension of Minimally Processed Lettuce Leaves (*Lectuca sativa*)

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Cold storage is one of the best methods to maintain the qualitative and quantitative properties of Minimally Processed lettuce (*Lectuca sativa*). The study was conducted to optimize the shelf life of minimally processed lettuce which were stored in three different packing materials. Lettuce which was obtained from same cultivation with similar maturity level was stored in Biaxially-oriented polypropylene (BOPP) Antifog 35 micron, Polypropylene (PP) Micro Perforated and Biaxially-oriented polypropylene (BOPP) Antifog Breathable 40 micron at 12°C were evaluated separately for Physiological Loss in Weight, pH, Total Soluble Solids, Total Chlorophyll Content, Ascorbic Acid Content, Total Phenolic Content, Total Anthocyanin Content, Visual Quality Assessment, Total Plate Count and sensory evaluation at the one-day interval. The minimally processed lettuce stored in BOPP Antifog Breathable 40 micron, BOPP Antifog 35 micron, and PP Micro Perforated had shelflife of ten days, eight days, and three days respectively. Lettuce from both BOPP Antifog Breathable 40 micron, and BOPP Antifog 35 micron packs reported a significantly lower physiological loss in weight throughout the storage period. In the tenth day of storage, the lowest total soluble solid (3.7 ± 0.09) was with the BOPP Antifog Breathable 40 micron pack. The highest pH value (6.61 ± 0.03) and total chlorophyll content (2.22 ± 0.04) were recorded in the BOPP Antifog Breathable 40 micron pack on the last day of storage. PP Micro Perforated pack, BOPP Antifog 35-micron pack, and BOPP Antifog Breathable 40-micron pack failed the visual quality assessment on the third day, the seventh day, and the tenth day of storage respectively. The results indicate that BOPP Antifog Breathable 40 micron film is the most suitable packaging material for minimally processed lettuce.

Keywords: Lettuce, Minimally processing, Cold storage, Packaging materials

Comparative Study on Physicochemical Properties of Pot Still and Column Still Palmyrah Arrack

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Palmyrah arrack is produced either by pot still or column distillation of Palmyrah toddy. This study was conducted to fill the gaps in information on the physicochemical properties of these two types of Palmyrah arrack and to investigate whether they comply with the Sri Lankan Standard (DSLS 919: 2019) requirements. Both arrack samples were collected from two distilleries located in the Jaffna district. Ethanol, total solids, total acids as acetic acid, fixed acids as acetic acid, esters as ethyl acetate, higher alcohol, volatile acidity, reducing sugar, total sugar, total phenols, and vitamin C contents and color and pH of these samples were evaluated. Pot still arrack contained significantly ($p < 0.05$) higher amount of ethanol ($29.3 \pm 0.6\%$), total solids (791.9 ± 17.6 g/100 L), total acids (34.5 ± 3.2 g/100 L), fixed acids (7.7 ± 0.3 g/100 L), volatile acids (26.8 ± 2.9 g/100 L), esters (101.2 ± 1.6 g/100 L), Vitamin C (3.6 ± 0.0 mg/100 g), total phenols (0.63 ± 0.0 g/100 g) and Color (8.1 ± 0.2) than column still arrack ($16.0 \pm 1.0\%$, 297.6 ± 12.8 g/100 L, 18.4 ± 1.2 g/100 L, 1.8 ± 0.1 g/100 L, 16.6 ± 1.1 g/100 L, 55.3 ± 0.4 g/100 L, 2.9 ± 0.1 mg/100 g, 0.26 ± 0.0 g/100 g & (7.6 ± 0.1) respectively). Meanwhile, total sugar (9.4 ± 0.14 g/100 g), and reducing sugar (2.73 ± 0.0 g/100 g) contents of pot still arrack were significantly lower than those of column still arrack (15.0 ± 0.7 g/100 g & 5.3 ± 0.7 g/100 g respectively). It can be concluded that pot still and column still Palmyrah arracks are significantly different in terms of their physicochemical properties. Both arracks comply with Sri Lankan Standard requirements.

Keywords: Palmyrah arrack, Pot still, Column still, Physicochemical properties, Sri Lanka standard requirement

Effect of Gamma Irradiation on Physicochemical and Microbiological Properties of Ceylon Black Pepper (*Piper nigrum L.*)

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Ceylon black pepper (*Piper nigrum L.*), commonly known as the “King of Spices”, has dominated the international spice market due to its high piperine content, strong aroma, and rich flavor. Ceylon black pepper is highly susceptible to contamination with different types of microorganisms. This study focused on evaluating the effects of different doses of gamma irradiation on physicochemical and microbial properties of Ceylon black pepper. Samples were collected from a particular exporter in the western province, Sri Lanka. The collected samples were irradiated at five different doses (0, 5, 10, 20, and 30 kGy) by using an industrial Co-60 gamma irradiator. Treated samples were analyzed for water activity (Water activity meter -Novasina LabMATER), moisture content (Moisture analyzer -MRS 120-3), antioxidant activity (DPPH assay method), total polyphenol content (Folin ciocalteu reagent method), flavonoid content (Colorimetric method) and volatile content (GC-MS). Total plate count and yeast and mold counts of these samples were enumerated. This experiment was repeated thrice. Irradiation dose did not affect significantly ($p < 0.05$) on the tested physicochemical properties of Ceylon black pepper. All tested irradiation doses were capable of reducing total plate count and yeast and mold count significantly ($p < 0.00$) as compared to the control. Therefore, it can be concluded that irradiation with 5 kGy dose will ensure the microbial quality of Ceylon black pepper while preserving its original physicochemical properties.

Keywords: Ceylon black pepper, Gamma irradiation, Dose, Microbial safety

Pre-harvest Soil Application of Rice Husk Ash on Post-harvest Quality of Green Chili (*Capsicum annuum* L.)

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Green chili (*Capsicum annuum* L.) is commercially grown as a spice crop in Sri Lanka. Rapid changes in post-harvest quality and pre-harvest and post-harvest diseases are the main problems in the green chili industry. Silicon (Si) application has shown many beneficial effects on plant growth and disease control. The present study evaluated the effect of soil application of Rice husk ash (RHA), a natural Si source on postharvest quality of green chili, compared to the fungicide treated plants and non-treated control plants. RHA was added to plants (2g/plant) starting at 10 days after seedling establishment and continued up to 28 days at seven days intervals. Si accumulation in leaves and pods were tested during the growth. Natural disease occurrence, changes in chlorophyll content, pH, total soluble solids (TSS), Titratable acidity (TA), ascorbic acid content, total phenolic content, peel color, visual quality rating (VQR), weight loss, cuticle epidermal layer thickness, crude protein, crude fat, crude fiber, total ash, and moisture percentage were measured in the harvested pods. Soil amendments with Si significantly reduced the postharvest weight loss through delayed ripening and reduced natural disease occurrence hence enhancing VQR ($p < 0.05$). Accumulated Si content in leaves of the RHA treated plants was significantly higher ($p < 0.05$) than that of control plants although the differences among the pods of different treatments were insignificant ($p > 0.05$). RHA treatment increased the Crude Protein, ash, total chlorophyll, total phenol content, and cuticle epidermal layer thickness significantly but did not affect other physico-chemical parameters tested ($p > 0.05$). These results suggest that by using the pre-harvest soil application of RHA, the postharvest quality of green chili can be improved. Enhanced Si content in leaves and increased phenolic content in pods may have some role in Si-induced disease resistance and other quality parameters.

Keywords: Green chili, Rice husk ash, Post-harvest quality, Post-harvest disease, Si Content

Effects of Viscozyme, Tannase and Protease Enzymes on Catechin and Caffeine Profiles of Cold-Water-Soluble Instant Black Tea

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Different enzyme treatments have been invented to improve the clarity of cold-water-soluble instant black tea. This research was conducted to study the effects of different enzyme treatments on the catechin and caffeine contents of cold-water-soluble instant black tea. Samples of black tea extract were separately treated in triplicates with different combinations of Viscozyme, Tannase, and Protease enzymes at previously optimized level (0.3% wt/wt, based on tea solid in tea extract) at 40°C for 40 min. Samples were heated to 90°C and cooled to room temperature. Then they were centrifuged at 3500 rpm for 10 min and supernatants were analyzed for catechins and caffeine contents by High-Performance Liquid Chromatography. Data were subjected to Analysis of Variance and mean separation ($p < 0.05$). Tannase can degallate gallated catechins releasing gallic acid and degallated catechins. Viscozyme hydrolyzes carbohydrates releasing constituents complexed with it. Therefore, samples treated with a combination of Tannase and Viscozyme contained a significantly higher amount of gallic acid ($306.7 \pm 35.1 \mu\text{g ml}^{-1}$) than the other samples and this sample contained a significantly higher amount of Epigallocatechin ($72.5 \pm 5.7 \mu\text{g ml}^{-1}$) and Epicatechin ($89.2 \pm 8.4 \mu\text{g ml}^{-1}$) than the control and samples treated without Tannase. Moreover, samples treated with Tannase contained significantly higher amounts of total catechins and caffeine than the other samples. Catechins and caffeine positively affect the organoleptic properties of tea infusion. It can be concluded that treatment with a combination of Viscozyme and Tannase will enhance the catechins and caffeine contents of cold-water-soluble instant black tea.

Keywords: Cold-water- soluble instant black tea, Viscozyme, Tannase, Protease, Catechins

Effects of Extraction of Tea with Tannase and Viscozyme Enzymes on Physiochemical and Sensory Properties of Cold Water Soluble Instant Tea

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Due to the presence of Polyphenols and calcium haze develop and it affects the appeal of the beverage. Therefore, the effects of pre-treatment of tea with Tannase and Viscozyme enzymes on the physiochemical and organoleptic properties of cold-water-soluble instant black tea were investigated. Black tea samples (50 g each) were treated with five different levels (0.02%, 0.04%, 0.06%, 0.08%, 0.1%) of enzymes (dissolved in 150 mL of distilled water) separately at 40⁰ C for 40 minutes. Then, 150 mL of boiling water was added to each sample and extracts were obtained after brewing at 95⁰ C for 10 minutes. Extracts were centrifuged at 3500 rpm for five minutes at room temperature and the supernatants were obtained. Based on the physiochemical properties like Turbidity, polyphenol content, total soluble solids. Of supernatants, enzyme levels for pre-treatment were optimized. Secondly, black tea samples were treated with a combination of optimized enzyme levels following a similar procedure. Supernatants were freeze-dried and analyzed for physiochemical and sensory properties. Each experiment was repeated thrice. Physiochemical and sensory data were analyzed by Duncan Multiple Range test and Friedman test ($p < 0.05$) respectively. The enzyme level of 0.06% which resulted in the lowest turbidity by both of the enzymes was selected as optimum. Revealing improvement in physiochemical properties, the sample treated with enzyme combination was significantly lower in turbidity (88.2 ± 5.2) and higher in Theaflavin content ($1.3 \pm 0.1\%$) and brightness (88.8 ± 1.4) as compared to the control (99.4 ± 5.5 , $1.0 \pm 0.1\%$ and 70.2 ± 2.8 respectively). Further, it received higher ranks for sensory properties. Viscozyme and Tannase pre-treatment of tea extraction improve the quality of Cold-Water-Soluble Instant Tea.

Keywords: Instant black tea, Viscozyme, Tannase, Haze

Development of Protein Rich Cookie Using Desiccated Coconut and Soy Protein Isolate

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Coconut based products becoming popular in Sri Lanka. Nevertheless, less protein content of coconut impairs the nutritional quality of such products. Soy protein powder is rich in high-quality protein and it improves the texture, taste, and colour of food. This study was conducted to develop protein rich cookie using desiccated coconut and soy protein isolate powder as main ingredients. Three treatments of cookies were prepared in triplicates by incorporating desiccated coconut and soy protein isolate in the amounts of 42.4:4.7, 37.7:9.4 and 33:14.1 % (w/w) respectively and using fixed quantities of sugar, brown rice syrup, vanilla, salt, sodium bicarbonate, and water. Cookies were baked at 105°C for 2-3 hours. Sensory properties of cookies were evaluated by a sensory panel consisting of 30 untrained panelists using a 9-point Hedonic scale. Crude protein, total fat, free fatty acid, sugar, and moisture contents of the selected sample were analysed. Sensory data were analysed by Friedman test ($p < 0.05$) using Minitab 18 version. The organoleptic characteristics evaluated were colour, texture, aroma, taste, and overall acceptability. As per the sensory results, cookie prepared 70g desiccated coconut, and 30g of soya protein isolate was selected as the best. This product contained 18.5% protein, 34% of total fat, 21.5% of sugar, 0.9% of free fatty acid, and 0.45% of moisture. It can be concluded that protein rich cookie with better sensory properties can be prepared by incorporating desiccated coconut and soy protein isolate at 70:30 ratio respectively.

Keywords: Desiccated coconut (DC), Soy protein isolate powder, Protein content.

Assessment of Peanut Varieties Grown in Sri Lanka for Peanut Butter Production

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Great potential exists for value-added products of peanut (*Arachis hypogaea* L.) due to its functional properties. The study was focused on the development of peanut butter using peanut varieties grown in Sri Lanka to find the best peanut variety and the best method for peanut butter production. Peanuts were roasted and blanched with 90°C hot water for 3 minutes. Vegetable oil (15%), sugar (8%), salt (1%) were added to peanuts and ground using a colloid mill. Peanut butter was filled into sterilized glass bottles and stored at -4°C. The experiment was laid out in a complete randomized design with five treatments; peanut butter prepared from *Tissa*, *Indi*, *Lanka Jambo*, and *ANKGL3* varieties and commercially available product replicated thrice. Proximate, physicochemical, sensory, and microbial analysis were determined against a commercially available product. Peanut butter prepared from *Indi* variety was selected as the best product by sensory evaluation with thirty untrained panelists using a nine-point hedonic scale. The lowest moisture ($0.66 \pm 0.01\%$), highest ash ($5.21 \pm 0.14\%$), crude protein ($26.45 \pm 0.82\%$), carbohydrate ($21.95 \pm 0.89\%$) and crude fat ($54.85 \pm 0.16\%$) contents were exhibited in peanut butter prepared from *Indi*, *Tissa*, *Indi*, *ANKGL3* and *Indi* varieties. Total soluble solids and titratable acidity were increased, and pH was decreased in all the products and phenolic content and peroxide value were 0.98 mg GAE g⁻¹ and 0.04 meq g⁻¹ of peanut butter prepared from *Indi* variety during storage of 3 months. Total plate count and yeast and mold count were less than 101 CFU g⁻¹. The best condition for roasting of large nuts: *Lanka Jambo* and *ANKGL3* was 170°C for 30 minutes and for small nuts: *Indi* and *Tissa* were 150°C for 65 minutes. According to shelflife evaluation, there was no significant change in all the peanut butter and no significant microbial count in peanut butter prepared from *Indi* variety throughout 3 months storage period, thus it was selected as the best product.

Keywords: *Arachis hypogaea* L, Peanut butter, Shelflife

Quality Characteristics of Probiotic Milk Incorporated with Stevia (*Stevia rebaudiana*) Leaf Extract Powder as Natural Sweetener

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Probiotic milk is a popular fermented dairy product. *Stevia rebaudiana*, leaves can be used to extract zero-calorie sweetener, which also has antioxidant and anticancer properties. The present study was done to develop value-added probiotic milk by incorporating stevia leaf extract powder and assess its quality parameters. Stevia leaf extract powder (SLEP) was prepared by hot water extraction (85°C/2 hrs) of stevia leaves filtration, rotatory evaporation, treatment with ion exchange resin followed by spray drying. Probiotic milk was prepared with 0.2% (w/v) *S. thermophilus* culture and different levels of SLEP and sugar at ratios of 0:5, 0.2:4, 0.4:3, 0.6:2, 0.8:1, 1:0. Stevia leaf extract powder was analyzed for moisture, fat, protein, total phenolics, total flavonoids, antioxidant activity, and soluble sugar content using gravimetric, soxhlet, kjeldhal, Folin-Ciocalteu (FC), AlCl₃, 2,2-diphenyl-1-picrylhydrazyl (DPPH) and phenol sulfuric methods, respectively. Sensory evaluation was conducted using a 9-point hedonic scale and 30 untrained panelists to select the best treatment. Probiotic milk with 0.4% (w/w) SLEP and 3% sugar was chosen as the best treatment during the sensory evaluation. The selected treatments were tested for pH, antioxidant activity, Brix value, microbial quality (*E. coli*, yeast, and mold), and total plate count against the control at a 7-day interval during 28 days of refrigerated storage (4°C). Further crude fat, crude protein, and soluble sugar were analyzed for the probiotic milk samples. Results revealed that probiotic milk with 0.4% (w/w) SLEP had higher ($p < 0.05$) antioxidant activity (58.24%) and lower ($P < 0.05$) soluble sugar contents compared to that of the control, which contained 0.4% SLEP and 3% sugar. *S. thermophilus* counts were not affected by the addition of SLEP. *E. coli*, yeast and mold were absent in all samples. It was concluded that stevia leaf extract powder can be used to replace sugar up to 3% in probiotic milk.

Keywords: Probiotic milk, Stevia leaf extract powder, Antioxidant, Microbial, Sensory

Development of Aloe Vera (*Aloe barbadensis*) Gel Cubes Incorporated Jelly

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Aloe vera (*Aloe barbadensis* Mill. or *Aloe vera* (L.) Burm. F.) gel derived from the leaf pulp has drawn considerable attention owing to its functional properties and exhibited wider applications in the food industry. The present study was aimed towards the development of jelly using Aloe vera (87.55%), sugar (9%), gelatine (3%), flavorings (0.25%), colorings (0.1%) and aromatic agents (0.1%). Jelly was made from removing latex and unwanted parts from leaves followed by the heat treatment at 65 °C for 15 minutes. Three levels of sugar content (1%, 5%, 9% (w/w)), three types of flavorings (strawberry, pineapple, and orange) and three types of aromatics (vanilla, rose and almond) were selected to determine the best combination. The final jelly was made from the best sugar level, flavor, and aroma. The prepared jelly was packed in polypropylene cups and stored at 4°C. The physicochemical properties were measured for the final jelly and data were analyzed using one-way ANOVA. Aerobic plate count was determined to evaluate the shelf life. Appearance, aroma, texture, taste and overall acceptability were evaluated as sensory attributes using a nine-point hedonic scale. Data were analyzed using the Friedman test with a 95% level of significance. Treatment with a 9% sugar level was selected as the best sugar level and strawberry and vanilla were selected as the best flavor and the best aroma, respectively. The pH, total soluble solids, and titratable acidity at the initial were 5.034 ± 0.001 , 10.62 ± 0.01 , and $0.050 \pm 0.001\%$ respectively. There was no significant difference ($p < 0.05$) of total soluble solids during the four weeks of storage. However, there was a significant difference ($p < 0.05$) in pH and titratable acidity with storage time. Based on the microbial analysis, the product is safe for consumption up to one month period. In conclusion, Aloe vera gel can be effectively utilized to develop jelly and further studies are required to increase the shelf life.

Keywords: Aloe vera, Jelly, Sensory evaluation, Shelf life

The Public Awareness on Food Habits and Cancer Incidences – A Sociological Study in Eastern Region of Sri Lanka

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This study challenges to comprehend the level of public knowledge on food habits and health issues and eventually means of mitigating the problematic wellbeing concerns. The study employed with the adult urban public, 385 semi-structured questionnaires on a simple random sampling method, along with such comparisons of percentages, regression, and correlation analytical techniques. Consumption of red meat and processed meat products are considered as a non-inherent aspect of creating cancer cells. The majority of the respondents (61.80%) were not aware of colorectal cancer that has a positive correlation with unhealthy food patterns. The consequences of knowledge on cancer causative agents; food habits were not considered as causative factors by 27.80% of respondents. The knowledge on red meat and processed meat products as causative factors were significant correlations among religion, educational level, monthly income, and DS division at a 95% confidence level. The degree of perception to mitigate the cancer incidences by diminished consumption of red meat and processed meat products were determined. The majority of the respondents (42.10%) had a lack of awareness of the relationship between the consumption of red meat, processed meat products, and cancer incidences. Conducting the awareness programs and mitigating measures will be supportive to make aware the younger generations to minimize the cancer incidences in the future.

Keywords: Cancer incidences, Colon rectal cancer, Food habits, Processed meat, Public awareness

Fruit Leather from Woodapple (*Feronia limonia* L.) Pulp: Formulation, Production and Quality Evaluation

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Woodapple (*Feronia limonia* L.) is a delicious tropical fruit, which belongs to family Rutaceae. Seasonality of the fruit limits to substantial level of postharvest losses and usage for producing value added products throughout the year. Development of fruit leather is a promising alternative to preserve pulp as a delicious stable product at ambient temperature and to reduce the losses during the season. The best formulation was selected out of four treatment formulations. The developed fruit leathers were subjected to sensory evaluation with 30 un- trained panelist using 9-point hedonic scale and keeping quality tests. The best formulation for the woodapple leather was 80 % pulp, 20 % sugar, 1.5 % liquid glucose, 3 % gelatine and 0.2 % preservative (Sodium metabisulphite (SMS), E223). Woodapple pulp with the ingredients were mixed and heated until reached 30 °Bx followed by dehydration using air convection tray dryer with 5 - 6 mm thickness at 65 ±1°C for 8 hours. SMS was added and mixed just after heating the mixture. Physico-chemical parameters were moisture content (14.55 ±0.40%), titratable acidity (4.48%), pH (3.18), texture (1.78 kg) and colour (0.96 Hue and 6.05 Chroma). The thickness of the leather, 4 mm and polyethylene (300 gauge) packages were selected. The shelf life was two months at ambient temperature (28 ±2 °C). Microbiological quality parameters; TPC 30 cfu/g and yeast & mould count 20 cfu/g were compatible with the standards for fruit leather. Mean scores of the sensory attributes were colour 3.70 ±0.18, flavour 3.80 ±0.19, texture 4.50 ±0.17, aroma 4.13 ±0.20 and overall acceptability 3.82 ±0.15. In conclusion the above best formulation is recommended for woodapple pulp leather production with 2 months storability at (28 ±2 °C). Wood apple pulp mixed fruit leathers and extended storability test and degradation kinetics of nutrients are recommended for further studies.

Keywords: Woodapple, dehydration, fruit leather, shelf life, pulp

Determination of Viability of Probiotic Bacteria in Garlic (*Allium sativum* L.) and Red Onion (*Allium cepa* L.) Incorporated Prebiotic Butter

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Dairy products have a large market share, of which butter is an important product. Butter is the most popular fatty spread all over the world. Nowadays people are looking for convenient food with functional properties. For health purposes, they tend to buy beneficial products which contain prebiotics and probiotics together. Garlic and red onion are a natural source of prebiotics. This study was conducted to develop garlic and red onion incorporated probiotic butter and to investigate the effect of garlic and red onion on the survival of lactic acid bacteria (CHN 22) during long term refrigerated storage. Dried garlic and red onion powder were incorporated into butter at the level of 3% (w/w) and 5% (w/w). Then, 3% (w/w) of powder mix (1.5% (w/w) garlic powder and 1.5% (w/w) red onion powder) incorporated butter sample and 0% (w/w) of powder incorporated butter samples were prepared and chemical, microbiological and proximate analysis was done. Starter culture [CHN 22, 3% (w/w)] was inoculated into cream (40% fat) before churning. The viability of lactic acid bacteria in the butter was evaluated weekly to ensure the values were above 10⁶ cfu/g up to 28 days of storage at 4 °C. Lactic acid bacteria enumeration was carried out by pour plating on MRS media. Sensory characteristics, proximate analysis, physicochemical properties and microbiological parameters were analyzed in all four butter samples. The highest scores in the sensory assessment were obtained by 3% garlic powder incorporated butter and 3% red onion powder incorporated butter. Results obtained from chemical (pH, titratable acidity and peroxide value) and microbiology analysis (probiotic count and E. coli count) did not deviate from SLS specifications of butter. Viability of lactic acid bacteria was increased up to 14 days of storage in all samples, and then reduced during 28 days of refrigerated storage. Lactic acid bacteria count was increased with increasing garlic and red onion percentage compared to 0% powder incorporated butter sample, may be due to the prebiotic compounds in garlic and red onion such as crude fiber and inulin, which promoted the growth of probiotic bacteria. Therefore, garlic and red onion can be used successfully as a prebiotic source for the production of butter.

Keywords: Functional butter, *Allium sativum*, *Allium cepa*, Probiotic, Lactic acid bacteria

Determination of Calcium in Selected Eggshell Types and Selection of Best Calcium Level for Bread Enrichment

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Eggshell powder (ESP) is an underutilized waste in Sri Lanka, which can be identified as a natural source of calcium (Ca) with other elements. Enrichment of bread with ESP might be a more effective way to diminish the nutrient deficiencies as well as a new approach to waste management. The Recommended Daily Allowance (RDA) of Ca is 1000 mg for adults. The developed bread will be beneficial for people, who cannot access the required amount of Ca in a country like Sri Lanka. The objective of this work was to select the best Ca level for bread enrichment without affecting its physicochemical and sensory properties. The mineral composition was analysed in ten different types of eggs and Shaver white eggshell which has the highest amount of Ca (175.63 mg/g) was selected for the enrichment of bread. The microbiological safety of ESP was determined by *Salmonella* and Total *Coliform* tests. Three levels of ESP (0.5 %, 1.0 %, 1.5 %) were selected to compare the different parameters of ESP incorporated bread compared to that of the control (0 % ESP). Leavening index (LI), dough firmness, baking loss, bread color, moisture content, crude fiber, acid insoluble ash, ash content, the mineral content of prepared bread, pH value, crumb firmness, and crust firmness were compared between ESP incorporated bread samples and the control bread. The product was stable in terms of microbial quality (TPC, Yeast, and mold). Bread porous structure was compared by using total porous count and porosity (area fraction %) which were analysed using ImageJ software. The optimum level of ESP to be incorporated into the bread without affecting negatively its physicochemical and sensory properties compared to that of the control bread is 1.5 %. The bread made with 1.5 % ESP contains 205.33 mg Ca/100 g of bread and it contributes significantly to the RDA. Only 1/4 of bread (146.3 g) is enough to supply the amount of calcium that can be taken from one cup of milk (300 mg).

Keywords: ESP, Bread, Calcium, Minerals, Recommended Daily Allowance

Development of Pasta using Jack Fruit (*Artocarpus heterophyllus*) Seed and Bulb Flours and Quality Evaluation

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Jackfruit (*Artocarpus heterophyllus*) is a well-known perennial tree and one of the major suppliers of edible foodstuff in Sri Lanka. However, utilization of jack fruits has less attention due to seasonality, pre-preparatory activities, and availability in urban and semi-urban areas. Hence, the development of value-added products is one of the potential alternatives to increase the shelf life, consumption, and utilization of jack fruits during the season and to reduce the postharvest losses. Development of jack fruit pasta was experimented by adding jack fruit seed (JFS), jack fruit bulb (JFB) (*Madullu*) flour and cassava flour (CF) yielded after drying, grinding, and sieving (particle size <200 μ m). Experiment were conducted with four composite flour formulations of JFS, JFB, CF, corn starch and semolina as treatments, T1:30:30:10:10:20, T2:35:35:7.5:7.5:15, T3:40:40:5:5:10, and T4:35:35:0:0:30 respectively. The best flour mixture was selected based on the sensory evaluation using the Hedonic scale (7-points, 1-extremely dislike, 7-extremely like) with 36 panelists and data analyzed by the Friedman test. Based on the mean scores (colour 6.1, flavour 6.9, texture 5.1, aroma 5.3, and overall acceptability 6.3), T3 was selected as the best formulation. T3 pasta possessed the highest contents of crude protein ($13.26\pm0.18\%$), crude fiber ($4.91\pm0.61\%$), ash content ($3.35\pm0.04\%$) than the other treatments. However, there was no significant difference ($p>0.05$) among the treatments for hardness, moisture, and water activity. The cooking characteristics of pasta (T3), water absorption ($1.2\pm2.4\text{ g/g}^{-1}$), cooking time ($8.5\pm0.3\text{ min}$), swelling index ($2.5\pm4.2\%$) were higher than the other treatments while cooking loss ($15.5\pm 1.3\%$) less than the T1, T2, and T4. The lightness value of pasta was decreasing by increasing JFS and JFB flour. Developed pasta using composite flour of T3 has significantly higher nutrient content and more than 3 months shelf life at ambient temperature ($26\pm2\text{ }^{\circ}\text{C}$). The developed pasta has fulfilled the minimum product standards. In conclusion, the developed jack fruit flour pasta (T3) possessed a high potential for commercial-scale production as a convenient food for the consumers in urban areas with busy lifestyles.

Keywords: Jack fruit seed, Flour, Pasta, Cassava, Convenient food

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Socio-Cultural Impacts of Tourism Development: Empirical Evidence from Ella, Sri Lanka

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Tourism being a multifaceted industry extends into every sector of an economy covering economic, social, cultural, and environmental concerns. Sri Lanka being a small island, the tourism impacts are significant both in positive and negative terms. Ella is salient as an attractive destination in Sri Lanka for its location, attractions, and free social context. Major accommodation service in Ella being homestays, the interaction of the tourists with the host community is comparatively high. This study analysed the social & cultural impacts of the development of the tourism industry in Ella area to find out how tourism has influenced society & culture and community perception towards tourism development. Data were collected from schoolers, residents, government officials, social activists, and tourism stakeholders in Ella through in-depth interviews, employing accidental sampling technique. Qualitative in-depth analysis and thematic analysis were incorporated where data were analyzed under sub-themes. Findings disclosed that tourism development in Ella had both positive and negative impacts on society and culture but, results conclude that the negative impacts overrun the positive ones. Results pinpointed women's employment, living standards, cultural awareness, technology literacy, and language ability were high, while the negative socio-cultural impacts marked as a low tendency for education, drug addiction, over-dependence on tourism, displacement, materialistic community and damaged the traditional way of life and social values. Thus, the study recommends training and awareness programs on sustainable tourism for Ella tourism & hospitality workforce, to mitigate the negative socio-cultural impacts which damage the authentic lifestyle of the Ella community. Strict regulations, close monitoring, and quality control are recommended to make sure Ella to offer expected tourism services to tourists.

Keywords: Tourism development, Social impacts, Cultural impacts, Qualitative research

A Study on Identifying the Reasons for Airline Crew Complaints During the Stay at Hotels

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The tourism industry plays a vital role in the Sri Lankan economy. The hotel industry is a sub-industry of the tourism industry. The hotels accommodate various clientele and airline crews are one of the clienteles that accommodates hotels for their stays. This study examined the reasons for airline crew complaints at their stay in the hotels. The objectives were to identify the relationship between factors with the complaints and to identify solutions for the complaints at their stay in the hotels. The factors consisted of organizational factors of the hotels and the behavioral factors of the airline crews. These two were subdivided to obtain better findings: service quality, facilities provided, amenities provided, quality of food, and quality of rooms in the hotel, attitudes, perception, and personality of the airline crews. Three hotels close to Katunayake International Airport were selected as the research site. These hotels have been used by the airlines for their crew layovers for a long time. The researcher has used the quantitative approach for the research. Using a stratified sampling technique, 162 questionnaires were distributed to the airline crews in the hotels. Also, 20 web-based comments were analysed and have been used to justify the findings. Pearson correlation coefficient and hypotheses testing were carried out. The results revealed that both organizational factors and behavioral factors of airline crews were reasons for the complaints and have shown a positive relationship with the complaints. However, results revealed the quality of food and attitudes of airline crews were not the reasons for the complaints and showed no relationship with the complaints. It was identified that organizations should focus on the reasons for the complaints and improve their standards to delight the customer at their stay and focus on introducing training programmes for the employees to have a better understanding of the customers to reduce the complaints.

Keywords: Airline crews, Complaints, Hotel stay, Organisational factors, Behavioural factors

Determinants of Length of Stay of Asian Tourists in Sri Lanka; What Makes their Stay Long or Short?

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The emerging industry remarks indicated a growing average length of stay over the years in Sri Lankan tourism. Length of stay denotes the amount of time that the tourist spends at a given destination whereas the durations of tourism trip refer to the length of time between departure from and return to home. However, Asia, the top source region to Sri Lanka has continuously reported the lowest length of stay over the years compared to all other regions. Therefore, the current study was carried out to identify the determinants of length of stay of Asians tourists in Sri Lanka in terms of socio-demographics, travel characteristics, destination attributes, and travel motives. Further, this study examined the contribution of travel agencies to extend the length of stay of Asian tourists in Sri Lanka. To achieve these objectives, primary data were collected through structured questionnaires from 150 Asian tourists who visited the cultural triangle and occupied structured interviews for managers of 8 travel agencies who handled the inbound tourism in Sri Lanka with the Asian market. A convenient sampling technique was employed to select tourists and travel agents in the sample. Descriptive statistics, correlation analysis, and, thematic analysis was used to analyze the data. Accordingly, the socio-demographics, travel characteristics, and destination attributes indicated a significant relationship with the length of stay of Asian tourists in Sri Lanka. Further, the budget and the free time were two of the most significant reasons for the lower length of stay. Problems with the allocated budget, language barriers, and itinerary changes were the most critical reasons for the lower length of stay as highlighted by the travel agent. Customized and improved tour package, integrated marketing communication, flexible pricing strategies, and, lowering the tax/levy and other charges will make a significant influence on the extended length of stay of Asian tourists' in Sri Lanka.

Keywords: Length of stay, Cultural triangle, Travel motives, Asian tourists, Sri Lanka

Impact of Information Technology on Service Standards in MICE Tourism in Sri Lanka

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The Meetings, Incentives, Conventions, and Exhibitions (MICE) industry is an important and growing segment of the tourism industry with great potential. Further, with its exponential growth, many international MICE organizations are using information technology to maintain service standards within the industry. Hence, the objectives of the study were (i) to identify the present situation of using information technology, (ii) to identify the current issues and barriers associated with information technology, (iii) to identify benefits to the company by using information technology, (iv) to examine the factors affecting in improving information technology on service standards in MICE tourism in Sri Lanka. Primary data were collected through structured interviews, using a purposive sampling technique, from 12 MICE managers out of 28 event management organizations in Sri Lanka. All these organizations had membership of Sri Lanka Association of Professional Conference, Exhibition and Event Organizers. Qualitative data analytical method was employed and the collected data were transcribed and analysed by using thematic analysis. The findings of the study revealed that present situation of using information technology was not adequate and costly, difficult to convince, tech-savvy employees, and lack of government support as current issues and barriers associated with information technology on service standards in MICE tourism in Sri Lanka. Further, technologized MICE events could be used by organizers as a tool for gaining competitive advantages, cost reduction, time-saving, increase efficiency, and maintaining a good relationship with clients of the company which is affected by service standards in the MICE tourism industry. Moreover, this study identified price factor, government support, tech-savvy personals, and accurate database management system as factors affecting to improve information technology on service standards in MICE tourism in Sri Lanka.

Keywords: MICE tourism, Information technology, Service standards

Factors Affecting on Performance of SMEs (With Special Reference to Women-Owned Tourism SMEs in Galle District)

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Small and Medium Enterprises (SMEs) contribute to the socio-economic development of a country through generating employment and income and also reducing poverty and inequality. The tourism industry is a fast-growing industry in the world and most of the businesses related to the tourism industry are SMEs. Apart from that, women's business participation has been increasing not only at the global level but also at the local level as well. The current study attempted to examine the factors affecting on the performance of SMEs with special reference to women-owned tourism SMEs in Galle district. The study empirically tested five factors affecting the performance of women-owned tourism SMEs. The factors included individual characteristics, motivation and goals, resources, entrepreneurial orientation, and environment factors. Data were collected from 100 women entrepreneurs who were engaged in tourism-related SMEs in Galle district. The data were analyzed using descriptive statistics, correlation coefficient, and multiple linear regressions. This study identified four challenges (lack of adequate funding, inability to separate the business capital, lack of crucial infrastructural facilities, and lack of proper business and management skills/knowledge) faced by women entrepreneurs descriptively. The study concludes that the entrepreneur's personal qualities directly influence the success of an entrepreneur and there is a positive relationship with enterprise performance as well. The results also emphasize that the five factors are positively affecting the performance of the women-owned tourism SMEs. The study recommends to women entrepreneurs and tourism SMEs to incorporate such factors and also policymaker and other interest parties to consider these facts when developing policy strategies on tourism-related SMEs and women entrepreneurs.

Keywords: Women entrepreneur, Tourism SMEs, Performance factors, Enterprise performance

Contribution of Rural Tourism as a Development Strategy for Rural Community (Special Reference to Hiriwadunna Village Track, Meemure and Heeloya Knuckles Valley Tourism Village in Sri Lanka)

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Rural tourism is one of the niche markets of the tourism industry and crucial determinant which mostly deals with the rural lifestyle. Sri Lanka is a country that has the potentials for rural tourism development as an island with rich natural resources and human capital. Yet, there is a few types of research related to rural tourism development in Hiriwadunna Village Track, Meemure, and Heeloya Knuckles Valley Tourism village in Sri Lanka conducted on rural tourism activities regularly as one of their main livelihoods. The main focuses of this study were to identify the impact of destination attributes on visitor satisfaction and determine the contribution of rural tourism initiatives on the household economy and socio-culture of tourism stakeholders. A convenient sampling technique was used to select two sets of respondents such as 100 foreign, local visitors, and 12 tourism stakeholders as the sample. Both quantitative and qualitative research design (mixed methods) was adopted in the research. The information was derived from questionnaires and structured interviews. The study used descriptive analysis, multiple regression analysis, and thematic analysis methods. Findings indicated that attraction, accessibility, amenities, ancillary services, available packages, and activities (destination attributes) significantly influenced visitor satisfaction. The need to improve accessibility and ancillary services through infrastructure development. The benefits of rural tourism have been expressed as direct employment, economic growth, social empowerment, living standard, cultural exchange, and destination image. According to the results, the negative impacts were revealed as poor quality jobs, cost of living, cultural influences, and misbehavior. There is a huge potential to develop sustainable tourism concepts under rural tourism such as agro-tourism, community-based tourism, and nature-based tourism as an instrument of multidimensional poverty in these rural areas.

Keywords: Rural tourism, Destination attributes, Tourists satisfaction, Household economy

Community Perception and Support for Wildlife Tourism: Empirical Evidence from Udawalawe National Park

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Wildlife-viewing has become a popular nature-based tourism activity worldwide providing opportunities for tourists to enjoy wildlife in natural habitats such as protected areas, marinas, and underwater settings. Equally, the significance of wildlife-related activities is increasing though little empirical evidence is available in Sri Lanka. It is critical to understand what drives residents' support for such activities to design successful wildlife tourism activities. The main purpose of this study was to examine residents' attitudes and participation in wildlife tourism and to explore factors that affect residents' support and participation in tourism-related activities around Udawalawe National Park in Sri Lanka. 160 local residents in the study area were the respondents to the self-administered questionnaire. The data were analysed using Structural Equation Modeling (SEM) with smart PLS and SPSS tools. The findings revealed that there was a significant relationship between community participation and community perceived impacts. Hence, there was a significant relationship between community participation and support for wildlife tourism and there was no significant relationship between the perceived impact and wildlife tourism support. It can be concluded that community participation can be increased by the education level of residents to understand their rights and the need for greater participation in the decision-making process. Thus, the study argues that increased education and understanding of the importance of wildlife of local residents can result in successful wildlife tourism in a community. A qualitative approach to understanding deeper thoughts, attitudes, and feelings of individuals is recommended as a future research area to further understand this context.

Keywords: Wildlife tourism, Community participation, Community perceived impact, Tourism support

Nexus Between Hotel Corporate Socially Responsible (CSR) Practices and Traveler's Perception on Hotel Selection Decision (Special Reference to Down South of Sri Lanka)

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The global environmental threats, scarcity of natural resources, and socio-economic impacts force individuals and companies to evaluate their impact on natural, social, and economic environments. During the past decade, consumers have become progressively more interested in Corporate Social Responsibility (CSR). Therefore, hoteliers have focused on investing in CSR activities. The purpose of this research was to identify the nexus between hotel CSR practices and traveler's perception of hotel selection decisions. The research was based on three key questions. The structured interview method was used to investigate the traveler's awareness on CSR, the link between hotel selection perception and CSR activities, and to ascertain the impact of CSR. Data were collected from 14 respondents using purposive sampling technique in a qualitative approach. Collected data were transcribed and analysed manually using thematic analysis. Results of the study revealed, there was no identifiable nexus between hotel CSR practices and traveler's perception of hotel selection decisions. Further, the impact of CSR practices on hotel selection decision was very low. The results reflected that travelers perceived a positive attitude towards CSR and expect hotels to engage more in CSR. But CSR was not considered as a hotel selection factor. Therefore, it is necessary to work on enhancing the importance of CSR among tourism stakeholders to convert the potentiality of CSR into a key decision factor to attract tourists in the future.

Keywords: Corporate social responsibility, Traveler's perception, Hotel selection, Awareness, Impact

Determinants of Restaurant Revenue Management; RevPASH Analysis for Registered Tourist Restaurants in Colombo District

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Revenue management is a sophisticated form of supply and demand management. Its primary focus is managing customer demand through the use of variable pricing and capacity management to maximize profitability. Most restaurant owners and managers are trying to increase their revenue. But they used the wrong determinants to measure the revenue. This research intended to identify the determinants of Revenue per Available Seat Hour (RevPASH) in registered tourist restaurants in the Colombo district. RevPASH is a performance metric in the restaurant industry. Further, this study examined the relationship between RevPASH and its determinants in a registered tourist restaurant in Colombo district. To achieve these objectives, the study was conducted as a quantitative study and used a questionnaire as a data collecting technique. A total of 75 SLTDA registered tourist restaurants in Colombo district were selected as the study sample. Descriptive statistics and correlation analysis were used to analyse the data with the support of the SPSS 22 version. Determinants of RevPASH were identified using descriptive statistics. According to the results of the correlation analysis, a weak positive relationship was indicated between the total number of employees in the restaurant, services & facilities of restaurant, the centrality of the restaurant corresponding to the location with the RevPASH. Further, there was no relationship between the total number of covers in restaurant, restaurant-grade, restaurant establishment year, restaurant refurbishment, and distance to the main road from the restaurant with RevPASH in registered tourist restaurants in Colombo district. According to the results, restaurant owners and managers in registered tourist restaurants in Colombo district should pay more attention to the total number of employees in restaurant, services & facilities of restaurant and centrality of the restaurant corresponding to the location to increase the RevPASH of their restaurant to enhance the revenue.

Keywords: Revenue management, Restaurant industry, RevPASH, Performance metric, Determinants

Visitor Satisfaction on Minneriya National Park: The Role of Park Attributes

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Tourist satisfaction has been a central focus of scholars specifically to explain the marketing and management of issues of tourist destinations. The increased demand for visitors is creating increasing pressure on visitor satisfaction particularly in protected areas such as national parks. Yet, only a few studies have been carried out to evaluate visitor satisfaction in Sri Lanka's national parks. Thus, the investigator sets out to explore and recognize visitor satisfaction in Minneriya national park. Further, it uncovers the role of park attributes in shaping visitor satisfaction at Minneriya national park. Accordingly, the study was conducted based on four key objectives: to identify the park attributes influence on visitor satisfaction at Minneriya national park, to identify the intermediating role of travel motivation in shaping visitor satisfaction at Minneriya national park, to identify the intermediating role of destination image in shaping visitor satisfaction at Minneriya national park, and to identify the most significant attributes affecting visitor satisfaction at Minneriya national park. Sample of 160 tourists was drawn using purposive sampling. Data were collected by using a structured questionnaire and analysed by SPSS and SmartPLS software to achieve research objectives. Descriptive statistics, Sobel test, SEM model were used to analyse the data. The findings showed that the positive relationships between park attributes and visitor satisfaction at Minneriya National Park. This study suggests that the tourists who visit Minneriya National Park are satisfied, willing to behave positively and revisit. Tourist information supplied through printed media and the website should be given in other languages, including Chinese, Japanese, Russian, French, Italian to improve and diversify the visitors' markets. The government must attempt to maintain the destination as pure as possible given its setting renowned.

Keywords: Park attributes, Visitor satisfaction, Travel motivation, Destination image

Study on Factors Affecting to Guest's Decision Making on Online Travel Agencies for Hotel Booking, Evidence from Five Star Hotels in Kalutara District, Sri Lanka

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Technology development leads hospitality and tourism industries to utilize online-based business activities. In the present scenario, the majority of guests are taking aids of online travel agencies (OTA) to book accommodation. However, factors affecting guests' decision making on OTA for hotel booking remains unclear. Also, few studies have been found on factors affecting guests' decision making on OTA for hotel booking in Sri Lanka by researchers. Therefore, the objectives of this study were to identify the major factors influencing on guests' decision making on OTA for hotel booking and to identify the most influencing factor/s of guest's decision making on OTA for hotel booking. An instrument was developed based on previous tourism studies as well as a self-directed survey, and data were collected from 300 hotel guests of the Kalutara district. Quantitative data were collected from the sample by using a convenience sampling method. Based on the data from the survey and using factor analysis, this study identified three influencing factors: social demographic factors, internal factors, and external factors. Among these influencing factors, internal factors and external factors were the most affecting factors. The result further suggested that hotels need to develop their main website with updated applications. Several recommendations were made to the government and hotels, regarding further development of this OTA for hotel booking.

Keywords: Five-star hotels, Guest's decision making, Hotel booking, Online travel agencies

Identify the Potential Demand for Geotourism Travel Trend (Special Reference to Jathika Namal Uyana, Knuckles Mountain Range and Horton Plains in Sri Lanka)

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This study focused on the potential demand for geotourism travel trends in the context of the Sri Lankan tourism industry. Geotourism is a new concept and a niche market that has specific needs. This research aimed to describe the geological significance of the sites with the basic concept of the creation of geosites and to identify the potential demand for geotourism travel trends benefiting the tourism stockholders to enhance their knowledge to the future demand of the tourism industry. Hence, the study was conducted to identify potential demand for geotourism travel trends, to identify the impact of visitor perception on the potential demand for Geotourism, and to identify the relationship between destination capabilities and potential demand for geotourism, and to identify the travel agency perception on the potential demand for geotourism travel trend. Research-based was on mixed-method approach. The primary data were collected from 120 foreign tourists using a convenience sampling technique and a questionnaire consisted of 45 questions. 10 structured interviews were conducted with travel agencies to cover the qualitative section of the study. The quantitative data analytical method was employed in analysing the data following descriptive statistics, simple linear regression analysis, and correlation analysis using SPSS 22. Qualitative data were analysed using thematic analysis. The finding reflected that visitor perceptions were significantly influenced by the potential demand for geotourism travel trends towards geosites. There was a strong positive relationship between destination capabilities and potential demand for geotourism travel trend of the foreign tourists towards geosites of Namal Uyana, Knuckles Mountain Range, Horton Plains. Introducing awareness programmes, innovative tour guide lectures, motivating tourism stockholders to address the new market it directly affected on the potential demand for geotourism travel trend towards Sri Lanka.

Keywords: Geotourism, Geosites, Potential demand, Destination capabilities, Visitor perception

A Study on Chinese Inbound Tourists' Spending Patterns on Accommodations Selection and Shopping in Sri Lanka; Tourism Stakeholders' Perspective

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Sri Lanka has been identified as a booming tourist destination in the world. Although, Sri Lanka is receiving an increasing number of Chinese tourists' arrivals annually, it does not capitalize on the higher spending opportunities. Therefore, maximum profitability cannot be taken by the Chinese market to Sri Lankan tourism industry. Hence, the objectives of the study were to identify the Chinese inbound tourists' current spending pattern on accommodations selection and shopping and to identify the reasons for lower spending patterns of Chinese inbound tourists on accommodations selection and shopping. Primary data were collected from 22 tourism stakeholders who are dealing with and knowledgeable person about the Chinese market. Structured interviews were conducted for data collection under the qualitative research approach. Collected data were transcribed and analysed using thematic analysis. Purposive sampling technique was adopted. The findings of this study revealed that product attributes, salesperson service, trip-related attribute, store policy, service of the staff, travel party type, length of stay, food habits under the parental theme to identify current spending patterns and language barriers. Lack of staff and service quality, price and payment method related issues, product-related issues, bad perception about tour operate the system, lack of facilities, time factor, lack of government support, and Chinese residents' involvement were the reasons for lower spending patterns of Chinese tourists in Sri Lanka. Further, increasing Chinese language skills of the shop owners and local community, government support, service quality, payment method facilities, effective promotional programs, shopping information and facilities related to shopping and accommodations, etc. will be beneficial to enhance the profitability of the Chinese market.

Keywords: Chinese inbound tourists, Spending patterns, Accommodations selections, shopping.

Does Culinary Tourism Act as a Pull Factor in Tourist Destinations in South Coast of Sri Lanka?

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Tourists by arousing their taste buds towards food dishes and it has been already considered as a motive for the choice of travel destinations. In recent years, a large number of tourists in the world have traveled searching new and unique cuisines in traveling destinations and revisited to familiar destinations for them to enjoy the dishes that they have tasted during their previous trips. Culinary tourists usually select a destination based on the availability of cuisines in the destination. Food or culinary makes a destination unique and therefore, gastronomy is a strategic element in defining the brand image of the destination. Considering that, this study focuses on investigating whether the culinary tourism act as a pull factor in tourist destinations in the South coast of Sri Lanka. A questionnaire-based survey was conducted around the South coast of Sri Lanka with 100 respondents applying a purposive sampling technique. After a comprehensive literature review, confirmatory factor analysis was employed as a technique of data reduction in the variables. Initially, regression analysis, thematic analysis, and descriptive statistics were used to analyse data to achieve the objectives of the study. The results revealed that culinary tourism as a pull factor had a significant and direct impact on the destination choice of culinary tourists in the South coast of Sri Lanka. To develop culinary tourism at a satisfactory level, food consumption patterns of culinary tourists should be properly diagnosticated. Further, studies related to culinary tourism with the mediation effect of destination image can be consummated.

Keywords: Culinary tourism, Culinary tourist, travelling destinations, Pull factor, Gastronomy

Analyzing the Potentials of Promoting Rail Cruise Tourism in Sri Lanka: Special Reference to Up-country Rail Line

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This study attempted to identify the potentials of promoting luxury rail cruise tourism as a novel tourism strategy in the up-country rail line to attract more tourists. Apart from that, the study also examined what were the main challenges of implementing rail cruise tourism in Sri Lanka. There are many tourist destinations such as Nine Arches Bridge, the Damodara Railway Loop, Nanuoya-Idalgashinna station which are located along the up-country railway track. Therefore, the initialization of such rail cruise itinerary will attract many tourists to those cities and that will generate thousands of revenues to the Sri Lanka Railway as well as to the GDP of Sri Lanka. Both the empirical and knowledge gaps are filled by this research. The study used explanatory sequential mixed method. Data were collected through key informant interviews and a survey was conducted for 100 tourists using a convenient sampling technique. Mainly, descriptive statistics and thematic analysis were used to accomplish the objectives of the study. The database was developed in the SPSS software interface. The result of the study revealed that Sri Lanka has the potentials to promote rail cruise tourism and tourists had a positive perception of rail cruise tourism in Sri Lanka. However, the study also emphasized that there are several barriers related to infrastructure, organizational and technological barriers in relation to promoting rail cruise tourism in Sri Lanka. In conclusion, the study highlights the possibility of promoting rail cruise tourism in Sri Lanka, and hence government intervention to resolve the barriers related to rail cruise tourism is highly recommended.

Keywords: Rail-cruise tourism, Niche tourism, Sri Lankan railway, Sri Lanka tourism

A Study of Tourist Perception on Tourist Harassment on Destination Image (With Special Reference to Arugam Bay Area)

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Tourist harassment is one of the major challenges which affects the competitiveness of various tourist destinations over the globe and it destroys the tourists' positive destination image perceptions. In the Sri Lankan context, there are more pieces of evidence to prove that the tourists have been facing various types of harassment while they are traveling and staying in Sri Lanka. Thus, the main aim of this research was to explore the association between tourists' perception of tourist harassment and destination image. The target population of the study was international tourists who visited Arugam Bay from July to August 2019 and the sample size was 100 international tourists. A self-prepared structured questionnaire was used to collect primary data from the sample. Purposive sampling technique was used to gather data from international tourists. Simple linear regression analysis and descriptive statistical analysis were used to analyse the data to achieve the research objectives. The results revealed that there was a positive significant association between tourists' perception of tourist harassment and destination image. Also, verbal harassment was the mostly occurred harassments of Arugam Bay. Further, there was a higher level of influence on tourist harassments due to demographic factors like gender, age, marital status, etc. With the findings of the study, it is recommended to have the involvement of government organizations to avoid or minimize tourist harassment in Sri Lanka. Conducting comprehensive research related to the tourist harassments in Sri Lanka would be useful to avoid tourist harassment within Sri Lanka.

Keywords: Tourist perception, Tourist harassment, Destination image

Impact of Tourist's Perception on Hotel Brand Choice: The Intermediate Role of Brand Loyalty with Special Reference to Four- and Five-Star Hotels in Southern Province of Sri Lanka

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Branding is one of the most dominant trends in the hotel and catering industry. Various studies have shown that brand loyalty results from many factors. Among them, perception is one of the factors that play a significant role in rapid and active share in brand loyalty which influences the brand choice of the people. This study seeks to contribute to the literature on tourist's perception of hotel brand choice; the intermediate role of brand loyalty. The study used a quantitative approach to bridge the gap between service industry brand loyalty and brand choice in the Sri Lankan context. Primary data were collected by using a purposive sampling method and surveying a sample of 120 foreign tourists who visited selected six-four and five-star hotels in Southern province. Proportionate to the number of rooms, tourists were selected from each hotel. The main objectives of the study were to identify the relationship between tourists' perception and brand choice and ascertain the intermediate role of brand loyalty. The data were analysed using descriptive statistics, regression, correlation, and Baron and Kenny Approach for mediator analysis with the support of SPSS. According to the findings, the brand image represented the highest mean value of the dimension and demonstrates that the brand image as the most influential aspect of brand loyalty, and most of the tourists were high spenders who came from European countries. There is a strong positive relationship between the tourists' perception and brand loyalty but the mediator effect is partially insignificant. To achieve the highest level of loyalty from the tourist and to build up strong brand loyalty among tourists, hoteliers can arrange effective marketing strategies like follow-up (email) marketing. This study was limited with cross-sectional data and was conducted based on the four and five-star hotels and therefore, it can be applied to another type of classified hotel or restaurant.

Keywords: Tourist perception, Brand loyalty, Brand choice, Brand image

A Study on the Relationship between Destination Attributes and Tourist Satisfaction Mediated by Memorable Tourist Experience Empirical Evidences from Drive Tourists in Sri Lanka

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Drive tourism is a new trend that emerged in the recent past. It is one of the emerging concepts in the modern Sri Lankan tourism context. Since drive tourism is a new concept, a limited number of researches has been published. This study focused on investigating the relationship between destinations attributes and tourist satisfaction mediated by memorable tourist experience: empirical evidences from drive tourists in Sri Lanka. A questionnaire-based survey was conducted around Ella, Mirissa, and Negombo areas of Sri Lanka and 120 respondents were collected employing a purposive sampling technique. Pearson correlation analysis was carried out to identify the relationship between destination attributes and satisfaction of drive tourist and the relationship between destination attributes and memorable tourist experience and finally Baron and Kenny approach and Sobel test was applied to identify the mediating relationship of memorable tourist experience between destination attributes and satisfaction of drive tourists. The results revealed that the relationship between destination attributes and satisfaction of drive tourists were partially mediated by the memorable tourist experience. A significant strong positive relationship was found between destination attributes and satisfaction of rive tourists while strong positive relationships between destination attributes and memorable tourist experience. To offer the drive tourists with memorable tourist experience, facilities addressing especially drive tourists such as accommodations with ample parking spaces, fuel refilling centers, and money exchange should be improved further to the standard scale.

Keywords: Drive tourism, Memorable tourist experience, Destination attributes, Drive tourist satisfaction

Impact of Destination Attributes and Travel Motives on Destination Choice (With Special Reference to Free Independent Travelers in Southern province)

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Free Independent Travelers (FITs) classify as an important travel segment. They are referred to as leisure travelers. In Sri Lankan context although tourism arrivals and leisure tourists are increasing, tourism growth change has been decreasing. So, it is important to identify how destination attributes and travel motives are influenced the travel segment to select the destinations. The study aimed to investigate the impact of destination attributes and travel motives when they select the destinations in Southern province as a holiday choice. The objectives of the study were to identify the profile of independent travelers who are traveling to Southern province, to examine the relationship between destination attributes and destination choice, to examine the relationship between travel motives and destination choice, to identify the most and least destination attributes and travel motive factors influence on destination choice when they select the destinations in Southern province. Primary data were collected through self-administered questionnaires in Southern province. The purposive sampling method was used to collect data from 160 Independent travelers and quantitative data analysis method was used in analysing the data using descriptive statistics, Pearson correlation coefficient, and multiple linear regression analysis. Salient findings of the study indicated that the demographic and profile of the travelers were significantly associated with independent travel styles. Destination attributes and travel motives showed a positive significant association on destination choice. Further, it revealed, other than activities, other attributes and travel motives significantly influenced on destination choice and attraction. Pull motives were mostly influence on destination choice of independent travelers in Southern province. Therefore, destination attributes and travel motives could be used in formulating promotional strategies and other policies to best satisfy their needs.

Keywords: Free independent travelers (FITs), Destination attributes, Travel motives, Destination choice

A Study to Assess the Tourist Satisfaction Towards Marine Tourism: Special Reference to Whale and Dolphin Watching at Trincomalee

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Marine tourism is a niche tourism product and it can be identified as a sustainable alternative to tourism. During the last few decades, marine mammal-based tourism has showed a rapid growth in tourism. Significantly, watching Whales and Dolphins have enjoyed phenomenal growth and is one of the fastest-growing tourism products in the world. Utilization of the true potentials of Whale and Dolphin watching tourism has to be developed and promoted within Sri Lanka. The study focused on assessing tourist satisfaction towards marine tourism with special reference to Whale and Dolphin watching at the Trincomalee area. The objectives of this study were to identify the profile of tourists who are visiting for Whale and Dolphin watching, to identify the relationship between destination attributes and tourist satisfaction on Whale and Dolphin watching and to discover the innovative practices which will be expected by tourists from the service providers of Whale and Dolphin watching industry in marine tourism at Trincomalee area. The study mainly depended on the primary data that were collected through questionnaire and structured interviews. The purposive sampling method was used as a sampling technique to collect data from the 100 both local and foreign tourists. Quantitative and qualitative data analytical methods were employed in analysing the data deploying descriptive analysis, correlation analysis, and thematic analysis. Findings reflected that there was a positive relationship between all the destination attributes (6A's) and tourist satisfaction towards marine tourism. Moreover, findings discovered certain innovative practices expected by tourists from their service providers in Whale and Dolphin watching industry. Findings suggested implementing expected innovative practices and rules and regulations to promote and sustain the Whale and Dolphin watching tourism in Sri Lanka.

Keywords: Marine tourism, Whale and Dolphin watching, Tourist satisfaction

The Impact of Work - Family Conflict and Organizational Support on Presenteeism of Operational Level Employees in Hotel Sector

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Presenteeism discusses the person's physical availability in the workplace while distracted the intrinsic capacity for performing. It suggests the importance of the supportive working state of affairs from the organization's end, as well as from the family of employees. The conflicts in the family space originated due to the work, and conflicts arising from family into the workspace may affect the employees' mental and physical health and, therefore associated with the presenteeism. The hotel industry has faced a shortage of skilled labor around the world and reported the highest turnover rate in recent decades and presenteeism would generate a significant influence to the tourism industry. In this context, this study was performed to identify the impact of work-family conflict, family-work conflict, and organizational support on presenteeism in the hotel industry. A structured questionnaire was used in collecting primary data with a sample of 207 operational level employees representing three to five star graded hotels in Colombo district, Sri Lanka. Independent sample t-test, one-way ANOVA, correlation coefficient analysis, simple linear regression analysis, and multiple regression analysis were used to analyse the data. Results revealed a strong positive relationship between work-family conflict, family-work conflict, and presenteeism and there was a weak positive relationship between supports of organization and presenteeism. Moreover, work-family conflict, family-work conflict, and support of the organization indicated a positive impact on presenteeism. Further, family-work conflict was the most influencing predictor of presenteeism and there was no difference of presenteeism in terms of demographic factors of the employees. Hence, managers should strategically address the work-family balance of employees. Organizational policies must be more favourable for the workers to manage physical and mental health to continue an effective and efficient service delivery process in the hotel sector.

Keywords: Presenteeism, Work-family conflict, Family-work conflict, Organization support, Hotel industry

A Study of Impact of Dive Tourism on Community Development: Special References to Southern Province of Sri Lanka

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The study focused on the dive tourism impacts on the host community of Southern province in Sri Lanka. Finding out the impacts of dive tourism will help to reach the positivity and to overcome the negativity of tourism to contribute to community development. This study investigated whether the active local participation is possible and to what extent, how far host communities are exposed to the impacts of dive tourism and the motivational factors of divers. The study covered Southern province and examined many aspects of local community life that influenced by local host communities. The research employed more qualitative techniques and data were analysed using SPSS software. A purposive sampling technique was adopted and data were analysed using descriptive analysis, correlation coefficient, and thematic analysis. The findings showed local communities feel the impacts of dive tourism through positive developments or negative consequences like the rise of real estate costs and increased pollution. This area is a very suitable area for varieties of dive tourism activities and recreational activities. New activities can be introduced and started and can re-built previous activities, especially camping sites, underwater photography, cultural activities, and dive based innovational activities. With the help of the community, these activities can be started and they can get benefits while preserving the environment.

Keywords: Dive tourism, Tourism impacts, Community development, Motivational factors

Investigation on Geotourism as a Tool for Tourism Development in Sri Lanka: Special Reference to Ussangoda National Park and Mahapelessa /Madunagala Hot Springs

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Geotourists are experience hunters seeking knowledge while appreciating earth's geological wonders through exploring myriad topographies. Geotourism can be defined as tourism activity where visitors can witness attributes, abiotic, and biotic (ABC) and culture with more focus on abiotic properties of the natural setting. Geotourism is a wing of sustainable tourism and this study aimed to find out whether the Geotourism application could be used as a profitable tool for sustainable tourism development in Sri Lanka. The study was carried out qualitatively with twenty (20) in-depth interviews from tourism stakeholders including tourists, local communities, and government officers. The transcribed data sheets were thematically analysed by coding and axial coding. The results of the study revealed that lack of awareness towards the Geotourism concept caused Geotourism in Sri Lanka to be in its infancy though Sri Lanka is having an abundance of marketable opportunities for its diversified tourist locations to initiate Geotourism developments. In conclusion, it could be emphasized that Geotourism can be used as a profitable tool for tourism development by addressing certain issues like improper destination management, lack of promotion by examining two excellent geoheritage sites, Ussangoda National Park and Mahapelessa (Madunagala) hot springs. The research recommended new strategies for Geotourism development such as improving proper destination management, propagating awareness programs on Geotourism, an adaptation of geoconservation providing quality geo interpretation. Future studies should focus on diversified geoheritage sites as this investigation was limited to geoheritage sites with geological significances.

Keywords: Geotourism, Geotourists, Geoheritage sites, Tourism development, Sri Lanka

Challenges and Opportunities for Community Based Tourism Development in Kithulgala

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Tourism is one of the world's fastest-growing industries and it is a major source of income for many countries. Community-Based Tourism (CBT) concept relates more specifically to tourism operations involving local communities, taking place on their lands and oriented on their cultural and natural resources and attractions. This study especially focused on identifying challenges, opportunities for CBT development in Kithulgala, and particularly intended to study the community perception towards CBT development in Kithulgala. This study adopted a mixed-methods approach and data were gathered through questionnaires and interviews. Two separate questionnaires were used gathered data from hoteliers, tour operators, and tourists. The convenience sampling method was used to collect data from 100 hoteliers, operators, and 50 tourists, and 10 local community members were interviewed. Quantitative data were analysed using descriptive and exploratory factor analysis with the support of SPSS and qualitative data were analysed using thematic analysis. According to the results, lack community interest, lack of government, lack of awareness and training, lack of marketing and promotional activities and lack of infrastructure identified were identified as challenges and there were several opportunities identified such as increasing revisit intention, improvements of desire to explore remote locations, introducing novel adventure-based activities, focusing on positive recommendations of the visitors and providing facilities to different experience about local culture. There should be some implications for the development of tourism in Kithulagla, product diversification, and quality enhancement, develop marketing and promotion through social media and company websites, and increase government involvement.

Keywords: Community based tourism, Challenges, Opportunities, Community perception

An Analysis of the Relationship between Human Resource Management Practices and Employee Retention in Hotel Industry (With Special Reference to Star Class Hotels in Western Province)

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The hotel industry is one of the booming industries and plays a significant role in Sri Lankan economy and labor market. The principal challenge of majority industry organizations is to retain employees for a long period within the intensive competitive environment. Effective Human resource management (HRM) practices are crucial factors for employee retention and assist organizations to retain valuable employees. Therefore, it is essential to retain employees via effective HRM practices. The main objective of this study was to explore the relationship between HRM practices and employee retention and to identify the highest and least influential factor in employee retention. The study particularly identified recruitment and selection, training and development, performance appraisal, and compensation and incentives as the four key HRM dimensions to analyse the study objectives. 120 permanent operational levels of employees in the hotel industry was selected using a purposive sampling method and data were collected through self-administered questionnaires. The study systematically described, analysed, and interpreted data using a quantitative approach. The data were analysed using the Pearson correlation coefficient and multiple linear regression techniques. The results denoted that all four dimensions of human resource practices had a strong positive relationship on employee retention. Compensation and incentives were the highest influential factor while training and development was the least influential factor in employee retention. Finally, this study suggested that Human Resource executives in the hotel industry need to pay more attention and should adapt effective HRM practices which make employee satisfied and affect on employee retention in the organization.

Keywords: Hotel industry, Human resource management practices, Employee retention

Potentials for Agro Tourism Development in Pinnawala, Sri Lanka

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Agrotourism, as an alternative to mass tourism, is a rapidly growing segment of the tourism industry. At present, agro-tourism is done by most of the countries in the world aiming at sustainable rural development. Pinnawala area has several features that can be developed as an agro-tourism destination. Due to the lack of government involvement and support, awareness on agro-tourism and infrastructure facilities, the development of agro-tourism has been slowed down in Sri Lanka. There is an empirical gap due to the limited studies done in the agro-tourism sector. Pinnawala is an emerging area of interest among tourists where the agro-tourism can be practiced. This research aimed to study the potentials for the application of agro-tourism in the Pinnawala area. After, a comprehensive literature review, a structured questionnaire was constructed. The target sample for the study was tourists who visited Pinnawala from July to August 2019 and the tourism stakeholders in the area. The convenience sampling method was used and the primary data were collected from 73 tourists using the structured questionnaire and from 7 tourism stakeholders with in-depth interviews. Data were analysed with descriptive analysis, Pearson's correlation coefficient, thematic analysis, and Friedman test. According to the results, it was revealed that there was a relationship between environmental facilities and potential to the agrotourism development in the area. Lack of government involvement and support, lack of agro-tourism awareness, lack of agro tourism-based activities in the area were identified as the most influencing challenges and issues to develop agro-tourism in the area. Based on the findings, it is recommended to concern on development of agro-tourism awareness and training, implementing agro tourism-based activities and products, formulate agro-tourism standards to promote the agro-tourism in the destination. Further, comprehensive research related to the agro-tourism activities and product development would be useful to develop agro-tourism in Sri Lanka.

Keywords: Agro tourism, Potentials, Tourism development

Economic Impact of Tourism at Knuckles Forest Reserve; A Case Study in Atanwala Village

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The Knuckles forest reserve has a favourable condition for nature-based tourism. Knuckles forest reserve can be accessed through three main entrances and 'Atanwala' entrance being the uprising entrance. Therefore, Atanwala entrance and Atanwala village were selected as the study area for this research. Also, the number of researches carried out in these areas is negligible. Hence this study was designed to investigate the economic impact of tourism at Knuckles forest reserve considering the case of Atanwala village. This study was mainly focussed on the economic impact of households who live in Atanwala village and also to identify the community perception towards tourism, the current situation of tourism, and thereby to identify strategies for tourism development in Atanwala-Knuckles forest area. A judgemental sampling technique was used and adopting a mixed-method data were collected distributing questionnaires among the households who live in Atanwala-Knuckles forest area. Also, personal interviews were carried out for descriptive analysis. The findings of this study showed that all of the economic impact dimensions had significant positive effect. Further, the research found that the community showed a favourable stance for tourism development in the knuckles forest reserve and it helps the coordination of the recreation-based rural tourism development in the destination. Therefore, the policymakers should capitalize these opportunities to create several labor-intensive job opportunities for women, youth, poor and unskilled persons residing in the area.

Keywords: Economic impact, Employment, Income, Knuckles, Eco tourism

Identification of Foreign Tourists' Perception on Quality of International Food and Beverages Available in Destination Food Outlets in Sri Lanka with Special Reference to Ella Area

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Food being one of the basic human needs, it is considered as one of the important factors which creates a memorable experience for a tourist. Therefore, while traveling from one place to another place tourists require to access food and beverages. Meanwhile, due to food neophobia tourists usually tend to consume international food and beverages when they are on traveling. In this context, the present study aimed to identify the foreign tourists' perception of the quality of the international food and beverages available in destination food outlets in Sri Lanka. The research site selected was Ella which is very popular among tourists. The sample of the study was 100 foreign tourists who consumed the food and beverages at food outlets available in Ella during their stay in Sri Lanka. A self-administrative questionnaire was purposively distributed to collect the data from the respondents. Descriptive analysis, correlation analysis, and multiple regression analysis were used to analyse the data with the support of SPSS. The finding of the research elaborated that tourists almost satisfied with the existing quality of international food and beverages and there was a strong positive relationship between food quality and the tourists' perception of international food and beverages. According to the regression analysis, the appearance of the food and the wholesomeness showed a positive significant impact on tourists' perception of international food and beverages. Hence, attractiveness and the cleanliness of food and beverages should be improved to attract more tourists to food outlets. Further, the present study only dealt with the tourists' perspective and it would be useful to investigate the perspective of service providers on the quality of international food and beverages available in destination food outlets.

Keywords: Food quality, Tourists perception, International food and beverages, Destination food outlets, Foreign tourists

Identify the Factors Influence on Purchase Intention of Local Foods by Foreign Tourists in Coastal Area in Sri Lanka

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Sri Lanka is well-known for unique and authentic traditional food varieties and they have become one of the key attractions in tourism over the years. Recently, many initiatives have been taken at different levels contributing to develop and to promote gastronomy tourism. Accordingly, this study was aimed at identifying the inbound tourists' perception of local foods and to identify the factors that influence local food choice of inbound tourists in the coastal area of Sri Lanka. Primary data were collected from 160 tourists on the South and East coast distributing a structured questionnaire using convenience sampling. Further, in-depth interviews were carried out interviewing 15 local food vendors using purposive sampling. Confirmatory factor analysis, descriptive statistics, and thematic analysis were employed to analyse the data. Results revealed that there is a high potential for local food to promote gastronomy tourism in the country. Further, socio-demographic, motivational, and psychological factors were influenced on the local food purchasing intention of tourists. The purchase intention of inbound tourists in the Sri Lankan context was not affected by sensory appeal and new taste (under the motivational and psychological factors). The study showed that the promotion of local food depends on government involvement whereas a strategic marketing campaign could be used to bring traditional local food to the international level. Restaurant environment should be familiar to international tourists while maintaining the authentic features of the restaurants. Moreover, tourists were willing to have mild spicy varieties of food and healthy authentic local food. Further, this study directs future researchers to investigate the local food vendors' perception of local food as a tourism product and tourists' intention specifically on Ayurveda food in Sri Lanka.

Keywords: Gastronomy tourism, Local food, Purchase intention, Vendor's perception

Analyzing the Relationship of Factors Affecting on Tourists' Buying Behaviour of Handicraft Products (With Special Reference to Galle District)

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Handicraft products are one of the important products which can market in the tourism and hospitality industry. The handicraft industry can be benefited from gaining understanding about the tourists' buying behaviour of handicraft products. The main purpose of this study was to analyse the factors that affecting on tourists' buying behaviour of handicraft products. Marketing mix factors, situational factors, and personal factors were considered as the influential factors of the buying behaviour of handicraft products. This study was focused on the Galle district of Sri Lanka. This quantitative study was mainly based on primary data that were gathered using a questionnaire with a five-point Likert scale. The target population for this study was the local and foreign tourists who visit handicraft shops in Galle District and from which a sample of 100 was selected (10 tourists from 10 selected shops) using convenience sampling method. Descriptive statistics and Pearson correlation analysis were used to analyse the data collected. Results disclosed that marketing mix factors, situational factors, and personal factors had a positive relationship with tourists' buying behaviour of handicraft products whereas the marketing mix factors showed the highest relationship and the situational factors the least. The study revealed that there is a need for introducing modern technology for creating a properly established market. Besides, it should re-establish the art and craft villages and giving incentives to encourage locals for their creations. Further, is influential vital to conduct training programs and workshops for traditional craftsman to uplift the quality of their products and to attract the market.

Keywords: Tourist, Handicraft, Buying behaviour, Marketing mix, Situational factors, Personal factors

A Study on Community Involvement in Tourism Benefit Sharing in Sri Lanka with Special Reference to Dambulla

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The level of local community involvement in tourism will result in more benefits to livelihood having a strong rapport between the local community and tourism industry. Active participation is important to gain benefits from tourism activities otherwise community involvement can be a disturbance to tourism development in the area. This research mainly focused to identify tourism benefits, how the community involves sharing benefits, and to identify challenges, issues while observing community expectations to enhance community involvement in tourism benefits sharing. The study utilized a qualitative methodology underpinned phenomenology research approach with 13 community members in Dambulla in Sri Lanka. Focus groups and semi-structured interviews were carried out to gather primary data and the collected data were transcribed and analysed manually using thematic analysis and micro-interlocutor analysis. According to the findings of the study, there were more economic benefits than the other benefits generated through the tourism industry in the area. Further, the huge involvement of the community was shown as employment opportunities. There were some challenges and issues faced by the community and expectations such as the need for awareness programs, development of infrastructure facilities required to assure better sharing tourism benefits. Build-up more business opportunities, continue awareness and training programs, usage of environment-friendly transportation methods, the participation of host community leadership to the decision-making process can be mentioned as recommendations of the study. For future research, factors affecting on community livelihood through tourism activities, factors affecting the perception of the host community towards cultural tourism preservation and promotion in the cultural triangle can be recommended.

Keywords: Tourism benefits, Community involvement, Challenges and issue, Expectations

Role of Tourism as a Community Development Tool with Special Reference to Patna, Deniyaya

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Community development is a way of empowering civic activities and strengthening civil society and their perspective on social, economic, and environmental policy development. Tourism can play a critical role in empowering local communities. The tourism industry has many economic, social, and environmental benefits to the rural community. Rural tourism is a major contributor to rural development. This research aimed to identify the role of tourism in the context of rural community around Patna. Patna is a rapidly growing destination and in its early stage of tourist destination life cycle, ponders a range of opportunities through tourism. It is situated proximity to Deniyaya town just outside of Sinharaja Rain Forest. It is a rural village belongs to the Wiharahena Grama Niladhari Division. This research focused on factors influencing the development of the tourism industry, community development, and outlook. Using purposive sampling, twenty (20) tourism stakeholders was drawn for the study. Data were collected through in-depth interviews from the participant; visitors, community members, and government officers (Grama Niladhari, Economic Development officers). The transcribed detailed interview outcomes were scrutinized and analysed using thematic analysis techniques. Findings revealed that lack of infrastructure, lack of government involvement, negative environmental and social impacts have disturbed tourism and related community development potentials while tourism seems as an effective tool to improve the income level of the community. In sum, the study found that tourism has a limited impact on the Patna community with little improvement in their income levels. Based on the findings it recommended to improve government involvement, improve infrastructure facilities in the Patna area. Moreover, effective promotional techniques, promoting tourism-related community enterprises are some potential areas for future research.

Keywords: Community-based Tourism, Community empowerment, Rural tourism, Tourism development, Tourism impacts.

Impacts of Tourism Development on Rural Livelihood in Haputhale Area

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Tourism industry has been progressively using for, and directly connected with, rural livelihood poverty reduction in developing countries. In ongoing years, it has, however, been reprimanded by rural developers due to their lack of concern for the rural poor and for being too increasingly focused on tourism specifically. The main purpose of this study was to identify the impacts of tourism development on the livelihood of rural residents in the Haputhale area and specifically to identify the existing level of rural livelihood, the relationship between tourism development and rural livelihood, and identifying the impacts of tourism development on rural livelihood in Haputhale area. A structured questionnaire with a five-point Likert scale was used as a research instrument to gather information from 150 respondents. Further, in the analysis, the reliability analysis, descriptive analysis, correlation analysis, and multiple linear regression analysis were used. The existing level of rural livelihood was analysed using descriptive statistics. According to the correlation analysis, there was a strong positive relationship between tourism development and rural livelihood in the Haputhale area. Based on the research findings it is recommended that in order to develop tourism in Haputhale rural areas it should consider economic, socio-cultural, and environmental impacts considering the livelihood patterns in the rural area.

Keywords: Tourism development, Impacts of tourism, Environmental impacts, Economic impacts, and Socio-cultural impacts

Identify the Potentials to Develop Yoga Tourism with Special Reference to Western Province

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Currently, yoga tourism has become a new trend around the world and there are more than 300 million yoga practitioners in the world. When consider the Sri Lankan context Yoga tourism is not much popular. The research study aimed to identify the potentials to develop yoga tourism in Western province. Qualitative and quantitative methods were adopted to gather data by using data collection methods of self-administrative questionnaires and structured interviews. The population of the study was international Yoga tourists who visit the western province as well as yoga instructors and in-charge person of the Yoga centre/hotel. The convenience sampling technique was used and 50 yoga tourists, 10 yoga establishments' in charge person/ yoga operators, and 10 yoga instructors were interviewed. Factor analysis and content analysis were used to analyse quantitative and qualitative data and SWOT analysis were used to identify the potentials. To identify potentials for yoga tourism in the Western province the profile of the yoga tourists, yoga tourists' expectation and behaviour, current situation of yoga centers/yoga centers in the hotel, competencies of yoga instructors were evaluated. The results of the study showed that the most influenced factor to do yoga was yoga program and competency of yoga instructors. And the Western province has good yoga establishments and there are experienced and qualified yoga instructors. All findings reflected that Western province has huge potentials for yoga tourism as a new tourism market. It is recommended that the Sri Lanka Tourism Development Authority should establish a legal procedure to register and introduce standards and guidelines for yoga centers and yoga instructors to promote yoga, and also to enhance the contribution of yoga instructors towards to promote yoga and promote yoga tourism with Ayurveda department.

Keywords: Spiritual tourism, Wellness tourism

Empirical Study on Residents Support Towards Sustainable Tourism Development in a Post-war Destination Sri Lanka: Special Reference to Trincomalee Area

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Sustainable tourism is one of the niche markets of the tourism industry and a crucial determinant that mostly deals with the local population. The success and sustainability of any development project and the support of the local population in the area has a significant association in various aspects. Sri Lanka as an island has its potential to elaborate the tourism activities to an extent level. Resident support is a key force in any form of tourism because it directly deals with tourism development. Yet few researches related to tourism development in the Trincomalee area have been conducted particularly the community-based tourism in a broader view. The main focus of this study was to identify the existing level of resident support, socio-economic and environmental impacts, and the ways to accelerate the industry towards sustainable tourism. A convenient sampling technique was used to select the 20 local residents as the sample. A qualitative research design was adopted in this research. The information was derived from direct interviews and thematic analysis was utilized for the data analysis. Findings indicated that knowledge of tourism, resident-visitor interaction, and resident's place image have the most favorable perception and they strongly influence on the existing resident support. Benefits of sustainable tourism were found as direct employment, economic growth, social empowerment, living standard, and cultural exchange. According to the results the negative impacts found were increased cost of living, cultural influences, illegal activities, pollution, and overcrowding. Furthermore, the results revealed that adequate government support (human capital and financial) and stakeholder participation (community participation) could help to accelerate developing Trincomalee as a sustainable tourist destination. Accordingly, disciplinary actions, community awareness, and adequate government support could help to accelerate the sustainable tourism activities with the resident support.

Keywords: Sustainability, Tourism, Resident support, Tourism development, Impacts

An Analysis of Barriers and Opportunities of Community-Based Tourism (Special Reference to Mannar District)

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Tourism is a vital contributor to the economy of any nation and it is a prime foreign income earner. Community-based tourism (CBT) is a form of tourism that is generally small scale and involves interactions between visitors and the host community, particularly suited to rural areas. The communities in Mannar who depended on natural resources have not been benefited from tourism in terms of enhancing economic and social welfare in a positive way. Many tourism development initiatives have been designed but without incorporating the knowledge of local communities which is essential in the process. It is assumed that if tourism is going to make a positive change in the living standards of these communities, CBT can offer hope for a partnership between the investors and communities. Hence, the objective of the study was to analyse the current situation, barriers, and opportunities for CBT in Mannar. The purposeful sampling technique was used to select 15 respondents from government sectors, private sectors, and community members. A qualitative research design was adopted in this research. The information was derived from direct interviews and thematic analysis was utilized for data analysis. Findings indicated that the current situation of CBT in Mannar has interaction with the awareness of tourism and perception of CBT. The operational limitations, structural limitations, and cultural limitations were identified as barriers for CBT in Mannar. Beach, wildlife, historical sites, cultural activities and pilgrimage activities were identified as the opportunities for CBT in Mannar. There is a huge potential in Mannar to develop CBT by overcoming the barriers. An adequate government support and stakeholder participation (community participation) could help to accelerate CBT in Mannar.

Keywords: Community, Tourism development, Opportunities, Challenges

The Influence of Rural Tourism Experience on Tourist Revisitation: Special Reference to Haputhale Area

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The objective of rural tourism is to provide net benefits to the people of rural areas and expand their participation in tourism product development. Recent trends in tourism demand have sparked widespread interest in rural areas as destinations for recreation and tourism. Travelers who travel into non-urban areas expect to get experience in nature-based activities, lifestyle, culture, tradition, etc. The main objective of the present study was to identify the influence of rural tourism experience on tourist revisitation. Referring to the literature, education, aesthetics, escapism, ecological and cultural attractions, and physical infrastructure were recognized as the main influential dimensions of tourism experience. The study collected responses from 125 respondents from the Haputhale area and the Structural Equation Model was applied as the analytical tool. Results revealed that all five rural tourism experience dimensions were positively affected on rural tourists' revisitation. Also, there was a partial mediation effect of satisfaction on the relationship between the tourism experience and revisitation. Future researchers can replicate this research in different geographical locations and compare.

Keywords: Rural tourism, Rural tourism experience, Satisfaction, Revisitation

The Impact of Planned Behavior on the Intention to Visit Green Hotels: Evidence from the Inbound Tourists visiting the Cultural Triangle

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The theory of planned behavior (TPB) is widely used in the field of tourism to predict and explain the tourists' behavior in different contexts. There is a growing trend that tourists prefer to deal with organizations that are less harmful to the natural environment. Also, over the past years, specific efforts within the hospitality industry have given to the idea of gaining competitive advantage through image building done with conservation and sustainability initiatives. The study explained the viability of the extended theory of planned behavior (TPB) together with the variable of past behavior to examine the intentions of individuals to visit green hotels in the Cultural Triangle of Sri Lanka. Accordingly, the study focused on identifying the impact of attitude, subjective norms, perceived behavioral control, and frequency of past behavior on the intention of an inbound tourist to visit a green hotel. A sample of 150 inbound tourists was selected using convenience sampling technique and questionnaire survey was administered to collect primary data. The findings revealed that attitudes, subjective norms, perceived behavioral control, and frequency of past behavior, positively impact on the intention of tourists to visit a green hotel. Additionally, the effect of frequency of past activity on intention to visit a green hotel was partly mediated the TPB variables. The results indicated that the adjusted TPB can be used to understand the behavioral intention of visiting a green hotel.

Keywords: Green hotels, theory of planned behavior, attitude, subjective norms, behavioral intention, past behavior

A Study on Factors Influencing the Decline of Middle East Tourists' Market in Sri Lanka: Stakeholders' Perspective

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Many people used to travel when they have their vacation to avoid the consistency of their lives. As declared by Lonely Planet, Sri Lanka is one of the world's number one destination to visit in 2018. Sri Lanka is a leading travel destination for Middle East tourists. Even though Sri Lanka has paid attention to the Middle East market, it has not been able to achieve a significantly high number of arrivals from the Middle East. Hence, the main objective of this study was to identify the reasons for decline of Middle East tourists' market in Sri Lanka. The researcher adopted the semi-structured interview to gather data about influencing factors of the decline of the Middle East tourist market. A sample of 15 stakeholders was selected using purposeful sampling method in which hoteliers, travel agents, tour and site guides, representatives from Sri Lanka Tourism Development Authority (SLTDA) and Promotion Bureau were interviewed. The views and opinions of the respondents were collected through the interviews. The analysis was done through thematic analysis and the researcher identified safety and security, facilities, attractions, marketing strategies, services, and other issues as the main themes. The findings revealed that the dissatisfaction of safety and security, lack of facilities, lack of manmade attractions, limitation of night functions, dissatisfaction of the hotel and guide services, lack of marketing strategies, and other issues such as terrorism and restrictions have attributed significantly to decline the Middle East tourists' market in Sri Lanka. Furthermore, implementing new rules and giving special attention for the Middle East tourists' expectation can turn around the situation and promote the Middle East market.

Keywords: Middle East tourists' market, influencing factors

Potentials and Pitfalls for Post War Tourism Development in Mullaitivu Area

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Its mandate to consider the post war reconciliation and development of the people where the war was took place, by using the sustainable manner. As Sri Lanka had experienced to increase GDP by poor tourism during the past three decade war we have the potentials to reach the millennium goals in all aspects including the tourism industry. Since end of the civil war of Sri Lanka the movements of both international and domestic visitors are increased based on few purposes. The tourism is played a significant role in the region. The result of increased arrivals of Diaspora, Domestic and international to the region, Sri Lankan economy and GDP too increased, though the northern part is not in adequate level. Therefore this research focused on potentials and pitfalls for post war tourism development in Mullaitivu district of the Northern Province. The sequential mixed method (qualitative & quantitative) was adopted to carry out this study therefore data gathering was conducted with five likers scale questionnaire with 50 international tourists those who have been in Mullaitivu, structured interviews with 10 stakeholders from the research area for primary data and data analysis is used by descriptive and thematic analysis. The finding of this study highlighted with fallowing aspect on tourism; present situation of tourism in Mullaitivu, identify both potentials and pitfalls for post war tourism development in the district. Based on the above finding this study depicts exact scenario of tourism development in Mullaitivu and how efficiently use the potentials and to overcome barriers for tourism development offered. Furthermore research says about the potential and considers the barriers that need to be decline. This research has positive destination attributes which needs to develop further and stakeholder participation needs to accelerate to develop tourism industry in Mullaitivu district. The research also refers about the current reflection of the people on tourism and their involvement in to the industry.

Keywords: Tourism, Potentials, pitfalls, War, Region and development

Impact of Organizational Culture on Career Development of Women Employees in Hotel Industry: Special Reference to Northern Province

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The aim of this study was to identify the impact of organizational culture on career development of women employees in hotel industry. Based on a comprehensive literature review, the authors adopted five dimensions of Hofstede's organizational culture namely, power distance, collectivism, masculinity versus femininity, uncertainty avoidance and long-term orientation and their influence to study how organizational culture could influence the career development of women employees in hotel industry. The study mainly considered the primary data. The primary data were collected through a structure questionnaire with 140 respondents from selected hotels in Northern province. Univariate and bivariate techniques were used in the data analysis. The results showed that organizational culture highly impacted on the career development of women employees. Furthermore, the dimensions of collectivism showed a high positive and significant impact on career development of women employees. The findings of this study have various managerial implications for hotels and other industries.

Keywords: Power distance, Uncertainty avoidance, Masculinity /Femininity, Long term orientation & career development

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Attitude Difference between Advanced Level Students and Currently Joined Students towards the Technical and Vocational Education Sector in Sri Lanka

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The government of Sri Lanka incurs considerable expenditure on Technical and Vocational Education and Training (TVET) system in the country and has made significant progress over the past decades through different strategies. Although this sector has been well organized to give opportunities up to degree level qualifications, the sector engages with three major problems such as low enrollment, high dropout rates, and a lower rate of job placement. Therefore, this study was carried out to investigate whether there is a significant attitude difference between Advanced Level (A/L) students and currently joined students towards the TVET sector. Eighty (80) students in TVET Institutes and A/L students in Matara District were the populations of this study. The data was collected through a questionnaire from all four TVET institutes, 10 students from each TVET institute and 10 students from each Educational zone covering all four educational zones. Independent Simple T-Test was used to compare the attitude difference between the students in two streams. According to the results, there was a change in variance between two groups but there was no significant difference in group means. The standard deviation of attitude of currently joined students was 0.52 and A/L students was 0.83. Accordingly, A/L students are having higher variance than the students who follow TVET programs. This indicated that currently joined students are having less variance towards attitudes in following TVET programs. Since A/L students are having a higher variance in their attitudes towards TVET than currently joined students, TVET sector needed to introduce appropriate actions and programs to change the A/L students thinking pattern and make a positive image on TVET.

Keywords: Attitudes, Technical and vocational education, TVET

Catering to the Training Needs of 21st Century Teachers

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Teacher training is an integral part of any system of education. Teaching professionals should ensure their Continuous Professional Development (CPD) to become competent teachers who are capable of delivering lessons to the students in the best way possible. The objective of the study was to figure out the gaps between desired training needs and the actual training delivered to teachers. The study was carried out using a self-administrated online survey. Fifty-seven (57) responses were received (93%-female, 7% male). Sixteen percent of the participants were satisfied with the training programs they had received so far while 11% of them were not satisfied and 74% were moderate. Five key characteristics of the desired training programs of the participants were figured out; Less monotonous nature (45.6%), Lack of repetition (42.1%), Updated knowledge to be delivered (31.6%), clear objectives (28.1%) sound preparation (26.3%). A focused group discussion was carried out with the participation of five education professionals to suggest recommendations to meet the desired training of the teachers in relation to the survey results. It was found out that teacher trainers should be updated, qualified, and pre-prepared. It was also noted that teacher trainers should have better communication with their co-trainers to make sure that repetition is avoided. A need for a network enabling quality circles of all the types of trainers in a given zone or a province was highlighted. It was also suggested that trainers should engage in action research and proper analysis of feedback to meet the needs of trainees in upcoming training programs.

Keywords: Teacher trainer, Training needs, Education systems, Continuous Professional Development (CPD)

The Causes and Associated Socio-Economic Effects of Floods in Ratnapura

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Sri Lanka is mostly affected by weather-related hazards as being a small island in the Indian Ocean in the path of two monsoons. Recurrent floods are one of the most common and frequently experienced hazards in Sri Lanka. It is affecting thousands of lives, livelihoods, and damages to properties. Ratnapura is among the severely affected districts from floods in recent decades. In this paper, an attempt was made to analyze the causes and associated socio-economic effects of floods in Ratnapura, Sri Lanka. The micro-level analysis was conducted in the active floodplains of Ratnapura Town West and North Grama Niladhari Divisions. The study employed a descriptive study approach and a sample of the population included the respondents in the bank of Kalu River in Ratnapura with a size of 150 respondents. Structured interviews were used to collect data and responses indicated that a wide range of actions has been employed to reduce the effects of floods. But these actions have not been perceived to make specific adjustments to mitigate the losses caused by floods. The findings of the research revealed that the floods occurred during the monsoon season is because of the activation of heavy rainfalls in the study area. Moreover, the intensity of the floods increased as a result of releasing of water from small and medium reservoirs, which rose the water levels of rivers and water streams by causing a heavy influx of flash floods. This triggers tremendous losses to housing, agricultural lands, standing crops, and other properties. The study found that The Disaster Management Authorities have only implemented limited structural mitigation measures. In addition to structural measures, it is recommended that land-use zoning and flood abatement strategies would largely help in reducing the adverse consequences of this recurrent phenomenon.

Keywords: Abatement strategies, Adverse consequences, Floods, Kalu river, Socio-economic effects

An Empirical Study of Students' Satisfaction with Professional Accounting Education Programs, Sri Lanka

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This study aimed at analyzing the factors affecting students' satisfaction with professional accounting courses offered by Professional Accounting Education Institutions and also aimed to assess the impact of students' satisfaction and students' loyalty towards Professional Accounting Education Institutions in Sri Lanka. It was evident that a significant gap exists between student enrolment and the rate of students' passing out as professional accountants as per the annual reports of the Institute of Chartered Accountants of Sri Lanka and the Institute of Certified Management Accountants of Sri Lanka (2014-2018). The study adopted a deductive methodology while employing a stratified random sampling technique and distributed 500 questionnaires which had a response rate of 80%. The data were analyzed using structural equation modeling via SPSS and AMOS versions 25. The study concluded that course assessment and institutional image, teaching methods, teaching staff, course organization and infrastructure facilities, and institutional administration and efficiency significantly impact the students' satisfaction. And also, it concluded that the students' satisfaction significantly impacts students' loyalty. This study added value to the literature by focusing the students' satisfaction from two extreme angles (i.e., students' need and loyalty) and introduced a new model which would enhance the appropriate administration of the Professional Accounting Education Institutions.

Keywords: Professional Accounting Education Institutions, Students' satisfaction, Students' loyalty, Sri Lanka

The Structure of the Verb Phrase in Spoken Sinhalese: A Linguistics Study

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According to structural linguistics, the structure of a language can be studied as sounds, words, sentences, and meanings. Sentences of all languages have both a deep structure, which gives the meaning of the sentence and a surface structure, which gives the form of the sentence as it is used in communication. The deep structure turns into the surface structure by using transformational rules. Hence, Phrase structure analysis is very essential for recognizing the structure of certain phrases and ascertaining inter-structural patterns of certain languages. The objective of the research was to recognize the structure of the verb phrase in spoken Sinhalese. The data is gathered from the book of “Kelani Paalama” written by R.R. Samarakoon. Accordingly, verb phrases were recognized from collected data by using phrase structure rules. The methodology of this research is analyzing the structure of the verb phrase by applying generative grammar. The findings of this study revealed that the verb in which the head of the verb phrase appears as various forms such as finite verbs, infinitive verbs, volitive verbs, involve verbs, transitive verbs, intransitive verbs, helping verbs and main verbs. Verbs behave in the form of reports, commands in a verb phrase, and emphasize and phrase focus happens in abundance in the verb phrase. Word order of the verb phrase of Sinhalese can be seen as free word order. When deep structure turns into surface structure simple sentences have no changes and complex sentences have some changes due to transformational rules. Sinhalese verb phrase has so many structures Moreover linguistics units such as nouns, verbs, adjectives, adverbs, prepositions, determiners, compliments, and sentences are included in the verb phrase in spoken Sinhalese.

Keywords: Transformational rules, Phrase structure, Verb phrase, Spoken Sinhalese

Influence of L1 Transfer on the Acquisition of L2 Syntax: A Study Based on the Written Composition of Undergraduate Learners

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In the Sri Lankan context, the majority of the language learners speak Sinhala as their first language (L1) and they are exposed to the English language only once they start their primary education. Before learning the Second Language (L2) these learners already have developed a strong first language system. Further Sinhala and English are structurally different and the students have little or no exposure to the target language outside their learning environment. L1 influence is common in both their oral and written communication. This has resulted in language errors even in the communication of undergraduate students although they are advanced learners who have been learning the language for several years. L1 influence is particularly common in syntax which is one of the basic yet crucial aspects of language. This hinders the teaching-learning process and much of the classroom time is consumed in addressing these errors while the actual focus of learners should be advanced aspects of the language. This poses a severe problem in following their respective degree programs as well because L1 influence severely affects their academic writing. Hence this study was concentrated on analyzing the influence of L1 on undergraduate learners' second language errors through a comparison of the syntax of Sinhala and English. A sample of 50 first-year students following three different degree programs at a government university was selected for the study. They all follow the English language as a compulsory subject during their first year at the university. The students were assigned to write a composition on a given topic which was later examined for errors. 40 errors influenced by L1 were found and they were categorized and analyzed based on their syntactic features. The findings of this study would enable the curriculum designers to devise materials focusing on addressing the L1 influence on second language acquisition.

Keywords: Second language acquisition, L1 Influence, Syntax, Language errors

Factors Influencing Consumer Purchase Intention towards Fresh Milk Packets: Special Reference to Colombo District

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Among the different types of dairy products, the demand for fresh milk is extortionate. Because, it is a nutritionally rich and precious human nourishment. After spreading a rumor that the imported powdered milk contains pig fat, palm oil, and other harmful chemicals for humans, Government Medical Officers Association (GMOA) recommended consuming fresh milk instead of powdered milk. Under this backdrop, it is prudent to answer the question of how Colombo district consumers' perception has been fabricated on purchase intention towards fresh milk packets. The general objective of this study was to identify consumers' perceptions of purchasing fresh milk packets. Further, the study attempted to identify the factors influencing the consumer purchase intention for fresh milk packets. The study adopted the stratified simple random sampling technique to generate a sample of 650. The operational methodology for this study had three stages. The first stage was the Exploratory Factor Analysis to identify the major factors that influence the consumer purchase intention towards fresh milk packets. The second stage was the Confirmatory Factor Analysis to confirm the identified major factors from the Exploratory Factor Analysis. Finally, the Structural Equation Model was applied to identify the relationships between the identified factors in the model. The study found that perceived price, perceived packaging, perceived quality, brand name, and product advertising positively influence consumer perception to purchase fresh milk packets. Moreover, the study revealed that Perceived Quality is the most crucial factor in consumer purchase intention. Therefore, the study suggested that fresh milk packets production should focus more on quality. Hence, the companies should strict to maintain the quality that the consumers in the Colombo district expect.

Keywords: Consumer purchase intention, Factor analysis, Fresh milk packets, Perceived quality, Structural equation model

Association between Tourist Receipts and Economic Growth of Sri Lanka

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The travel and tourism industry is a service-related industry that utilizes many services; transportation, accommodation facilities, food and beverages, and entertainment. Sri Lanka is a country, which has a higher tourist attraction since it shows increasing tourist arrivals over the past years. The research problem of this study was that; is there an association between tourist receipts and economic growth in Sri Lanka? The key objective of the study was to estimate the relationship between tourist receipts and the economic growth of Sri Lanka. The study design was a time series study using secondary data (economic growth rate and tourist receipts) from central bank annual reports and the considered period was from 1977 to 2018. In data analysis, the Pearson Correlation analysis was used to identify the relationship and the Granger Causality test was employed to find the direction of the causality. According to the trend analysis, there was no clear association between two variables since there was a sharp increase in tourist receipts after 2009 while economic growth shows fluctuations over time. There was a significant strong positive relationship between two variables ($r = 0.864$, $p < 0.01$). Granger causality test revealed that the causal relationship was unidirectional relationships and the causality goes from tourist receipts to economic growth. In conclusion, there was a positive relationship between tourist receipts and economic growth in Sri Lanka and the association comes from tourist receipts to economic growth. It is because; the tourism industry is a service-related industry, which involved many industries in the service sector. Therefore, when increasing the tourist arrivals and the tourist's expenses in deferent kinds, it is contributed to the gross domestic product of the country. Hence, it is more important to pay more attention to increasing tourist arrivals and require new planning to move forward to increase the tourist receipts.

Keywords: Correlation, Economic growth, Granger causality, Sri Lanka, Tourism receipts

Determinants of Household Expenditure on Education in Negombo D.S. Division

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Educational expenditure is a vast area and it covers household level all expenses incurred by households, public sector, and voluntary organizations. Traditionally, educational expenses can be categorized as public and private expenses. Both public and private expenses on education create the social domain. Moreover, two are inter-related and inter-dependent that, in the absence of either of them, there is likely to be under allocation of resources for education. When considering the private expenditure on education it is done by the individual households. Determinants of household education expenditure can be categories as household head specific characteristics, household-specific characteristics, school-student specific characteristics, and demographic characteristics. The main objective of this study was to identify the determinants of household education expenditure in the Negombo D.S. Division. Only primary data was used in this study. A questionnaire focused on group interviews, and observations were used to collect data. 100 households were selected as the sample size. The multiple regression model and the descriptive analysis method were applied to establish relationships between determinants and household expenditure on education. The findings of the study indicated that the household income, the number of schoolchildren have a significant effect on household expenditure on education. Furthermore, the paper found that the household head's level of education has an increasingly positive and significant effect on expenditure on education. On the contrary, the head's age was a negative determinant of the household expenditure on education. According to the findings educated household heads to prefer to invest more in their children's education.

Keywords: Educational expenses, Determinants, Households, Negombo D.S. Division

Fiscal Deficit Sustainability in the West African Monetary Zone

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The West African Monetary Zone is working towards having a single currency union. Macroeconomic convergence criteria have been set and all intending members are expected to meet these criteria. Among the criteria is that all countries shall have a fiscal deficit of no more than three percent of their Gross Domestic Product. Evidence shows that not all member countries have consistently satisfied this particular criterion from 2000-2018. The experience of the European Monetary Union suggests that having sustainable fiscal policies is important for the successful take-off of a single currency union in West Africa. Given this background, it becomes imperative to find out if these countries are pursuing sustainable fiscal policies. The main objective of this study was to evaluate fiscal deficit sustainability for the West African Monetary Zone member countries. To achieve this, a fiscal policy reaction function was estimated using annual data for a panel of six countries over the period 2001-2018. The dependent variable used was the primary balance as a percentage of Gross Domestic Product. The explanatory variables included lagged public debt as a percentage of Gross Domestic Product, the output gap, and some variables to capture political and electoral institutions. The model was analyzed using the fixed effects estimator. The empirical findings showed that there is weak fiscal sustainability among the countries. Primary balance rises by 0.018 percentage points for every one percentage point increase in the public debt after controlling for the effects of other explanatory variables. Institutions had a statistically significant impact on the primary balance. The implication of this is that weak fiscal sustainability portrays a danger sign for the West African Monetary Zone countries to form a monetary union. Individual governments must reduce public debts and deficits and strengthen fiscal institutions. The study suggested that the planned monetary union be suspended for now.

Keywords: Fiscal deficit sustainability, Primary balance, Public debt, West african monetary zone, Monetary union

Does Oil Price Effect the Gross Domestic Product of Sri Lanka?

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Energy is one of the critical determinants of economic growth, development, and welfare status of any country in the world. The impact of oil price changes on macroeconomic variables is mostly documented in academia and the degree of impacts are varied from energy-exporting vs. importing countries, dependency on non-renewable energy vs. renewable energy, and small country vs. large country. In this context, this study aimed to explore the impact of oil price changes on economic growth in Sri Lanka by employing time-series econometric techniques. The period covered by the study was 1987 to 2017, which coincides with the open economic policy phase. The unit root test revealed that all the variables become stationary at their first difference form. The Johansen Co-integration test confirmed the existence of a long-run association between variables. The Vector Error Correction Model indicated the negative impact of local oil prices on the Gross Domestic Product in Sri Lanka. The negative impact of oil price changes on economic growth in Sri Lanka was mainly due to the higher dependency on imported energy (fossil fuel), inadequate adoption of energy-efficient technologies in the production system, inadequate focus on alternative or renewable energy sources by the economy, higher dependency on traditional export items, and less responsiveness of supply-side adjustment to price changes or exchange rate depreciation to enhance export. The study emphasized the need to move the economy towards renewable energy sources and the adoption of energy-efficient technologies in the production system to minimize the adverse fallouts of the oil crisis in the world market on the economic development of the country.

Keywords: Economic growth, Non-renewable energy, Oil price, Renewable energy, Sri Lanka

Why Younger Generation Reluctant to Continue with Farming? A Case Study in Huruluwewa Modern Colonization Scheme

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Modern agricultural colonization schemes were introduced to the Dry Zone of Sri Lanka to achieve the country's food self-sufficiency. However, less interest in young farmers to continue with farming has become a major issue in these schemes. Therefore, this study attempted to identify the reasons for the young generation in the colonization schemes in Sri Lanka to be less interested in continuing with farming, by testing the *Huruluwewa* Colonization Scheme in the North Central Province as a case. Primary data were collected through the field survey which covered 155 farm households by employing a random sampling method. Descriptive and inferential analytical methods were used to analyze the collected data. The economic factor analysis indicated that yield and price risk of farming are the critical factors that affect farming income. The specific concern of the farmers in the scheme is drought and thereby the water management issues. Less profitability of farming systems in the scheme was another economic reason for the lack of interest of young in farming. This was mainly due to the absence of innovativeness in farming or less ability of the farmers to think out of the box as most farmers traditionally grow rice the same as the first generation did at the establishment of the scheme. Analyzing the social factors indicated less social recognition of farming is the main reason for the younger generation's decision to quit farming. The root causes here were the economic and social stagnation or less or slow transformation of these communities for many decades. This has created multiplier effects on the second and third generation of the scheme in terms of societal, for instance, out-migration (both temporary and permanent), social issues in terms of marrying, crimes, and drug addictions. The selected progressive farmer cases revealed that they are innovative farmers who think beyond the traditional farming system in the scheme, with entrepreneurial freedom for farming.

Keywords: Colonization Scheme, Farming, Huruluwewa, Less interest, Socio-economic factors

Water Management Practices as Adaptation Strategies for Drought: A Case Study in Huruluwewa Irrigation System, North Central Province in Sri Lanka

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Huruluwewa is a major Irrigation System, which is also known as a colonization scheme that facilitates farming activities covering a massive capacity. However, in the drought period, farmers in the left bank of the system face serious issues of inadequate water supply for cultivation due to the geographical setting of the left bank. Therefore, this study was aiming to find the availability of water management practices among farmers as adaptation strategies in dry periods. This was a cross-sectional study done by using an interviewer-administered questionnaire. The study sample consisted of 113 farmers of the left bank and the data were analyzed by using descriptive-analytical methods. According to the result, 78.2% of farmers used adaptation strategies, 19.3% avoided farming in the dry season and 2.5% were in moderate. Among the farmers who were using adaptation strategies, five approaches were found. One is using water from huge wells dug close to the canal and one well is owned by 2-3 farmers mostly. However, it is a successful technique, although they have not taken any permission or advice from the authority when constructing. The others are; making land as moisture protected, cultivating paddy only on a part of the farmland where has higher moisture level, using alternative short-term crops which require less water, using multiple types of crops as in *chena* cultivation. Using multiple crops also a wise method, as destroying 1-2 crops may not significantly affect the farmers' income. Finally, it can be concluded that, the majority of farmers in the Huruluwewa Irrigation Scheme have succeeded in their cultivations using different water management methods as adaptation strategies for drought. Further, the intervention of authorities in constructing huge cultivation wells using precise techniques and promoting multiple crop cultivation can be recommended.

Keywords: Adaptation strategies, Cultivation, Drought, Water management practices

The Effectiveness of Specialized Translators and General Translators on Sports Journalism in Sri Lanka

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The general public of Sri Lanka has traditionally placed a high value on sports, therefore the print media and electronic media have often been very useful resources for thousands of sports enthusiasts. The Sinhala and English newspapers of the same publisher frequently share the news items expecting that both Sinhala and English readers of the same publisher do not miss out on valuable information and that's where the translation becomes such a crucial factor. However, at present plenty of mistranslations especially in the field of sports journalism could be observed in both print and electronic media. Generally, most of the translations in media organizations are carried out by general translators who do not have specialized knowledge in sports and that leads to many mistakes. Although similar research on the fields of commercial translation, medical translation, and legal translation has been conducted previously, no research has been conducted about translation related to sports journalism. Hence the main objective of this study was to investigate the effect of specialized translators and general translators on sports journalism in Sri Lanka. A case study was employed to carry out the research having selected five experts in sports translators through expert sampling, and five general translators using simple random sampling. They were provided with identity documents to be translated from Sinhala to English and their performance was evaluated in line with the instructions of the "Unbabel Blog" website. The study revealed that the specialized translators improved the content, completeness, and the time spent, in contrast to general translators, but there was no significant difference in terms of grammar accuracy. It was also seen that the most common errors committed by general translators are related to the terminology, sentence structures, and context which suggest that lack of expertise is the major reason behind the failure. Therefore, this research has presented sufficient evidence to suggest that specialized translators are a much better option in comparison to general translators, and more specialized translators in sports should be recruited by a media organization to produce better sports translations.

Keywords: Sports journalism, Translation, Specialized translators, General translators, Sri Lanka sports journalism

The Clash of Identities as Depicted in the Short Story “Unaccustomed Earth” by Jhumpa Lahiri

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Problems encountered by immigrants in their host-land have provided a large body of research for the last few years. There is a high tendency, of people who are unable to actualize their dreams in their homelands migrating to countries, whose images are held up by society. This particular study is an attempt to discover the clash of identities in migrant characters as depicted in the prolific writer, Jhumpa Lahiri's short story "Unaccustomed Earth". The literature was analyzed using the postcolonial lens of Homi. K. Bhaba to get a better insight into how the hybrid nature of their identity is the driving force in creating controversies barring migrant journey towards achieving better prospects. The research was qualitative and the primary data was accumulated through textual analysis and conducting semi-structured interviews with academics. Accumulated data, which was analyzed using the concept of 'Hybridity' was incorporated in the discussion. The past researches reveal those conflicting situations such as language-related issues, alienation, cultural dichotomies, fragile relationships as some of the harsh realities encountered by the migrants who are domiciled in America, the land of hope. The research findings in this respect ascertain that the above-mentioned problems emerge owing to the clash of dual identities of the disillusioned Asian immigrants. Thus, it was further manifested that compromise adaptation, correct attitude, self - awareness could mitigate the aforementioned issues.

Keywords: Dual identities, Alienation, Hybridity, Indian immigrants, Host-land

A Hegemonic Study on Youth Problems Appeared in Modern Sinhala Poetry: from 2000 to 2020

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The present study focused on the youth problems addressed in modern Sinhala poetry in terms of hegemony from the year 2000 to 2020. However, modern poetry is a newly emerged segment which is different from the poetry of Colombo era generations. The birth of this new generation was started in 2000 which could be named as century poets. After the year 2000, the tendency of poetry was different than that of writing in the 1970s. Among them, the trend was mainly focused on the problems of the youth of Sri Lanka who lived in that period. Many authors have discussed these problems in terms of poems. These poems should be investigated or criticized using newly developed theory known as Hegemony which is the evolution of traditional Marxism. Hegemony is the theory that was developed by Antonio Gramsci through his manuscripts written in Prison Notebooks. Dominance or hegemony is the most important fact in Gramsci's concept. According to Gramsci, there are two authorities as dominance and suppressor. Dominance; ruled by self-assent while suppressor is ruled by the authority after the huge suppression. After the year 2000, the poetry depicts both marginalized youth and hegemony. Amongst them, (i) The working of Hegemony to marginalize youth, which includes; youth unrest, the transformation of young love, un-employability, life struggle of labor class (ii) Cultural hegemony in Sri Lanka, which includes sex, economy, education (iii) Globalization and Hegemony, which includes; popular culture, post-war era are the important facts that are appeared and discussed in poetry which were written during 2000-2020 years. During these two decades, most prominent poets who have written poems with related to hegemony are Kumara Hettiarachchi, Manjula Wediwardane, Lakshantha Athukorala, Mahinda Prasad Masimula, Malathi Kalpana Ambrose, Timran Keerthi, Ruwan Bandujeewa, Saumya Sandaruwan Liyanage, and Lahiru Kithalagma. Overall, most of the poetry revealed that the base for that poetry is the ideological state apparatuses which were discussed in hegemony.

Keywords: Poetry, Youth problems, Hegemony, Ideology

Military Analysis of Attack Phase of the Vijithapura Battle

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The Battle of *Vijithapura* fought between King *Dutugemunu* and King *Elara* is documented in ancient chronicles of the country to be of irrefragable significance in the Sri Lankan military history. Though the diverse literature sources reveal this battle, it has not been analysed in a military angle. This was an exploratory type of pure research and it was aligned with the naturalist research paradigm. Further, it has based on the secondary data sources and the research approach acquiesces with the qualitative method. The scope of this research was to analyse the attack phase of the *Vijithapura* Battle using the present-day battle appreciation format of the Sri Lanka Army. In the battle stage, it can be identified that the *Vijithapura* fortress was the strongest among the other 36 fortresses and it was well secured by three moats and high walls. During the attack, King *Dutugemunu* has considered many factors which are not having much recognition of the present-day battle appreciation format. King *Dutugemunu*'s force has effectively used the besiege tactics including encirclement, elephants to breach gates, and hunt down escaping troops by using horses. As the next step, they have proceeded with a well-planned siege warfare tactic to capture the *Vijithapura* fortress. For the planning purpose, the spy service was used strategically to cluster information. In addition to that, assigning tasks to *Mahasona*, *Theraputtabhaya*, and *Gothaimbara* (recorded in the history to be among Ten Giants) to attack three entrances that were located around the *Vijithapura* fortress can be identified as the tactic of "effective use of human skills". Besiege tactics, siege tactics, spy service and effective use of human skills are the lessons learned from the *Vijithapura* battle and finest points to concern in empowering the present-day battle appreciation format of Sri Lanka Army

Keywords: Ancient military tactics, Anuradhapura kingdom, Attack phase, Battle appreciation format, *Vijithapura* battle

Institutions, Investment and Economic Growth: Evidence from Sub-Saharan Africa

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Sub Saharan African countries experience low private investment compared to other developing countries in the world. For instance, private investment in the region averaged 15% of GDP from 2010 to 2016, as compared to 22%, 18%, and 17% for developing countries in Asia, Europe, and Latin America respectively. This low investment level constrained the region's ability to grow and improve social outcomes such as; increase in real wages and poverty reduction. Low-quality institutions could explain this phenomenon. Therefore, this study aimed to examine the effect of institutions on investment and economic growth of 37 SSA countries from 1996 to 2017 using a dynamic panel data model. The data were retrieved from Worldwide Governance Indicators, World Development Indicators and the Chinn-Ito index. System Generalized Method of Moments was used to estimate the result. The key findings generated by the study confirmed that these measures of institutional variables and their interaction with investment yield a positive and statistically significant result. Indicating that strengthening the quality of these institutions could positively affect investment and economic growth of the region. For instance, a unit increase in controlling corruption increases investment by 1.4%. Furthermore, there is evidence showing financial development slows investment growth, which can be attributed to the weak institutional arrangements, as the coefficient of financial development is negative and statistically significant. The study recommended that SSA countries should pay greater attention to institutional reforms particularly; control of corruption and political stability to drive meaningful growth and development in the region.

Keywords: Institutions, Investment, Economic growth, Sub Saharan Africa

Effective Usage of Models at the Tertiary Level ESL Writing Classroom

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Writing is an extremely complex cognitive activity. Learners of English as a Second Language need to produce pieces of writings in different genres. Therefore, teachers of English as a Second Language are expected to provide writing models to guide the learners. However, there is a counter-argument remaining that the learners replicate the models as ideal ones instead of producing their writings. On the other hand, students may face difficulties in writing a particular genre as a consequence of their lack of experience in reading and writing. Therefore, this study was an investigation on the effective usage of models in learning essay writing in the ESL writing classroom of second-year students from the Faculty of Science, University of Jaffna. The data were collected by conducting a pre-test and post-test. The students were divided into two as the control group and the experimental group. SPSS statistical package and paired sample T-tests were used for data analysis. The duration of this study was for four months. The experimental group was given models as instruments to guide and modify their writing and produce original pieces. Learners won't be rewarded for having memorized full blocks of texts. After the treatment period, a post-test was given to both groups to see the significant differences between the two groups. Finally, in the post-test, the experimental group out-performed the control group. At this juncture, the findings showed particular improvements on the micro and macro level of writing especially the overall organization, content, and the structure of sentences and paragraphs in writing. The results have some implications for language teachers and material designers.

Keywords: English as a Second Language, Writing skill, Models, Micro and macro level of writing

History of Smallpox Epidemics that Ravaged Ceylon from 1500 to 1800

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Smallpox, caused by the *variola* virus, was a deadly scourge that plagued mankind for centuries, causing severe disfigurement, blindness, and death in most cases. In Ceylon, smallpox was known as Vasuriya, Vaduru rogaya, Deviyange ledé (divine affliction), Maha leda (great disease), Divi dosa (leopard misfortune), Ankaria and Masurika and the natives worshipped deities like, Mari Amman and Pattini to ward off smallpox, which was believed to be an indication of divine displeasure. It is surmised that it wreaked havoc in the time of Panduvasdeva and led to the collapse of the Rajarata Civilization. At the time of Arahat Mahinda's visit, smallpox ravaged Anuradhapura & during Srisangabo's reign in the 3rd century, it wiped out half of Ceylon's populace. This study aimed to trace the history of smallpox and to explore the herbal remedies used for treating pox boils and its complications. Also examined are the waves of smallpox epidemics that repeatedly assailed Ceylon from 1500 to 1800, and its influence on Colonial expansion, Lankan culture and tradition. I argue that smallpox was the 'unspecified pestilence' that desolated Mannar at the time of St Xavier's advent in 1543 and that the European Colonists introduced new epidemics into Ceylon. I also argue that Prince Sakka Senatipati, King Karaliyadde Bandara, Princes Dom Luis & Dora Joao of Kotte, Modliar Simon de Melho and the wife of Governor Adriaan van der Meyden fell victim to smallpox. An archival review was conducted for this study and I perused the writings of Loten, North, Gollonese, De Orta, Daelmans, Grimm and Hermann. To date, there has been no research wholly dedicated to the history of smallpox epidemics before the British rule in Ceylon, ergo, my research will not only fill the knowledge gaps but it will also add to the existing body of knowledge available on the history of medicine of Sri Lanka. Moreover, the lessons learned from smallpox eradication are essential in tackling the ongoing global pandemic of COVID-19.

Keywords: Bezoars, Colonialism, Herbal remedies, Medical history, Smallpox epidemics

The Impact of Psychological Wellbeing on Entrepreneurial Engagement: Special Reference to Military Entrepreneurs in Sri Lanka

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Entrepreneurial engagement through the entrepreneurial process involves individual entrepreneurial growth by the development of psychological wellbeing. Military entrepreneurs are a niche segment that had the rarest concern but yielding a higher contribution to society. Their involvement in crimes as they become deserters and lack of welfare measures during the post-war period are the major factors that have caused underworld development. Given the fact of a lack of empirical evidence, the research was conducted regarding the impact of psychological wellbeing on entrepreneurial engagement by military entrepreneurs in Sri Lanka. The mixed-method was followed to determine the supportive nature of qualitative findings to quantitative findings. The stratified sampling method and snowball sampling method were employed to highlight the specific subgroup of 206 and 22 military entrepreneurs respectively. Data was gathered by using self-administered questionnaires and semi-structured interviews. Apart from the descriptive data, Structural Equation Modeling, correlation, and thematic analysis were performed to analyze the data. Psychological wellbeing was measured using the Ryff's six-factor model and entrepreneurial engagement was measured using the entrepreneurial process of identification, evaluation, and exploitation. The analysis revealed that autonomy had the least impact on military entrepreneurs while the other dimensions had a moderate impact. Alongside this, it was found that there was a significant positive relationship between psychological wellbeing and entrepreneurial engagement. Moreover, the study found that there were barriers and supporting factors for the engagement in entrepreneurial activities, and further recommended that government support and counseling is essential for the development of Psychological wellbeing and Entrepreneurial Engagement.

Keywords: Psychological wellbeing, Entrepreneurial engagement, Military entrepreneurs, Planned behavior

A Critical Evaluation of the Grade 7 English Pupil's Textbook Used in Sri Lankan National Curriculum

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The objective of the research is to examine the validity of grade seven English pupil's textbooks used in the Sri Lankan national curriculum as a practical study material in learning/teaching the language. The use of a textbook in a language classroom is a debatable issue in the post-method era of which the communicative competency becomes the primarily expected learning outcome. The study was qualitative research in which the researcher attempted to conceptualize self-experiences as an English as a Second Language teacher and pupil's textbook user in teaching the English language to grade seven students. In addition to direct observation of grade 7 students, content analysis was employed as a research methodology; a selected section of the textbook was analysed based on David Williams' criteria for evaluation of textbooks (1983) and the theoretical perspectives of Donovan and Smolkin (2002) on the genre and writing development in designing language courses for elementary students. The selected section of the textbook consists of the lessons that are expected to be learned/taught in the third term of a calendar year. The research showed the negatives of using the textbook in a language classroom, the alternative study materials, and methods that could be introduced to the classroom to upgrade the practical use of English. The findings of the research also suggested that the content of the textbook that is expected to be learned by grade seven students and the up-to-date knowledge on designing/writing textbooks do not correlate, making the pupil's textbook less productive study material.

Keywords: English language, Grade seven, Pupil's textbook, Study material, Language planning

Koombiyo (The Ants) and Deweni Inima (The Second Innings): an Insight to the Preference of University Undergraduates for Sri Lankan Popular Culture Teledramas

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The purpose of this comparative study was to examine the type of teledrama genre predominantly preferred by university undergraduates in Sri Lanka, out of the two teledrama genres: romance and realistic teledramas and the rationale behind its popularity. During the past two decades, Mega teledrama cult centered on romance fiction subverted Sri Lankan teledrama culture, appealing to a wide range of spectators. However, with novel and innovative approaches in teledrama direction, realistic teledramas are being produced at present. Both these genres of teledrama have gained notable popularity in modern Sri Lankan society, in comparison to other previously popular Indian and Korean teledrama series. Thus, this research was conducted based on two popular Sri Lankan teledramas: *Koombiyo* and *Deweni Inima* that premiered in 2017, belonging to two teledrama genres; realistic and romance drama, respectively. Semi-structured questionnaires were used as the research method to collect data from the research participants to conduct a qualitative study. By using simple random sampling, fifty undergraduates in different faculties from the University of Kelaniya were thus provided with the questionnaires. The study presented an insight into the preference of university undergraduates for Sri Lankan popular culture teledramas regarding Stuart Hall's Audiences and Reception theory (1993) and Raymond Williams' (1961) theoretical frameworks on popular culture. The primary finding revealed the most popular teledrama as *Koombiyo* with a 68% voting as it is identified as an atypical, realistic teledrama. The research also identified various factors influencing university undergraduates' inclination towards Sri Lankan teledramas. The outcome of this interdisciplinary research disseminated new information and knowledge in media and cultural studies while proposing dimensions for teledrama direction to produce atypical works to retain the audience of the youth for Sri Lankan teledramas.

Keywords: Popular culture, *Koombiyo*, *Deweni Inima*, Sri Lankan teledramas, University undergraduates

Teaching English for Grades One and Two: A Study of the Issues and Challenges Encountered by the Teachers in Conducting a Special English Program in the Schools of Wattagama Education Zone

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Over the past decade, many countries such as India, Pakistan, and Kenya have started to teach English as a second or foreign language at a very early age. In the Sri Lankan school education system, formal English education starts from Grade 3. Yet, for grades one and two, English is taught under the program, *Activity Based Oral English (ABOE)* aiming at improving English for conversation. Along with ABOE, in 2013, a special English program was initiated to teach English for grades one and two of the government schools in Wattagama Education Zone. The books, *The Radiant Way* and *New Millennium* which were mainly used to improve reading and writing were used as the primary teaching materials. The purpose of the study was to investigate the challenges and issues encountered by the teachers in conducting this program. The data were collected from twenty five (25) teachers of fifteen schools (15) through interviews conducted over the phone and were analysed qualitatively, putting the recordings into a paper, defining themes. The findings revealed the lack of teacher training to teach English to pre- primary/ primary stages as a major issue. The mismatch between the assigned books in certain aspects hindered the teaching process. Changing the materials/text books according to the choice of the teacher without informing the authorities, teaching writing despite the authority's advice not to do so, the lack of importance given to the improvement of listening skill, the lack of a proper syllabus, and facilities were some other issues. The study suggested actions to be taken to overcome these issues which can improve the program to be implemented island wide such as, providing adequate teacher training, setting up a proper syllabus, better supervision system to maintain the consistency of the program, providing adequate facilities for the schools, appointing experts in the field to do a survey of the program to decide whether writing should be introduced at such an early stage.

Keywords: Activity based, Challenges, English as a second language, Primary teaching

Perspective of ESL Undergraduates on Mobile Assisted Language Learning

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Mobile-Assisted Language Learning (MALL) - a topic of current interest - is a subset of the approach, Computer- Assisted Language Learning (CALL), deals with handheld mobile devices making the learning process more personalized, spontaneous and ubiquitous (Miangah and Nezarat). Various researches identified that mobile learning (m-learning) is capable of supporting more innovative constructivist, collaborative, learner-centered instruction in contrast to teacher-led classroom pedagogical situations. Having set an objective to investigate the end-users' perception of the use of MALL approach in relation to the advantages and disadvantages of its adoption and implementation in English Language learning, the population (twenty students) of the second year English as a Second Language (ESL) undergraduates of the Sabaragamuwa University of Sri Lanka was selected. An open-ended questionnaire survey was conducted to obtain data and the data were analyzed qualitatively. The analysis confirmed that the majority of the respondents do have a positive attitude towards the use of the MALL approach for distance learning. The results of the study depict the abundance of advantages of using m-learning in tertiary education, such as easy and quick access and availability of plenty of resources, software, and apps. It was found to be supportive in developing almost all the four language skills including grammar, vocabulary, and pronunciation. In view of the difficulties encountered when using m-learning approach, the data manifested the commonness of difficulties encountered by ESL learners in the categories of connection problems, financial issues, lack of high-tech sophisticated devices, accuracy, and reliability issues. Although the findings convince that the students still choose teacher-led classroom education, MALL would be more preferred if all its features are fully employed.

Keywords: English as a second language, Mobile- Assisted language learning

Incorporating Songs to Enhance English as a Second Language Listening Comprehension: a Study Conducted with Special Reference to Udagama Maha Vidyalaya

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As stated by Feyten (1991) listening has emerged as an important component in the process of Second Language Acquisition. Although a child exposes to his First Language (L1) through listening, in the Second Language (L2) learning environment, teachers pay the least attention to developing listening skills. As diminutive provisions have been provided in Sri Lankan English as Second Language (ESL) syllabuses, the teachers use diverse strategies in teaching listening. The use of songs in teaching listening has recently attracted attention in the ESL context. Thus, this study aimed to investigate the use of songs to enhance the listening comprehension of ESL students. The researcher decided to focus on a limited sample because of time and resource constrictions. The study was conducted with special reference to Udagama Maha Vidyalaya in Balangoda and the sample of the study consists of eight ESL teachers of grades ten and eleven and the sample was selected using a convenient sampling method. The structured interview method was used to obtain data and data was analysed quantitatively and qualitatively. The findings of the study illustrated that songs which are in the textbooks had been used to practice listening skills. Further, it indicated that the difficulties faced by the teachers, such as lack of resources, limitation of time allocated for practicing songs in the classroom, and difficulty in giving attention to students individually. Sometimes the students could not comprehend the songs because of the speed of the words and the unacquainted accent so that the teachers had to replay the song. Also, the students were not interested in the songs that they found in the syllabus. Therefore, this study concluded that the incorporation of songs enhances the listening comprehension of ESL students if the songs are well-chosen by considering the facts; the predilection of the audience, language proficiency of the students, and the content of the songs.

Keywords: Incorporating songs, Listening comprehension, English as a second language

The Impact of Virtual Learning Environment on Teaching English as a Second Language

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Students who are born and raised in the modern digital millennium are natives to the digital world where the teachers are digital immigrants. Students being more active in the modern technological world, the dire need arise in the education system to craft education to meet modern educational needs. The integration of modern teaching platforms to education is an affirmative pace towards active learning. Hence this study focused on investigating the effectiveness of Virtual Learning Environment on teaching English as a second language. To achieve the key aim, the researcher investigated the perception of the students and teachers on using VLE as an English language teaching and learning platform and identified problems and challenges of using VLE. The data for the study was collected from second-year undergraduates of Uva Wellassa University where students were tested on a pre and post-in-class test after allowing them to do supplementary English language modules via VLE. The researcher found that there is a positive impact of VLE on learning on students' performance in the English language. The mean value of the English assignment via VLE is 15.077 while the mean value of the in-class English language assignment is 14.281. Hence, incorporating English language activities to VLE could make the students more engaged and feel motivated to do the activities. Hence, in Uva Wellassa University where 99% of the students use the VLE for their academic purposes, VLE is a good platform to learn the English language.

Keywords- E-learning, Learning platform, Virtual learning environment

Comparative Study on Pedagogical Reasoning in University Level ESL Practitioners

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Teacher cognition or the pedagogical reasoning plays a vital role in ESL (English as a Second Language) teaching as it represents the self-reflections, beliefs, knowledge about teaching students, content, and awareness of problem-solving strategies related to classroom teaching. Teachers not only need to develop a knowledge base for teaching but also should be able to make reasoned decisions on classroom teaching. Therefore, it has been identified that pedagogical reasoning as an important skill which should be developed among the present-day ESL practitioners. The data for the study was collected from six (06) University level ESL practitioners employing classroom observations focused on lesson stages, activities, and interviews. Moreover, to develop a multi-perspectival account of the construct of pedagogical reasoning a qualitative approach was used. The findings of the research revealed that the skill of pedagogical reasoning developed with the experience. The more experienced practitioners tend to transform content knowledge in a pedagogically strong and powerful way which facilitates the understanding of the learners while less experienced practitioners struggle to put the theory into practice. On the other hand, practitioners with more experience tend to make decisions based on traditional ELT approaches while practitioners with less experience follow the process of informed decision making. Furthermore, it can be stated that the curricula of the universities facilitate the teacher autonomy and the pedagogical reasoning of the university level ESL practitioners as it allowed them to select and design the content. The study suggests that the ESL practitioners must be given opportunities to update the knowledge of pedagogical reasoning and some teacher training courses should be implemented to address the issues related to the skill of pedagogic reasoning among ESL practitioners.

Keywords: ESL practitioners, Pedagogical reasoning, Teacher cognition

The Impact of Social Media Usage and Academic Performance Among Students of Advanced Technological Institute

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Social Media Network (SMN) becomes one of the greater influences on the lifestyle and habits of teenagers which affects the educational environment and performance. There are different arguments about the possible effects of SMN on students' academic performance. Studies show that it quite appropriate for teachers and students to use social media to socialize by this means for academic purposes. Studies on the impact of SMN on academic performance among students of the Advanced Technological Institute (ATI) is hard to find in academic literature. Therefore, this study examined the use of SMN on academic performance among students of ATI. A self-administrative questionnaire was used to collect data from 148 students in different courses in the ATI–Sammanthurai using a stratified sampling method. The respondents were classified into four categories (non, light, medium, and heavy users) based on average time spent in SMN sites and apps. The students' academic performance was evaluated through the Grade Point Average (GPA) of respective students in their study program. The ANOVA statistical technique was used to find the impact of SMN on students' academic performance by comparing the mean GPA of groups of respondents. The study found that light users get the highest GPA than all other groups. Non-users also get a higher GPA than medium and heavy users. The mean GPA differences between the non-users and the medium users were not statistically significant. The light users spend less time relatively other groups of users. The light users may utilize the SMN for educational purposes. However, medium users utilize SMN for entertainment as well as educational purpose. The heavy users are spending much of their study time on SMN which leads to reduce in study time and adversely impacts their academic performance. This study concluded that the reasonable use of SMN helps to increase the academic performance of the ATI students.

Keywords: Academic performance, ATI, Education, Social media network

Impact of Learning Barriers and Finding Remedial Activities for Junior Secondary Students in the Intermediate Classes

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Uninterrupted learning will make for a better education. For students to grow better in their learning, students need to have a seamless learning process. The school, home, and community should be better collaborative. In general, students' learning process is affected by the commitment of schools, good home-scholling, good parenting, socialization and economic situation. This study was conducted in the Balangoda area in Ratnapura District. Survey respondents for this study were the teachers, the students, and the parents. For this study, one school of 1C and four schools of Type –III were selected based on the facilities, the number of teachers and students. The study aimed at investigating the learning barriers and finding out the remedial measures for junior secondary students in the intermediate classes. The mixed-method was used in the present study and the random sampling technique was used to recruit 100 students, 50 parents, and 4 principals. A questionnaire was used for the students and teachers where as principals and parents were interviewed. Based on the data analysed, it was revealed that there were various obstacles for student learning. The budgets for students' activities found to be restricted. Involuntary learning, parenting, lack of students' interest on education, lack of teachers' attention on students and poverty were also identified as main issues. By addressing these issues systematically, the learning environment can be improved to assure a better education for students.

Keywords: The impact of learning barriers, Students, Remedial teaching, Learning disruptions, Intermediate classes

Exploring the Effectiveness of Applying Active Reading Strategies in ESL Classrooms to Enhance Reading Comprehension of Learners

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Reading is indubitably an indispensable skill to master in the process of acquiring the English language for it provides learners the exposure to the target language whilst honing their lexicon, expression of ideas, grammatical knowledge, etc. Yet merely answering a set of questions after spending much time translating difficult words to one's native language which happens in most ESL classes does not adequately facilitate reading comprehension. Thus, this study intended to explore the effectiveness of applying active reading strategies in ESL classrooms to enhance the reading comprehension of learners. The objectives were to identify and implement active reading strategies in authentic ESL classes and to explore learners' perspectives on the use of these novel approaches. The primary data were accumulated from 160 students from the University of Ruhuna via group interviews, structured questionnaires, and participant observation. Secondary data were collected from books and research articles. The acquired data were analyzed both qualitatively and quantitatively. The researcher implemented the active reading strategies, scanning, skimming, critical reading, predicting, inferencing, summarizing, discussing, frontloading vocabulary, and choral reading in the ESL classroom. The respondents confirmed the researcher's observation that their exposure to the above reading strategies followed by constant practice assisted them to comprehend reading materials better and they sparked their interest to read more in English. Moreover, the majority stated that choral reading helped them practice pronunciation while frontloading vocabulary made them focus on the meaning of texts during reading sessions without having to focus much on decoding the words in texts. In conclusion, active reading strategies assist to enhance reading comprehension of learners.

Keywords: Active reading strategies, Reading comprehension

Parents' Psychological Circumstances and Parental Involvement in Child Related School Activities

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Most of the studies based on empirical surveys have witnessed that there is a positive relationship between parental involvement and child outcomes. Hence, the general view is that parental involvement in the lives of children has a positive influence on school-related outcomes and behaviour. Depression or anxiety seems to be a barrier to parental involvement. Experience of economic hardship was identified as an important factor in determining parental mental health and self-perception. On this backdrop, this study attempted to identify the impact of parents' psychological circumstances influenced by economic hardships on their involvement in child-related school activities based on an extended version of the Family Stress Interactionist Model. The study mainly focused on the constructs of economic distress, psychological circumstances, negative marital interaction, and parental involvement of both father and mother separately with the progress of child school engagement. Moreover, the study adopted an Actor Partner Interdependence Approach in examining the interdependency of dyadic relationships between father and mother. Cross-sectional primary data collected through a sample survey were used and the sample consisted of parents of 380 students from 5 selected schools in an urban setting including both low and middle-income families. Results of Structural Equation Modelling suggested that the significance of mothers' parental involvement in child school engagement in comparison to the fathers' in the context of Sri Lanka. Mothers' parental involvement was not significantly affected by their psychological circumstances compared to fathers' due to different roles of father and mother in the family. More specifically, findings identified the interdependency between father and mother and hence the study concluded that the psychological circumstances along with the economic distress of both parents are important in determining the progress of child-related school activities.

Keywords: Economic distress, Psychological circumstances, Parental involvement, School engagement

People's Willingness to Pay for an Improved Public Transport Service in Kandy: Single Bound Dichotomous Choice Analysis

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Severe traffic congestion in main urbanized cities is one of the major development bottlenecks Sri Lanka is currently dealing with. Existing road capacity is insufficient to meet the transport requirements of the increasing vehicle population. As statistics of the Department of Motor Traffic indicate, the vehicle population has increased by 8.6% average from 2008 to 2018 which is greater than both the average population and economic growth of Sri Lanka. This study mainly suggested attracting private vehicle users to improved public transport as a sustainable solution to this severe traffic congestion. Therefore, this study attempted to address the question of what is people's Willingness to Pay for improved public transport to reduce traffic congestion. To investigate the hypothesis, the study was conducted in Kandy and primary data were collected from 389 individuals by conducting interviews based on structured questionnaires. Willingness to Pay for improved public transport was estimated by using the Single Bound Dichotomous Choice method. The study found that the mean Willingness to Pay for improved public transport is LKR 162 under the 99% confidence level. This is approximately four times the current ticket price which emphasizes people's expectations and requirements on improved public transport. Also, survey results emphasized that the mean distance from the surveyed area to the city is 15 km approximately. It highlights that the current bus fare of LKR 2.33 per km gets increased to LKR 10 per km with improved public transport. Further, results revealed that income and travel time as major determinants of peoples' Willingness to Pay towards improved public transport. Meantime, educational level, employment category, and age also have a considerable impact. Based on these findings, this study argued that the public is willing to substitute private transport with improved public transport if certain conditions are met which leads to a significant reduction of traffic congestion.

Keywords: Kandy, Public transport, Traffic congestion, Willingness to pay

Impact of Service Quality on Passengers' Satisfaction in Bus Transportation in Kandy City

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This study attempted to identify passengers' perceptions towards the service quality and satisfaction gained by bus transportation in Kandy city. Further, the study is based on a cross-sectional design to gather primary quantitative data through a structured questionnaire. The study generated a sample of 591 passengers based on the Stratified random sampling technique. The first step of the analysis is the *Exploratory Factor Analysis* to identify the major factors that influence Service Quality in Bus Transportation in Kandy city. The second step is the *Confirmatory Factor Analysis* to confirm the identified major factors from the *Exploratory Factor Analysis*. Finally, the *Structural Equation Model* to identify the relationships between the identified factors in the model. Results emphasized that the first and second steps identified only four variables out of five that influence the service quality of bus transportation in Kandy city. The identified major latent variables are Tangibles, Reliability, Assurance, and Empathy. The study found that Tangibles, Reliability, Assurance, and Empathy have a significantly positive impact on the service quality of bus transportation in Kandy city. However, the impact of Empathy on the service quality of bus transportation in Kandy city is the most crucial factor in explaining 98%. Further, the study revealed that the service quality in bus transportation in Kandy city influences 100% on the passengers' satisfaction. This states that service quality is the major phenomenon which affects the passengers' satisfaction in Kandy city. Finally, the study suggests that bus transportation in Kandy city should focus more on strategies that enhance service quality to improve passenger satisfaction. These strategies may include, arriving and departure of the buses at the punctual time, minimizing the breaking down of buses on the road, employing skilled drivers and polite conductors, providing an efficient staff service, etc.

Keywords: Passengers' Satisfaction, Service quality, SERVQUAL Model

Review on Impact of Using Drug on Mental Health Care

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Lysergic corrosive diethylamide (LSD) was concentrated between the 1950s and 1970s to assess social and character changes, just as reduction of mental side effects in different disarranges. LSD was utilized in the treatment of anxiety, depression, psychosomatic diseases, and addiction. LSD perpetually includes a perplexing association between drug dosage, set, and setting. Impacts regularly incorporate changed musings, sentiments, and consciousness of one's environmental factors. A final choice of 10 articles was made after considering incorporation and prohibition standards through utilizing the PRISMA stream graph. PubMed database was looked at. Moreover, the Multidisciplinary Association for Psychedelic Studies Psychedelic Bibliography was likewise counseled. The objective of this review was to distinguish controlled and randomized clinical preliminaries that evaluate the expected utilization of LSD in psychiatry. To guarantee writing immersion, the electronic search was enhanced by literature reviews of eligible publications. Impacts ordinarily start inside thirty minutes and can keep going for as long as 12 hours. It is utilized mostly as a recreational medication or for profound reasons. Findings described significant and positive short-term changes in patients, even though in some studies an important homogenization was observed between the LSD treatment group and the control group at long-term follow-up. Therapeutic changes are maintained for 6-12 months after therapy. As a conclusion of this research suggests using LSD under the guidance of psychiatrists with the sufficient relaxation of law for the persons who need temporary mental changes such as people who perceived to suicide and suffer from depression and this drug should allow from the law only to the health care field for mental therapies. Recommend for a further researched to improve the physical effect of the LSD drug-using though it uses to the metal cure.

Keywords: Psychedelic Drugs, LSD, Addiction, Hallucinogen, Depression

A Comparative Study of a Phonological System Between Tamil and English Languages

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Comparative linguistics is the branch of linguistics that is concerned with the similarities and differences between languages. English and Tamil languages belong to two different language families. The comparative analysis of the phonological system between these languages is hard to find in literature. Therefore, this paper aimed to attempt a comparative study of the phonological system between these two Languages. Furthermore, this study investigated the difficulties encountered by Tamil language speakers in the area of phonology when they learn the English language. The study reviewed related previous studies and used them as authentic phonological materials. First, this research has identified phonological systems in the area of alphabetical, lexical, phonological comparisons. In the alphabetical comparison, it found that English has both Capital and Simple letters, but not in the Tamil language. Both languages consist of both vowels and consonants. But in Tamil, it has an extra alphabetical category, it is called Uyirmei eluthukkal (mixed of vowel and consonant). Further, the fricativisation process has been identified in Tamil phonology and it was marked by a grapheme known as Aytham. Moreover, the Tamil language has used five more Alphabet from Grantha alphabets. In the lexical comparison, English does not have categories of phonemes, but in Tamil has long and short phonemes of vowels. Further, some phones are considered as allophones in the Tamil language. But in English, they are considered as phones. Furthermore, some Silent words that are used in English but not in Tamil. Moreover, they are phonetically Antonyms in both languages. Finally, a major difficulty for Tamil speakers that when pronouncing in English, stress is important. But it does not in Tamil. This study concludes that some considerable phonological similarities and differences exist between both Tamil and English languages.

Keywords: Differences, English, Language phonological system, Tamil

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Intercalation of Acarbose into Sodium Montmorillonite for Sustained Release Formulation

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Among the numerous antidiabetic drugs, acarbose is the most extensively used digestive enzyme inhibitor for the treatment of Type-II diabetes. A simple and rapid UV-Vis spectroscopy method reported in the literature was modified and successfully implemented for the determination of acarbose in aqueous media. The method is based on the formation of a green-colored complex of acarbose with alkaline potassium permanganate. Concentration (in the range of 10-50 ppm) is proportional to the visible light absorbance at 426 nm wavelength, therefore, the above parameters were selected for the quantitative determination of acarbose in aqueous solution. The Beer–Lambert law is obeyed in the above-mentioned range with a coefficient of determination (r^2) value of 0.9826. The acarbose concentration in commercial tablets was determined using this method and the recovery was 99.65 % for 40 ppm solution. Short biological half-life and more side effects of acarbose have been recurring problems, owing to its low bioavailability and low patient tolerance, respectively. The controlled release of a therapeutic agent to patients is gaining prodigious importance during the recent time and clay minerals play a major role in modulating drug delivery. The present work is focused on the intercalation of acarbose into montmorillonite (MMT) as a controlled release drug carrier. MMT is an aluminosilicate clay composed of tetrahedral layers of silica stacked between octahedral layers of alumina with negatively charged surfaces. Due to its high cation exchange capacity and large specific surface area, MMT is extensively used in the formulation of various pharmaceutical products. In this study, acarbose was successfully incorporated into MMT by stirring MMT in a 100 ppm acarbose solution and showed 22.4% intercalation at pH 6. Acarbose intercalated MMT was characterized by X-ray diffraction and Fourier transformed infrared and the presence of N-H stretching peak at 1632 cm^{-1} and increase of d-spacing confirmed the successful intercalation of acarbose into the interlayers of MMT. The releasing properties of the synthesized acarbose-MMT composite would be investigated in the future.

Keywords: Acarbose, Montmorillonite, Intercalation, Drug delivery, Characterization

Study of the Use of Natural Pigments Extracted from *Nephelium lappaceum* (Rambutan) Peel and *Melastoma malabathricum* (Maha Bovitiya) Seeds as an Alternative to Synthetic Acid-Base Indicators

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Acid-base indicators are widely used for visual detection of the endpoint of an acid-base titration. Most of these indicators are organic dyes of synthetic origin. These are hazardous, expensive, and harmful to the environment. Natural pigments in plant extracts such as Anthocyanin are highly colored substances that can change color at certain intervals of *pH*. This study was designed to examine the indicator activity of methanolic fruit extract rich in Anthocyanin as an alternative to synthetic indicators. Extracts from the selected plants prepared using a sonication technique were screened for their use in acid-base titrations. They performed promisingly in the strong acid-strong base, strong acid-Weak base, and strong base-weak acid titrations. Sharp and clear color change from reddish-brown to yellow for the *Nephelium lappaceum* peel extract and blue to red for the *Melastoma malabathricum* extract were observed. The indicator dissociation constant values that were determined using a spectrophotometric method for *Nephelium lappaceum* and *Melastoma malabathricum* were about 6.22 ± 0.06 and 4.22 ± 0.05 , respectively. These values indicate that the *pH* ranges for the pigments investigated in this study are comparable to that of the synthetic indicators. These extracts were cost-effective, easy to extract, and eco-friendly yet performed exceptionally in acid-base titrations. Thus, studied natural pigments would be a potential candidate to replace the commercial synthetic indicators that are used in laboratories. Further, there is no commercial value for the peel of *Nephelium lappaceum* and *Melastoma malabathricum* seeds. This study exhibits the potential of converting these readily available materials into many useful value-added products.

Keywords: Natural pigments, Indicator, Low-cost, Value-addition, Titrimetry

Survey on Supplying the Sri Lankan Demand for Sand in Construction Industry Aided with a Sustainable Approach

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Demand for sand is ever increasing, as enormous construction projects are initiated in the country's suburbs. Mining sand and all other construction raw materials have to be increased to extreme levels to match the demand. But, the raw materials for constructions, mainly sand, are natural resources that cannot be renewed and regeneration of those natural resources need millions of years. Hence, the sustainability in mining sand and related raw materials are in a critical stage, if extraction happens in an ill-monitored manner; natural hazards will occur. Therefore, the governing body, Geological Survey, and Mines Bureau (GSMB) took initiatives to introduce mining licenses, so the authorities (the Police) can identify the illegal miners of raw materials. Starting from 2017, a sudden drop can be observed in the sand extracted from sources tracked at GSMB. When the analysis was carried out to determine the theoretical sand consumption in Sri Lanka using sand to cement ratio, the consumption during the 2017 and after are 69% more than the supply permitted from GSMB. This means that the only possible way of supplying the demand is to use illegal means in sand mining and transporting, which is thereby untraceable to GSMB. Furthermore, when identifying the factors which trigger this cause, it was determined that the current licensing process is cumbersome. The sudden shutdown at mining sites due to legal cases and civil unrest also increased illegal sand mining. The miners had a demotivation on pricing the sand market value above reasons, political intervention in the industry, and rise of the royalty charges and thereby used illegal means to extract and mine sand. As per this study, it could be concluded to have a scheme of interrelated concepts that aided using ICT so that GSMB can regain the total control of mining and transportation and eliminate illegal sand mining, thereby meeting the supply to the national demand without compromising the nature.

Keywords: E-licensing, Environment protection, Information Communication Technology, Illegal mining, Sustainable governance

Extraction and Isolation of Anti-hyperglycemic Compounds from *Cheilocostus speciosus* to produce sustained release formulations

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Diabetes mellitus is one of the non-contagious diseases which has now become a major health problem all over the world. This study was conducted to identify a natural, safe, and reliable solution for “diabetes” with proper scientific validation. The objective of the study was to extract and isolate anti-hyperglycemic compounds from *Cheilocostus speciosus* leaves. For this, a successive extraction with diethyl ether, ethyl acetate, and ethanol using sonication at room temperature was performed to extract oven-dried (40 °C, 48 h) leaves of *C. speciosus*. Percentage inhibition of the enzymes and the IC₅₀ values were determined. But the extracts of diethyl ether and ethyl acetate did not exhibit proper percent inhibitions for both alpha-amylase and alpha-glucosidase activities. Porcine pancreatic alpha-amylase inhibitory activity was performed using the DNSA method and it was detected in ethanolic extract of *C. speciosus* leaves with an IC₅₀ of 17.12 mg ml⁻¹ and *Saccharomyces cerevisiae* alpha-glucosidase inhibitory activity was detected with an IC₅₀ of 21.20 mg ml⁻¹. Both enzyme inhibitory activities were compared with that of commercial Acarbose (IC₅₀ values for alpha-amylase and alpha-glucosidase enzymes are 65.44 µg ml⁻¹ and 68.52 µg ml⁻¹, respectively). When comparing with acarbose, a crude extract of *C. speciosus* leaves show promising nature to isolate antihyperglycemic compounds. Results also indicate that the alpha-amylase and alpha-glucosidase inhibition by the ethanol extract of *C. speciosus* are dose dependent. Therefore, this study proves that the ethanolic leaf extract of *C. speciosus* has enzyme inhibitory activities toward alpha-glucosidase and alpha-amylase which may helpful for the development of an anti-hyperglycemic formulation to reduce the postprandial glucose level. This will be carried out by bioassay-guided fractionation and isolated active compounds will be intercalated to montmorillonite, an aluminosilicate clay with high cation exchange capacity, and large specific surface area to produce sustained release formulation.

Keywords: *Cheilocostus speciosus*, Alpha-amylase, Alpha-glucosidase, Diabetes mellitus

Characterization of Hydroxyapatite Synthesized from Commonly Available *Saccostrea cucullata* (Rock Oyster) Shells in Sri Lanka: Identification of a Commercial Application of Bivalve Shells

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Biological shells with simple components result in outstanding properties compared to the man-made materials. Bivalve shells can be reused as a low-cost raw material for different industrial applications. This study was focused on the characterization of *Saccostrea cucullata* (Rock Oyster) shells collected from the Southern coastal zone in Sri Lanka and identification the potential of synthesizing commercial products from oyster shells. Collected oyster shells from Dickwella coastal belt were subjected to prepare shell powder after sieving the crushed shells using a metal sieve with 600 micron of mesh size. Shell powder samples were sintered at 1000°C for two hours in the muffle furnace for removal of moisture, gases, and other remnants. Raw oyster shells and prepared shell powder samples were characterized using Fourier Transform Infrared Radiation (FT-IR), X-ray Diffraction (XRD) and X-Ray Fluorescence (XRF) Spectroscopy. After analysis of shell structure, functional groups, and composition, two wet precipitation techniques were employed to synthesize Hydroxyapatite (HA): $(\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2)$. The first method includes converting shell CaCO_3 into CaO as starting material, reacting with Nitric acid, Phosphate provider & NH_4OH at pH 10 and sintering. The second method consists of converting calcined shell CaCO_3 into $\text{Ca}(\text{OH})_2$, reacting with Phosphoric acid & NH_4OH at pH 10, and sintering. Based on characterization results, the oyster shell is mainly composed of CaCO_3 (98%), and extracted CaCO_3 powder is compatible with properties of commercial CaCO_3 product. Based on XRF, the oyster shell also consists of trace elements such as Zr, MgO , SO_3 , SiO_2 , and Sr. CaO level of shell powder was 97.9 % after thermal decomposition of CaCO_3 during firing. HA produced from the second method recorded characteristic peak with high intensity at 2 theta value of 31.79° by signifying the crystalline phase only for HA compound in XRD analysis. XRD and XRF results revealed that HA powder which was produced from the second method using $\text{Ca}(\text{OH})_2$ as starting material & sintering at a temperature of 900°C recorded similar composition ($\text{CaO}>77\%$, $\text{P}_2\text{O}_5>20\%$) to the commercially available HA. In conclusion, rock oyster shells act as environmentally friendly, value-added by-products to manufacture HA for medical applications with the technical possibility to replace commercial HA.

Keywords: Bivalve shells, Shell characterization, Fourier transform infrared radiation, X-ray diffraction, X-Ray fluorescence, Industrial applications, Hydroxyapatite

Enhancing the Performance of Dye-Sensitized Solar Cells by Utilizing Multilayered TiO₂ Nanoparticle Photoanodes in Combination of Novel PEO-Gel Polymer Electrolytes

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There is sustained attention to achieve high energy conversion in dye-sensitized solar cells (DSCs), as they exhibit the potential to overcome some of the pitfalls of conventional solar cells. Systematically arranged multi-layers of TiO₂ nanoparticles prepared to enhance light-harvesting efficiency and electron transport across the photoanode are suitable to make highly efficient DSCs. Further, the power conversion efficiencies of DSCs can be improved by employing binary iodides in the gel polymer electrolyte. In present work, photoanodes stacked to 1–6 layers are combined with gel electrolyte based on Poly(ethylene oxide) having LiI and tetrahexylammonium iodide (Hex₄NI) binary salts with the ratio of 2:3. The first two layers and 3rd layer of the photoanode are prepared by spin coating dispersions of TiO₂ nanoparticle of the size 13 and 21 nm respectively on the conducting glass substrate of fluorine-doped tin oxide. For the preparation of 4th, 5th, and 6th layers polyethylene glycol and Triton X 100 are also combined with TiO₂ nanoparticle dispersion of the size 21 nm before the spin coating. DSCs were assembled by sandwiching gel electrolyte between N719 dye-sensitized TiO₂ photoanodes consisting of 1-6 layers separately and Pt counter electrodes. The DSC with photoanode having five layers of TiO₂ nanoparticles exhibits J_{sc} of 12.55 mA cm⁻², VOC of 698 mV, and efficiency of 5.45% under the irradiation of 1000 W m⁻². The active area of the cell was 0.19 cm². Hence, this study reports a reliable and simple fabrication method to augment solar cell efficiencies by merging the positive effects of multilayered TiO₂ photoanode with well-ordered thicknesses and quasi solid-state gel polymer electrolytes with mixed salt system.

Keywords: Dye-sensitized solar cells, Binary iodides, Gel polymer electrolyte, Spin coating, Multilayered photoanode

Agar-Based Gel Polymer Electrolyte with KI and Tetrapropylammonium Iodide Salts for Dye-Sensitized Solar Cell

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At present, energy consumption is rising predominantly, thus low cost, renewable, and environmentally benign energy resources draw attraction extensively. Although many researches have been done on polymer electrolytes, there is a captivating direction to explore bio-polymer electrolytes in a quasi-solid state. In the present work, a novel gel polymer electrolyte was prepared by a hot press method utilizing tetrapropylammonium iodide (Pr_4NI) and potassium iodide (KI) as the binary iodide salt system. Agar bio polymer was combined with the glycerol and formaldehyde solvents to obtain the quasi-solid state polymer plasticizer matrix. The KI and tetrapropylammonium iodide weight ratio in the electrolyte was altered while keeping the masses of other ingredients constant to optimize the solar cell performance. Gel electrolytes displayed quite high viscosity while retaining a gel-like consistency at ambient temperature. Fourier transform infrared spectroscopy results indicate a peak heightens gradually at 750 cm^{-1} with increasing Pr_4NI salt amount. Electrical impedance spectroscopy was used to deduce the ionic conductivity of each electrolyte. The highest ionic conductivity of 3.39 mS cm^{-1} is achieved by the electrolyte sample only with KI at $26\text{ }^\circ\text{C}$ as the contribution for ionic conductivity from small K^+ cation is higher compared to the bulky Pr_4N^+ cation. The uniform shape of cyclic voltammetry curves of each electrolyte during 12 consecutive cycles with 5 min time steps revealed the stability of electrolytes. A dye-sensitized solar cell was assembled by inserting the highest conducting gel polymer electrolyte having Glass/FTO/ $\text{TiO}_2/\text{N719}$ -Dye/GPE/Pt/Glass configuration. The dye-sensitized solar cell fabricated with the highest conducting electrolyte displayed an efficiency of 0.36% with J_{SC} of 1.31 mA cm^{-2} , V_{OC} of 0.4 V, and fill factor of 0.68.

Keywords: Biopolymer, Gel polymer electrolyte, Agar, Tetrapropylammonium iodide, Dye-sensitized solar cell

Facile Way of Preparing Activated Carbon (AC) Electrodes from the Local Jack-Wood for Supercapacitors

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Supercapacitors (SCs) are used as high power density energy storage devices in many applications. Based on the charge-discharge mechanism, SCs are divided into three main classes; electrochemical double-layer capacitors (EDLCs), pseudo-capacitors, and hybrid capacitors. High specific surface area electrodes need to be developed using chemically and physically stable materials to prepare high energy density EDLCs having a long cycle life. By increasing the porosity of electrodes, the effective surface area of the interface can be enhanced. This study introduces a facile way of preparing activated carbon (AC) electrodes starting from the local Jack-wood. Besides, in this research, a novel low-cost SC is prepared using AC electrodes fabricated from Jack wood charcoal without using a binder or additive. The activation is done using a NaOH solution. AC electrodes of the size, $1\text{ cm} \times 2\text{ cm} \times 0.5\text{ cm}$, were used for SCs preparation. Platinum (Pt) electrodes were used as current collectors, and for this purpose, Pt was coated on one side of the carbon electrodes. The EDLCs were assembled using activated carbon electrodes and 5 M potassium hydroxide (KOH) electrolyte. For this purpose, polytetrafluoroethylene (PTFE) membrane filter paper separator having $0.2\text{-}\mu\text{m}$ pore size was sandwiched between two AC electrodes. To characterize EDLCs assembled, complex impedance, charge-discharge measurements, and cyclic voltammograms (CV) were measured with the help of PGSTAT128N – Metrohm Auto-Lab setup. The high chemical stability of the EDLCs within the charge-discharge window $+0.5\text{ V}$ to -0.5 V , can be inferred from CV. The highest gravimetric capacitances of the SCs were 71.89 F g^{-1} . Power density of 342.12 W kg^{-1} and the energy density of 0.27 Wh kg^{-1} were exhibited by the EDLC prepared using Jack-wood AC electrodes. The prepared low-cost Supercapacitor is suitable for many applications that need power for a short period.

Keywords: Activated carbon, Electrical double layer, Gravimetric capacitance Jack-wood, and Supercapacitor

Effect of Mixing Method on Properties of Natural Rubber/Acrylonitrile Butadiene Rubber Blend Composites Reinforced with Silica Extracted from Rice Husk Ash

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Acrylonitrile butadiene rubber (NBR) is used where rubber products require swelling resistance. Natural rubber (NR) can be blended with NBR for synergism of properties using either phase mixing or pre-blending methods. According to literature, the mixing method may have a significant effect on properties of blends and it has not investigated for NR/NBR blends filled with silica extracted from rice husk ash (RHAS). RHAS is used as the filler, an alternative to carbon black which induces high heat built-up in products. The sol-gel method was used to extract RHAS, X-ray diffractogram and Fourier Transform Infrared Spectroscopy proved the amorphous nature and the chemical compatibility of RHAS with commercial silica. Blends filled with 25 parts per hundred parts RHAS were prepared to keep NR to NBR ratio at 0:100, 20:80, 40:60, 60:40, 80:20, and 100:0 using phase mixing and pre-blending methods referring to the control, American Standard Testing Method reference formulation for oil seals. Curing, physical and swelling properties of blends were evaluated. Results revealed that there was no significant difference between mixing methods on properties. Blends with high NBR amounts showed higher crosslinking density while all blends showed acceptable scorch and cure times. Tensile and tear strength showed comparatively lesser values in all blends than the control while elongation properties were compatible with control. The compression set varied from 1-6%, control had 4.3%. Hardness ranged from 45-60 IRHD, control had 73 IRHD. Equilibrium swelling (%) of control in toluene is 82%, but all blends showed values from 80-150%. Equilibrium swelling (%) of control in hydraulic and engine oil was below 2% while high NBR content showed lower swelling. Equilibrium Swelling (%) ranged from 1-16% in hydraulic oil and 1-12% in engine oil. Overall, these blends can be used in the preparation of non-marking stationary sealing articles and there is a potential to use RHAS in NR/NBR blends for reinforcement.

Keywords: Natural rubber, Acrylonitrile butadiene rubber, Pre-blending, Phase mixing, Rice husk ash silica

Potential of Using Rice Husk Ash Silica as Filler in Acrylonitrile Butadiene Rubber Compounds

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Rice husk is a most available and reliable natural source which contains more than 90% of silica (SiO₂) in its ash. Silica in its amorphous or crystalline forms can easily be derived from rice husk ash (RHA). Replacement of environmentally harmful carbon black (CB) using such a natural source is important. Therefore, this study was conducted to investigate the potential of using RHA silica (RHAS) as filler for Acrylonitrile butadiene rubber (NBR) compounds as partial replacement of CB. Commercial grade silica (CS) was used for the comparison of the performance of RHAS during the study. RHAS was derived by sol-gel technique and X-ray diffractogram proved the amorphous nature of RHAS and Fourier Transform Infrared Spectrophotometric analysis underlined that the chemical nature of RHAS is almost similar to that of CS. NBR compounds (Series 1) were prepared by keeping CB: RHAS ratio as 55:5, 50:10, 45:15, 40:20, and 35:25 parts per hundred parts of rubber by weight (phr). The compounds (Series 2) which contain CB and CS were prepared using the same ratios. Compound with 60 phr of CB was considered as the control. Both series of compounds have shown desirable highest torque, Delta cure, and lowest torque with better-crosslinking density and processability at all loading levels compared to control. Scorch time and Cure time showed extended times. Hardness, compression set, and tensile strength of both series showed acceptable values even though elongation at break and tear strength showed somewhat inferior properties. Swelling resistance is very high in both series with no significant between the series and to the control. Overall, there is a potential to use RHAS as a partial replacement of CB in NBR compounds and can be used to replace CS.

Keywords: Acrylonitrile butadiene rubber, Carbon black, Commercial silica, Rice husk ash silica

Development of Novel Super Absorbent Polymer Using Banana Pseudo Stem Waste to Increase Water Retention Capacity of Agricultural Soils

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Water scarcity of agricultural fields for irrigation is a huge problem in many parts of Sri Lanka especially in dry zone where it covers 70% of the agriculture production. The objective of this study is to prepare a novel environmentally friendly Super Absorbent Polymer (SAP) using cellulose that extracted from banana pseudostem fibers and study the water retention capacity of SAP amended agricultural soil (AS). Cellulose was extracted from banana pseudo stem fibers by alkaline pretreatment and cross-linked with 3.75% w/w citric acid in the presence of water. Cellulose and prepared SAP was confirmed using Fourier Transform Infrared spectroscopy (FTIR) and X-Ray Diffraction (XRD) measurements. The water retention capacity of SAP was investigated with distilled water (DW) and tap water (TW). The water retention ability was examined by soil without SAP and amending SAP concentrations of 0.25, 0.50, 0.75, and 1% w/w for depths of 0-10, 10-20, and 20-30 cm. Soils with dry bulk densities of 1.78, 1.69, and 1.76 g cm⁻³ in the dry zone and 1.12, 1.34, and 1.35 g cm⁻³ in the intermediate zone were used to the SAP amendment. The absorption peak at 1724 cm⁻¹ was attributed to ester linkage due to anhydride formation and Full Width at Half Maximum values in XRD patterns for both cellulose and SAP were decreased from 3.020 to 2.950 with increased the crystallinity which confirm the cross-linking of SAP. FTIR and XRD results showed that the banana pseudo stem is a source for cellulose extraction. The maximum water retention capacity of SAP was 67.4 g/g for DW and 57.4 g/g for TW. SAP amended soils showed a significant increase in overall water retention than AS without SAP. The evaporation test showed that 0.75% is the best SAP concentration for water retention in all selected AS. It is needed to test water retention capacity for wet zone AS to get an overall idea about the effect of prepared SAP as the dry and intermediate zone AS showed the significant increase in water retention with the SAP amendment.

Keywords: Super Absorbent Polymer (SAP), Banana Pseudo Stem, Cross-linking, Evaporation Test, Agricultural Soils (AS)

Development of a Novel Composite for Bricks by Laterite, Fly Ash, Sand and Waste Plastic

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Natural aggregate sources are becoming depleted due to high demand in the construction industry and the amounts of disposed waste plastic material are increasing. Hence, researchers are exploring the use of alternative materials instead of natural resources. Therefore, the present invention provides a composite material wherein laterite, sand, chemically unmodified Polyethylene Terephthalate (PET), and fly ash (FA) are mixed in a container to disperse raw material in PET and molded. Initially X-ray diffraction (XRD) analysis have conducted for laterite, FA, and sand to identify major mineral phases. After preparing the sample bricks according to the different proportions of raw materials under four samples series, standard compressive strength (CS) in both dry and wet conditions and water absorption (WA) analysis was conducted. XRD analysis of FA and laterite have confirmed the presence of crystalline silica and kaolinite as major phases respectively and sand has responsible peaks for quartz and feldspar as obvious. The highest CS in wet and dry conditions has recorded for the combination in “series A” which has 35% PET, 25% FA, and 20% laterite and sand. Further, the increasing FA content able to increase CS in wet and dry conditions. Under the higher plastic content breakeven point cannot be detected due to the high plasticity nature. The composite with the highest plastic with only FA has lowest WA of 0.08% but its’ CS is lower than the aforesaid combination in “series A” and this combination has 0.32% of WA which is still below the standard WA to reference. Though higher plastic content in materials is lightweight and suitable for the high seismic active areas, the highly flammable nature stands as a major drawback. Therefore, 35% plastic, 25% FA, and 20% laterite and sand can be taken as a favourable and novel combination for the production of bricks.

Keyword: Compressive strength, Water absorption, Plastic, Fly ash

Root Cause Analysis for Warming Delay of Resilient Solid Tire Heel Compound on Warming Mill During Manufacturing

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Solid tires used in heavy-duty applications consist of three distinct parts: heel, cushion, and thread. The heel is the innermost layer which provides the resistance to air permeation while ensuring excellent adhesion to the rim and cushion. More fiber reinforced compounds are used in heel production. But a warming delay for about 8-10 minutes which is more than the specified time limits to warm the compounds before production has been observed when warm the compounds using warming mill. Therefore, this research focused to analyse the root causes of the warming delay of compounds during the warming operation. Minimum torque (ML) and Mooney viscosity (MV) of the heel compound, nip size of the warming mill, thickness, and maturity of the incoming compound sheets were selected as key factors for the warming delay. Multiple regressions analysis and simple linear regression were applied to predict the relationships of these factors with the warming time while using cubic regression to find the effect of nip size on the warming time. According to the results, there is a significant effect of these factors on warming time. Improper mixing of the compounds tends to show high values for MV, ML, and thickness of incoming compounds. The maturity of the compounds and the nip size of the warming mill was selected for further study. According to the two-way ANOVA, there is an interaction between maturity and nip size on warming time. The nip size (mm) was varied from 7 to 10 at 1mm interval and the maturity time of the compounds was varied as 6, 12, 24, and 48 hours. Results revealed that warming time can reduce using 9mm nip size and 48 hours maturity time of compounds at warming mill in the manufacturing process.

Keywords: Minimum torque, Mooney viscosity, Nip size, Solid tire heel, Warming delay

Development of Novel Composite Material Using Waste Polyethylene Incorporated with Calcium Carbonate Obtained from Sri Lankan Calcite

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Today, there is a great need for the reduction of polyethylene waste to reduce environmental pollution. The main objective of this study is to develop a novel composite material using waste polyethylene reinforced with calcite to make polyethylene/calcite composite. Calcite taken from the Lanka Mineral and Chemicals (Pvt) Ltd. is used as the reinforcement for the composite and low-density polyethylene obtained from waste shopping bags is used as the polymer matrix. Sample series of octadecanoic acid-coated calcite powder and unmodified calcite nanoparticles are used to synthesize the composite. The in-situ deposition is used to synthesize nanoparticles from raw calcite. Calcite is incorporated into low-density polyethylene with different ratios and properties are characterized to obtain the optimum strength. Calcite powder is characterized using particle size analyzer, X-ray diffractometer, and Fourier transforms infrared spectroscopy. The composite is characterized by tensile tests, compression tests, and differential scanning calorimetry tests. Calcite nanoparticles obtained 23.2×10^{-9} m of average particle size after In-situ deposition. Only the polymeric material acquired 64.57×10^6 N m⁻² of tensile strength and 44.62×10^6 N m⁻² of compressive strength. Tensile strength is increased up to 69.87×10^6 N m⁻², 78.98×10^6 N m⁻², 66.41×10^6 N m⁻² and compressive strength is reached to 90.58×10^6 N m⁻², 102.28×10^6 N m⁻², 75.98×10^6 N m⁻² when polyethylene combined with raw calcite powder, calcite nanoparticles, and surface-modified calcite powder (5:3 of polyethylene/calcite ratio) respectively. It provides evidence that the low-density polyethylene with calcite reinforcement attained to better mechanical properties than only the polymeric material.

Keywords: Low-density polyethylene, Nanoparticles, Surface modified, In-situ deposition

Synthesis of Reduced Graphene Oxide/ Cobalt Oxide Composite as a Super Capacitor Electrode Material Using the Compounds Obtained by Recycling Lithium-Ion Batteries

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Today Lithium-ion batteries (LIBs) are widely used in many portable electronic devices, hybrid electric vehicles, and electric vehicles due to their unique features. However, the rapid increment in the disposal of used LIBs to the environment causes severe damages to the environment due to the presence of heavy metals. Thereby environmentally friendly recycling processes are important for LIBs in aspects such as recovering valuable metals from spent LIBs. In this work, a composite electrode material prepared using cobalt oxide (Co_3O_4) and reduced graphene oxide (rGO) synthesized respectively from cathode and anode material of spent LIBs is described. The battery type considered here was Sony Phone Battery (AGPBO16-A001). Cathode material was subjected to an acid leaching process using 2M H_2SO_4 along with 10% H_2O_2 followed by collective precipitation. The pink colour precipitate, obtained at pH 1.5 was confirmed as CoC_2O_4 using X-ray diffraction technique, Fourier-transform infrared spectroscopy, and X-ray fluorescence data. Subsequently, the annealed sample at 450 °C for 2 hours was undergone with the above tests and conformed as Co_3O_4 with a crystallite width of 17.7 nm. rGO was synthesized from the anode material using sonication assisted oxidation of graphite. rGO showed an interlayer spacing of 3.4 Å and a crystallite width of 7 Å. Composites were prepared on a copper foil by varying the mass ratio of rGO and Co_3O_4 . All the grown samples were examined for cyclic voltammetry measurements in the same photo electrochemical cell. The best electrochemical performance was shown by the composite with the mass ratio of rGO: Co_3O_4 , 1:4. In future methods will be investigated to improve the capacitance of the composite electrode material.

Keywords: Lithium-ion Battery, Composite, Acid leaching, Capacitance

Synthesizing a Bone Ash Substitute Using Locally Available Eppawala Apatite

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Bone china is considered as the highest-grade porcelain with incomparable features due to the presence of bone ash as its main ingredient. But, as bone ash is sourced from animal bones; compositional variations, presence of high iron contents, and dissent of the vegetarians have become significant issues. Further, the local mineral resources with conformable compositions to bone ash have drawn less attention. So, an attempt was taken to synthesize a bone ash substitute using locally available Eppawala Apatite. Three products were synthesized by heat-treating apatite with calcium hydroxide ($\text{Ca}(\text{OH})_2$) at different temperatures; 700, 800, and 900 °C. The samples were characterized by Fourier Transform Infrared (FTIR), X-Ray Diffraction (XRD) and X-Ray Florescence (XRF) analytical techniques. A test ceramic ware was manufactured using the synthesized product to investigate its practical viability. A reference ceramic ware was produced using commercially available bone ash. The FTIR spectrums indicated that all the synthesized samples have the characteristic PO_4^{3-} and OH^- functional groups, of commercially available bone ash. The XRD analysis revealed that the samples have the inherent hexagonal crystal structure. The XRF analysis suggested that the samples have appropriate elemental compositions. Even though it is attainable to synthesize bone ash at 700, 800, 900 °C, the product that was heat-treated to 900°C, has the highest purity level with the best crystallinity and has the most appropriate elemental composition with least amounts of fluorine, chlorine, and iron. Also, the heavy metal free product could be denoted as safer, inexpensive raw material. The test ceramic ware expressed similar whiteness levels and higher strength compared to the reference ceramic ware. So, it can be suggested that it is possible to synthesize a bone ash substitute by treating Eppawala Apatite with $\text{Ca}(\text{OH})_2$ at 900 °C.

Keywords: Bone china, Bone ash, Eppawala Apatite

Synthesis of Silver - Graphite Composite via Ultrasonication Associated Chemical Reduction and Study of its Antibacterial Properties

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Graphene oxide is widely used to produce an antibacterial silver composite, but mostly required toxic chemicals for production and they are comparatively expensive. The present study was focused on synthesizing cost-effective less hazardous antibacterial composite using vein graphite and silver. Silver graphite composites can be made using various methodologies and those methods can affect the antibacterial property. Therefore, in this study, silver graphite composite was synthesized by ultrasonication associated chemical reduction method. Sri Lankan vein graphite was purified by the patented acid leaching method, then surface modified with patented mild chemical oxidation method. The silver-graphite composite was synthesized from an AgNO₃ silver precursor with a concentration of 0.00025 M, 0.001 M, 0.002 M by using tri-sodium citrate as a reducing agent. X-ray Diffractometry analysis indicated that composite only consists of silver nanoparticles and carbon in pure crystalline form. The composite was characterized by Scanning Electron Microscopy. Nano-scale silver particles were seen deposited on the surface of graphite. Antibacterial efficiency of the synthesized composites was analysed using *Escherichia coli* and the test was carried out using the shake flask method. For positive and negative controls, modified graphite and commercial antibiotic ofloxacin were used respectively. The samples were drawn out with a one-hour time interval from 0 to 6 hours and the number of surviving colonies on Eosin Methylene Blue agar was counted after 24 hours of incubation. The removal of the Colony Forming Unit for all samples gave efficiency over 99 %. The Kruskal-Wallis test suggests that colony removal depends on the time and concentration of AgNO₃ used in the synthesized composite. Therefore, this study suggested that silver-graphite composite synthesized via ultrasonication associated chemical reduction can be used for *E. coli* as an effective antibacterial agent.

Keywords: Graphite, Silver nanoparticles, Ultrasonication, Chemical reduction, Tri-sodium citrate

Identify the Potential of Applying Rice Husk Ash and Fly Ash for Cement-Based Grout

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Rice husk ash (RHA) is a fine agricultural by-product and commonly the brick industry in Sri Lanka produces a significant amount of RHA as a waste. Similarly, Fly Ash (FA) is resulted as a byproduct of coal power plants (CPP). In Sri Lanka, Nuraichcholai CPP generates about 200,000 MT/year of FA. Previous studies have reported that both RHA and FA have pozzolanic reactivity. Cement-Based Grout (CBG) used in geotechnical and other engineering aspects is expensive since the cost of Portland cement and grout additives. Therefore, the present study aimed to introduce RHA and FA to the CBG as a partial replacement for cement. FA and RHA samples were collected from Nuraichcholai CPP and brick industrial sites respectively. After initial purification, 63-150 μm sieve fraction of both FA and RHA were selected. Cement, FA, and RHA were thoroughly mixed in a small grinder to prepare different grout mixtures. Initially, phase analysis for FA and RHA was conducted by X-ray Diffraction (XRD). Before the solidification, each grout mixture was analysed with the Standard Flow Cone (FC) test and then Compression Strength (CS) test during the curing period of 7th, 28th, and 45th days was conducted. XRD analysis has shown that FA and RHA have the crystalline and amorphous form of SiO_2 respectively. FC efflux time in each combination is in the range of 14.1-17.5 sec. (FC efflux time < 15 sec. ASTM-C939-02). FC efflux time has increased with the increment of RHA amount. This may due to the porous nature of RHA, which tends to reduce the quantity of free water and increase water demand. Except for the FA+cement combination others have CS less than 20 MPa (CS > 20 MPa BSEN 12390-3:2002). The increment of RHA tends to decrease the CS. Hence, the application of FA as an additive for CBG is favourable than the RHA or combination of FA+RHA.

Keywords: Rice husk ash, Fly ash, Cement-Based Grout, Compressive Strength

Comparison of the Developed Coarse Flake of Radial Graphite with the Developed Needle Platy Graphite as the Anode Material of Lithium-ion Rechargeable Battery

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Sri Lankan Vein Graphite (SLVG) has been successfully tried for anode material application in rechargeable Lithium Ion Battery (LIB). As by previous studies, among the four-vein graphite morphologies, Needle Platy Graphite (NPG) has the highest purity while the Coarse Flakes of Radial (CFR) is having the lowest, in their raw forms. Hence, the study was to compare the performances of acid digested NPG and CFR in LIB anode application. 10g of all samples (<53 µm) were treated by acid digestion method. Material characterization was carried out with ASTM C-561 Carbon Content (CC), X-ray Diffraction (XRD), and Fourier Transform Infrared (FTIR) Spectroscopy. CR2032 coin cells were assembled using treated anodes and 1M LiPF₆ (EC: DMC; vol.1:1) electrolyte in an argon filled glove box. Galvanostatic charge-discharge testing was performed with a battery testing system (0.2 C, 0.002-1.50 V). CC analysis has shown that the purity has successfully upgraded over 99.98% and further confirmed by XRD phase analysis. The acid digestion has introduced favorable functional groups to the surface of both NPG and CFR, which is evidenced by FTIR analysis. Furthermore, XRD analysis has proved that the applied treatment does not adversely affect the graphite crystallinity. Treated NPG has shown the 378 mAh/g of stable capacity throughout the 50 cycles with Columbic efficiency over 99%. However, in CFR, the discharge capacity for the first cycle was 50 mAh/g and it increased up to around 300 mA h/g till the 5th cycle. Even after that, the capacity fluctuated in the range of 250-300 mAh/g throughout the rest of the 45 cycles. Notably, SEI layer formation was appeared around 0.7V and 1.13V for NPG and CFR, respectively. Normally, solvent co-intercalation, humidity contaminates or graphite exfoliation may appear around 1.45V. Therefore, contamination, solvent co-intercalation, or exfoliation may interrupt the cell permeances of CFR while NPG is facilitated by favorable SEI layer formation.

Keywords: Coarse flakes of radial graphite, Needle platy graphite, Anode, Lithium-ion battery

Fabrication of Hard Board Briquette Using Waste Papers and Coconut Husk Fibers

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The annual coconut yield in Sri Lanka is estimated as 2450 million nuts. Coconut husk fibers possess specific features such as higher lignin, lower cellulose, and hemicelluloses which leads to properties like resilience, strength, damping, resistance to attrition, and high elongation at break. Approximately 280 tons of paper wastes are collected per day in Sri Lanka. The objectives of this research were to add value to the coconut husk by introducing the hardboard to fabricate low-cost hardboard with high strength, and thereby to introduce a solution for paper waste accumulation in Sri Lanka. The hardboard briquette has been fabricated using coconut husk fibers, paper pulp, starch, and pure epoxy-based adhesive. The short length (around 1 cm) coconut husk fibers and paper pulp were mixed with pure epoxy-based adhesive and starch as binding materials and next compressed under 6894 N m^{-2} of pressure in a die and sun-dried for five days. The composites have a ratio of 3:1, 5:3, 1:1, 3:5 and 3:1 between paper pulp, coconut husk fibers showed the tensile strengths of 1518879 N m^{-2} , 1190175 N m^{-2} , 2340818 N m^{-2} , 1431441 N m^{-2} , and 2407740 N m^{-2} and compressive strengths of $12652940 \text{ N m}^{-2}$, 3438566 N m^{-2} , 6132221 N m^{-2} , 2099790 N m^{-2} , and $19100570 \text{ N m}^{-2}$ respectively. The stiffness and the strength of composite material are increased by fibers. Lignin provides strength to the coconut husk fiber and it is degradable at only a few microorganisms and strong chemicals. The sample that contained the greatest amount of fiber mass showed the highest tensile strength and compressive strength. Therefore, the fabricated hardboard briquette is capable to bear higher loads and it can be utilized in furniture and packing industries.

Keywords: Coconut husk fibers, Hardboard briquette, Waste papers

Development of Acrylonitrile Butadiene Rubber Composite with Improved Physico-Mechanical and Oil Resistant Properties by Incorporating Waste Egg Shell Powder as a Filler

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The present study attempted to develop a high-performance oil-resistant rubber material based on acrylonitrile butadiene rubber (NBR) by incorporating waste eggshell powder (ESP) as a filler to be utilized in automobiles industry while reducing the commercial Carbon Black (CB) content. Since CB is obtained from petroleum resources, its manufacturing process is hazardous and cause environmental pollution. Thus, the use of calcium carbonate (CaCO_3) is found as a remarkable way to replace the CB in the rubber compounds due to its non-toxic and environmentally friendly nature. Value addition to waste eggshells was one of the main aspects of this research. The effect of surface modified CaCO_3 filler on the cure, mechanical and swelling properties of NBR composites with respect to CB was studied. Filler amount was kept constant at 45 phr. Only the ratio of CB: ESP was changed. Ten ratios of samples were prepared by varying filler amounts by 5 phr. The surface modification of CaCO_3 was confirmed using Fourier transform infrared spectroscopy. Particle size having $3.05 \mu\text{m}$ CaCO_3 was successfully obtained from eggshell powder. X-ray diffraction patterns proved that raw eggshell powder was chemically similar to commercial CaCO_3 . The vulcanizates were evaluated by rheological, physical, and mechanical characteristics. The cure times and scorch times were at an acceptable level. NBR composites with ESP loadings of 0, 5, 10, 15, 20 phr showed tensile strengths of 7-14 MPa, compression sets of 2.38- 5.49 %, hardness of 61 - 72 IRHD. Therefore, it can be deduced that NBR filled with surface modified eggshell powder has competed favorably with the standard CB. Replacing CB from ESP loadings of 5, 10, 15, 20 phr did not show a significant difference in physico-mechanical properties. Hence eggshell CaCO_3 can be considered as one of the best conventional fillers suited for automotive applications with a high oil-resistant sealing material.

Keywords: Calcium carbonate, Carbon black, Egg shell powder, Filler, Oil resistance

Polyacrylonitrile Based Gel Polymer Electrolyte for Rechargeable Magnesium Ion Batteries

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The demand for energy storage devices has highly increased with the increment of the demand for electronic portable devices and electric vehicles. Therefore, developing rechargeable batteries has received the most attention. Among the components of a rechargeable battery, electrolyte is highly concerned as it is the medium for the transfer of charges between the pair of electrodes. Developing gel polymer electrolytes is mostly explored due to its favourable performances and minimum drawbacks compared to liquid electrolytes and solid electrolytes. In this research polyacrylonitrile based gel polymer electrolyte for magnesium ion batteries was prepared and characterized to investigate its physicochemical properties. Preparation of gel polymer electrolytes was carried out by a common solution casting technique using dimethyl sulfoxide as the solvent, magnesium trifluoromethanesulphonate as the salt and 1-butyl-1-methylpyrrolidinium bis(trifluoromethylsulfonyl)imide as the ionic liquid. Impedance spectroscopy, Fourier transform infrared spectroscopy, X-ray diffraction, and Differential scanning calorimetry was performed to analyse the prepared electrolyte samples. The maximum room temperature ionic conductivity of $2.33 \times 10^{-3} \text{ S cm}^{-1}$ and $3.33 \times 10^{-3} \text{ S cm}^{-1}$ were obtained for the sample before and after the addition of ionic liquid respectively. Considerable indications for the polymer-solvent, polymer-salt, and polymer-salt-ionic liquid interactions were investigated by analysing Fourier transform infrared spectroscopy. Although the crystallinity has increased with the addition of salt due to the formation of ion pairs and aggregates, the effect has been preserved with the addition of ionic liquid. The glass transition temperature has also increased from 80 °C to 104 °C after the coordination of polyacrylonitrile with magnesium trifluoromethanesulphonate, however, it is reduced to 102 °C after the addition of ionic liquid.

Keywords: Gel polymer electrolyte, Polyacrylonitrile, Magnesium trifluoromethanesulphonate, Ionic liquid, Ionic conductivity

Dependence of performance of Sb₂S₃ thin film solar cell on blocking TiO₂ layer

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The demand for low cost, high efficiency solar cells is the power of thin film solar cells. In recent years, antimony sulfide (Sb₂S₃) has much attraction as light harvesting material in solar cell applications. Sb₂S₃ solar cells are reported with a dense blocking layer and mesoscopic TiO₂ scaffold. But still, in both cases, the performance of Sb₂S₃ solar cells are unsatisfactory. However, planner Sb₂S₃ solar cells would be more competitive because it is simpler and has a higher open circuit voltage due to reduced charge carrier recombination. Herein, planner Sb₂S₃ solar cells have been successfully made using spin coated Sb₂S₃ as the absorber, dense blocking TiO₂ (bl-TiO₂) as the electron conductor and poly (3-hexathiophene) (P3HT) as the hole conductor. This study pinpointed the dependence of cell performance on the thickness of the blocking TiO₂ layer. The bl-TiO₂ was deposited by spin coating at rpm with a different number of spin coat cycles (1-5). The TiO₂ precursor solution was prepared by mixing of Titanium IsoPropoxide (TTIP), of butol-1-ol and of diethanolamine. The blocking properties and thickness variation of the bl-TiO₂ layers fabricated with a various number of spinning cycles were verified by cyclic voltammograms and UV-Vis spectra respectively. The optimization of the TiO₂ blocking layer to enhance the device performance was carried out on the planner device consisting of FTO/bl-TiO₂/Sb₂S₃/P3HT/Ag and the optimized device with of bl-TiO₂ exhibited the power conversion efficiency of at 1 sun illumination.

Keywords: Blocking TiO₂, Planner structure, Performance, Sb₂S₃, and Spin coat cycle

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Synthesis and characterization of a Composite Biomaterial Containing Cow Bone Derived Hydroxyapatite, and Polylactic Acid

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Hydroxyapatite is a ceramic biomaterial that mimics the mineral composition of bones and teeth of vertebrates. Hydroxyapatite can be synthesized from various chemical methods. However, most are non-economical and does not have sufficient biological properties as natural Hydroxyapatite in human bones. Cow bone waste is rich in biocompatible Hydroxyapatite as a natural source. The load bearing ability of pure Hydroxyapatite is very poor and it has limited its application as a bone grafting material. Polylactic acid is a biocompatible, biodegradable, and bioresorbable polymer which can be used to reinforce pure Hydroxyapatite to improve its mechanical properties. This study investigated the change of mechanical property of pure Hydroxyapatite when it is mixed with a varying ratio of Polylactic acid to form Hydroxyapatite-Polylactic acid composite. High purity Hydroxyapatite was extracted from cow bones using the thermal decomposition method by sintering at 900 °C for 3 h. The composites were prepared by blending Hydroxyapatite with Polylactic acid in various ratios with and without maleic-anhydride compatibilizer. The resulting composite blends were subjected to tensile tests separately with three replicates per blend. The thermal-gravimetric analysis was performed to determine the purity of cow bone derived Hydroxyapatite in comparison to a commercial Hydroxyapatite sample. 30% Hydroxyapatite loading composite blend with 4% maleic-anhydride has increased the tensile strength of the composite by about 7-folds. Scanning electron microscope shows, the interfacial adhesion between Hydroxyapatite and polylactic acid was increased by the addition of maleic-anhydride resulting in improved mechanical properties. Fourier-transform infrared spectroscopy, X-ray diffraction, and Thermal-gravimetric analysis show that derived Hydroxyapatite has similar material properties as commercial hydroxyapatite. The prepared composite has the potential of using bone drafting applications in humans.

Keywords: Hydroxyapatite, Polylactic acid, Maleic-anhydride, Bone grafting biocomposites

Geochemistry of Petroleum Potential Source Rocks in Barracuda Well of Mannar Basin, Sri Lanka

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Four exploration wells (Dorado North, Dorado, Barracuda, and Wallago) were drilled in the deep-water Mannar Basin during the second phase of hydrocarbon exploration. The Barracuda well was confirmed as gas potential due to presence of 85 wt% methane in the Upper Cretaceous sediments. Therefore, the current study focused to evaluate geochemistry of core sediments (depth from 2139–4741 m) in Barracuda well using X-Ray Diffraction (XRD) and stable isotopes analyses. The upstream petroleum industry prefers such supportive geochemical data at the development stage. Stable carbon ($\delta^{13}\text{C}$) isotopic values (-33.86‰ to -24.88‰) and C/N ratios (17.3–158.8) suggest a considerable supply of terrestrial plants organic matter (gas prone Type III kerogen) to sediment. XRD results identified several paleoclimatic chronozones based on dominant clay mineral assemblages. The Early Campanian age consists of montmorillonite dominant sediments suggesting that arid climate. Kaolinite dominant Late Campanian to Late Maastrichtian sediments indicates the warmer/wetter paleoclimatic condition. However, montmorillonite dominant sediments in the Late Maastrichtian can be controlled by short-term global cooling events and/or volcanogenic sediments followed by Deccan-Reunion basalt volcanism. The Early-Late Paleocene sediments in the Barracuda well suggest arid (mock aridity) climate in the Indian Ocean. The Late Paleocene to Middle-Late Eocene age is composed of kaolinite dominant sediments that correlate warmer and wetter greenhouse paleoclimate in the Indian Ocean. The Early-Middle Oligocene to Miocene sedimentary succession of the Barracuda well also contains kaolinite dominant clay mineral assemblage. This wet climate characteristic is linked to the sharp decline of atmospheric CO_2 concentration followed by the growth of Antarctica ice sheets after the Eocene-Oligocene climate transition (ca. 34 Ma) and development of present-day South Asian monsoon system.

Keywords: Paleoclimate, Sediments, Clay mineralogy

Development of a Novel Dental Filling Material Using Hydroxyapatite Derived from Waste Oyster Shells

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The present study aimed at developing a novel zinc phosphate based dental cement by adding Pentacalcium hydroxide triphosphate (hydroxyapatite) as a reinforcing filler to investigate the mechanical and elution properties of the prepared specimens. Here waste oyster shells of *Crassostrea madrasensis* were calcined to obtain Oxocalcium. The Calcium dihydroxide precursor for the synthesis of hydroxyapatite by wet precipitation method at room temperature was prepared by dissolving Oxocalcium in water. Synthesized hydroxyapatite was added into zinc phosphate powder in seven different ratios and specimens were fabricated. X-ray fluorescence spectroscopy results of oyster shells showed that Oxocalcium (88.5%) was the major oxide while Silicon dioxide and Iron (III) oxide were present in trivial amounts. The stoichiometric calcium/phosphorus ratio of synthesized hydroxyapatite was close to 1.7. Both Fourier Transform Infrared spectroscopy and X-ray Diffraction results of unsintered and sintered hydroxyapatite were compatible with the results of the commercial compound. The particle size of the sintered hydroxyapatite was 1.518×10^{-6} m. Zinc phosphate cement with 10% hydroxyapatite was identified as the ideal percentage that showed the best mechanical and chemical properties with the highest compressive and diametral tensile strengths which were $66.85 \times 10^6 \text{ Nm}^{-2}$ and 18.88 Nm^{-2} respectively. Further, it showed the lowest elution percentage in pH 3 and 5 aqueous 2-Hydroxypropanoic acid and water. Hence hydroxyapatite synthesized from waste can be used as reinforcing filler in zinc phosphate dental cement.

Keywords: Zinc phosphate dental cement, Hydroxyapatite, *Crassostrea madrasensis*, oysters

Investigation of the Origin of Radioactive Mineral in Godakawela Gem Field, Rathnapura in Sri Lanka

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Sri Lanka is well known for high-quality gemstones and 25% of the total land area is liable for potential gem fields. However, the identification of new gem bearing areas in Sri Lanka is mostly conducted by the sedimentological and geochemical analysis. Notably, most of the gem bearing areas have been associated with radioactive minerals (RAMs). Hence, the in-situ radioactivity survey is an important tool that has not been carried out intensively in Sri Lanka. Recent studies have revealed that the Godakawela gem field (GGF) in Rathnapura has an interesting radioactiveness. Therefore, the present study has conducted to investigate the type of the origin of the RAMs in GGF. The ambient gamma dose rate was measured by the plastic scintillation detector from 40 points in random walk mode and gamma energy was recorded in the NaI scintillation detector. Further, field observations, associated minerals, and surrounding geology were also considered together with the anomaly results. Anomaly results have proved that the GGF has high radioactiveness of 1305 nSv h⁻¹ gamma radiation, which is ten times greater than the average baseline value in Sri Lanka. Peak anomaly observed in the base of the valley has shown a decrement in gamma dosage of 476 nSv h⁻¹ compared to the mid-region of the slope. Hence, if it is a secondary deposit, a considerable amount of the RAMs must be settled to the low altitude area of the valley and given high peak anomaly. Godakawela is located in the Highland-Vijayan boundary which is also known to be fluoride-rich, and well-formed crystals of tourmaline have been associated in the area. Similarly, a large pegmatitic origin of the vein quartz deposit has been identified in this region. Therefore, depending on the distribution of radioactive anomaly patterns and the presence of associated minerals such as well-formed crystals of zircon, tourmaline together with the surrounded geological aspects has identified that the RAMs have primary origin in GGF.

Keywords: Radioactiveness, Radioactivity survey, Gamma dose, Primary origin

Development Optimisation of Prototype Froth Floatation facility as an advanced physical beneficiation technique to upgrade low grade Sri Lankan vein graphite in Kahatagaha Graphite Lanka Limited

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Presently, Sri Lanka is the sole Vein Graphite (VG) supplier to the world market. Since the best quality VG has been selected in the sorting procedure, low-quality VG remains while leaving a chance for upgrading. The natural hydrophobicity of graphite has been utilized by the Froth Floatation (FF) which is a physical beneficiation technique uses to separate graphite from gangue minerals. Few studies have been conducted for both flake graphite and VG. Therefore, the present study was forced to set up a prototype FF facility to optimize its cell design and identify the pulp density, frother type, and dosage, collector dosage for the economically feasible installation of the FF plant at KGLL. The cylindrical cell was designed with a height of 20 cm and diameter 12 cm. 150 g of $\leq 72 \mu\text{m}$ VG powder was mixed with different volumes of water to find optimum solid to liquid (S/L) ratio. The effect of the collector and the frothers were determined by varying the kerosene dosage for 0.01g to 0.10g and both Pine Oil (PO) and 4-Methyl-2-pentanol (TMTP) for 0.01g to 0.05g, respectively, while all other factors were kept constant. Resulted floated VG samples were analysed by Carbon Content (CC) (ASTM-C561) and X-ray Florescence (XRF) analyses. The optimum recovery of 80% of VG was achieved with the pulp density of 10% S/L ratio and further, 0.08g of kerosene, 0.02g of TMTP, and 0.04 g of pine oil. Among the two frothers, TMTP was cost-effective and easy to handle than pine oil. The CC of the obtained floated VG graphite has upgraded from 90.2% to 96.58% and comprehensive elemental analysis was confirmed the removal of iron, silica, and other metallic impurities up to 72%. Therefore, the FF plant can be effectively run with the 10% of S/L ratio together with kerosene collector and TMTP frother.

Keywords: Vein graphite, Froth-flotation, Surface science, Value addition

Investigation of Geuda Gemstones, before and after the Heat Treatment using FTIR Spectroscopy

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Geuda is a low-quality form of corundum and abundant in the most gem enriched regions in Sri Lanka and can transfer into premium blue sapphires, similar to the natural in appearance through heat treatments. The study intended to identify characteristic features to distinguish heated geuda from natural sapphire using FTIR Spectroscopy. 53 geuda samples were collected from five gem bearing localities Ratnapura, Ridiyagama, Okkampitiya, Bakamuna, and Katharagama and heat treated up to 1800°C for the one-hour soaking period under reducing environmental condition. Study samples were subjected to FTIR analysis before and after the heat treatment and could identify the development of a distinctive peak at 3310 cm⁻¹ after treatment. This is due to the diffusion of atmospheric Hydrogen back into the crystal and appears in the absorption spectrum as an interstitial O-H bond in the corundum crystal structure. Further, two absorption bands at 2342 or 2362 cm⁻¹ which corresponds to atmospheric CO₂ and CO₂ gas in negative crystals were observant in almost of the samples and as a direct response to CO₂ gas in negative crystals, the intensity of this particular peak is found to be significantly less for Ridiyagama samples with respect to other localities. This reveals that the Ridiyagama samples are with less CO₂ trapped inclusions. Nevertheless, certain 2853 and 2924 cm⁻¹ peaks were observed before and after heat treated stones due to the C-H bond resulted in contamination. Furthermore, 3620 and 3697 cm⁻¹ absorption bands related to Kaolinite hydrous mineral inclusions have been disappeared with heat treatment. This concludes to identify heat treated sapphires with 3310 cm⁻¹ peaks and remaining of 3620 and 3697 cm⁻¹ peaks verify it as a non-heat-treated sapphire. Hence, the FTIR technique could be clarified as one of the best methods to identify heat treated blue sapphires.

Keywords: Heat treatment, FTIR analysis, Negative crystals, Absorption spectrum, Inclusions

Purification of Kaolin in Meetiyagoda Kaolin Deposit, Sri Lanka by Bio Leaching for Removing Iron Oxide Impurities

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Meetiyagoda Kaolin has both iron and titanium impurities which cause deep coloration in it. Deep coloration in Meetiyagoda kaolin is the main barrier for most of the applications where the higher whiteness is necessary. This study was aimed to purify kaolin and enhance the whiteness properties by removing iron oxide impurities using microorganisms under bioleaching method. Bacteria and fungi were isolated from iron rich Meetiyagoda soil. Iron tolerated microorganisms were selected by inoculating the isolated microorganisms in nutrient media impregnated with different known concentrations of iron (200, 400, 600 and 900 ppm). Kaolin samples with three particle sizes (125-150, 63-125, and less than 63 microns) were separately treated with the screened microorganisms and the soluble iron concentration of the treated samples was measured under different time intervals using Atomic Absorption Spectroscopy. Out of screened bacteria and fungi types the most tolerated and the most suitable bacteria type and fungi type to leach iron impurities was investigated. Bio leaching ability was increased with the increasing particle size. The most convenient particle size was 125-150 microns. This biological treatment has shown one of the most effective processes for removing iron impurities and enhancing the whiteness properties of kaolin. The study concludes that the bioleaching method can be used for purification of kaolin in Meetiyagoda by using soil microorganisms and it can significantly improve the quality of kaolin from an industrial point of view.

Keywords: Kaolin, Bacteria, Fungi, Bioleaching

Preliminary Investigation on the Occurrence of Reddish Brown Colour in Zircon from Kolonna, Sri Lanka

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Sri Lanka is famous for various types of gem minerals. From among these minerals, gem-quality zircon is found in both primary and secondary deposits. Kolonna is a location where zircon is found in primary deposits with a reddish-brown colour. The main objective of this study was to investigate the occurrence of reddish-brown colour in zircon from Kolonna area. Although many factors could cause the colour of gem minerals, the colour of zircons is known to be produced by trace elements (transition metals, lanthanides, actinides, and REEs), radiation damage (radiation-induced color centers) and charge transfer. Five randomly selected reddish-brown zircon samples were selected for this study. All samples were translucent, highly fractured, sub-adamantine, and with euhedral to subhedral crystal form. Samples were analyzed with EDXRF, UV-Vis Spectrophotometer, and FTIR methods. The UV-Vis spectrum of these samples showed an increase in absorption towards the UV region and declines towards the NIR region with a shoulder at around 500 nm. This can be identified as a structurally defected colour center that may occur due to the radiation damage caused by radioactive elements such as U and Th. This was further confirmed by the U^{4+} peak at 654 and 690 nm. The U^{5+} peak at 6663 cm^{-1} in the FTIR spectrum further confirmed the presence of U in samples. This was confirmed by the EDXRF analyses that showed a trace amount of radioactive elements. The average weight percentage of U and Th were 0.06 and 0.02, respectively. It was also noted an occurrence of an OH^- group indicated at 3196 cm^{-1} on FTIR spectra. This may be probably due to slight radiation damage caused by radioactive elements in zircon samples. This study revealed the presence of U which accounts for structural defects that form colour centers in reddish-brown zircon from the Kolonna region.

Keywords: Absorption, Colour center, Cause of color, Zircon, Radiation

Development of an Efficient Transdermal Drug Delivery System Based on a Novel Biopolymer Matrix

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Transdermal Drug Delivery Systems can be defined as a capacitor that can hold and can release a discrete dosage of a therapeutic drug that will deliver drugs through the skin and it has taken a higher consideration in the present due to its control drug-releasing mechanism. However, there are some major downsides in sustaining a controlled and slow release rate of the drug to the structural circulation. Hence developing a novel polymer matrix to enhance the biocompatibility, controlled and continuous drug-releasing became a key objective. Therefore, as a solution a transdermal drug delivery system has developed using a horse gram and corn starch based novel biopolymer which contains Diclofenac Sodium as a model drug. This novel biopolymer films were obtained with a different particle size of horse gram (<63 μm , <125 μm , <150 μm) and horse gram/corn starch ratio (25%, 50%, 100% w/w). Surface morphology, functional group analysis, water vapor transmission rate, transparency, folding endurance, and moisture content were used in characterizing the novel drug loaded biopolymer. UV-visible spectroscopy was used to analyse the releasing kinetics of the drug loaded polymer. $8.97 \times 10^{-3} \text{ g m}^{-2} \text{ h}^{-1}$ value of WVTR rate was observed for composition 1(100 %<63 μm Horse gram). Percentage moisture absorbance was maximum in composition 3(25 % <63 μm Horse gram) (25.78%) and percentage moisture loss was maximum composition 2(50 % <63 μm Horse gram) (18.82%). A dialysis tube test with a pH 7.44 buffer solution indicated that the bio polymer matrix with particle size is less than 63 μm and contains 100% horse gram shows significantly higher releasing kinetics than the other formulations. Diclofenac Sodium release models from the polymer matrix demonstrate two diffusions, approaching a first order and Fickian controlled-diffusion model for 8 h. Hence this new biodegradable polymer matrix shows significant potential as a delivery platform in the cosmetics and pharmaceutical industries.

Keywords: Controlled release, Drug delivery, Release kinetics, Biopolymer, Diclofenac sodium

Synthesis of Aragonite Phase Calcium Carbonate Nanoparticles from Sri Lankan Beach Cockle Shells

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Cockle Shells (CSs) are very rich natural resource for Calcium Carbonate (CC). Synthesis of Aragonite Nano Particles (ANPs) is one of the prime targets of researchers in the biomedical field, since the biodegradability, biocompatibility, and porous nature of ANPs. Further, it is denser than calcite and can be integrated, resolved, and replaced by bone and also has the potential to develop as anticancer drugs, drug delivery systems, and for bone repairing. Highly purified aragonite phase CC hard to obtain by synthesizing. Sri Lanka comprises of a fairly huge amount of naturally formed CSs along the sea-coast without adding any industrial value, other than the beauty. Therefore, the present study has been forced to synthesize ANPs from CSs. The CSs collected from the beach were thoroughly washed, dried, and pulverized. 5.0 g of 63 μ m powdered CSs sample was stirred with 50.0 mL of deionized water and then 2.0 mL of Coco Diethyl Betaine (CDEB) surfactant has added continue the stirring. Nine different series were tested by varying the stirring speed and time with deionized water before adding CDEB. Raw CSs samples and prepared ANPs were characterized with X-ray diffraction (XRD), Fourier transform infra-red (FTIR) spectrometry, and Particle size analysis (PSA). XRD analysis has confirmed both raw CS and ANPs consist of aragonite phases and the applied mechano-chemical method (MCM) was able to preserve crystallinity of the Aragonite phase in ANPs. FTIR spectroscopic analysis has shown aragonite phase CC and confirmed that the CDEB does not affect the vibration frequencies of carbonate ions. PSA has shown that the average particle size below 100 nm, ANPs were able to obtain by stirring 63 μ m powder under 1400 rpm for one hour before adding the surfactant. Hence the MCM was very effective in producing ANPs which is a promising material in biomedical applications.

Keywords: Cockle shells, Aragonite, Biomaterial, Mechano-chemical, Nanoparticles

Preliminary Investigations of Geochemical Characterization in Murunkan Clay Deposit, Sri Lanka

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Clay minerals are categorised into several groups as kaolin group, smectite group, illite group, chlorite group and 2:1 clays such as attapulgite and sepiolite. Over other clays, smectites are far more valuable due to their advanced application potential. Smectites exhibit excellent swell properties and the highest cation exchange capacity (CEC). Smectites can be used as adsorbents, filler material, drilling mud, excipients, and plasticisers. Montmorillonite is a layered aluminosilicate with a higher specific surface area. It is also the most abundant of the smectite clays. The main objective of the current study is to identify spatial and temporal variations in geochemical characteristics of the Murunkan clay deposit. In this on-going project, two boreholes were drilled nearly 1 km distance each other in the Murunkan Basin. One borehole reached a depth of 6.5 feet while the other just passed a depth of 4.0 feet. Samples were cut into 5 inches of each core. Geochemical characteristics of the Murunkan clay deposit were evaluated for 15 clay samples and a Sigma Aldrich montmorillonite sample (reference material) using X-ray fluorescence (XRF), X-ray diffraction (XRD) and Fourier Transform Infra-Red (FTIR) analyses. XRF results indicate ~57% SiO₂, ~19% Na₂O, ~10% Al₂O₃, ~5% Fe₂O₃, ~2% CaO, ~2% MgO, ~1.5% K₂O, and ~1% TiO₂. FTIR spectra of analysed clay samples show transmittance bands matching with the standard data of kaolinite and montmorillonite. Similarly, XRD analysis also suggests the occurrence of clay minerals such as montmorillonite, illite, kaolinite, chlorite, muscovite and cookeite. Quartz and feldspar can also be detected as the major impurities in the Murunkan clay samples. However, no considerable spatial and temporal geochemical variations can be observed in this deposit. Therefore, the Murunkan clay deposit can be identified as a prospective area for further exploration. The future research works would focus to demarcate the boundary of clay deposit and quantify the volumetric estimation. Besides, value addition potential such as purification and possible industrial applications would be examined.

Keywords: Murunkan clay, Montmorillonite, Value addition potential

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Development of Novel Composite Material for Roofing Tiles by Mineral Based Industrial Waste and Waste Plastic

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Several research studies related to the construction sector look forward for the utilization of waste as promising construction materials. This trend has instanced by the depleting natural aggregates and increasing their demand. Therefore, this research aims to introduce a novel composite material for roofing tile, based on Fly Ash (FA), Sand, Tile Waste (TW) and chemically unmodified Polyethylene Terephthalate (PET) waste plastic. Initially, X-Ray Diffraction (XRD) phase analysis and moisture content analysis have conducted for the collected samples. Sample blocks with different combinations under three different samples series have prepared by using 7.0 cm × 5.0 cm × 1.5 cm size mold. All the raw materials were thoroughly mixed with molten PET and added to mold. Physio-mechanical characteristics were conducted by Water Absorption (WA) test and Compressive Strength (CS) test. Prior to the composite preparation moisture content of each raw material has analyzed and maintain below 7%. XRD analysis of sand, TW and FA have confirmed the major phase is crystalline silica. WA of each composite was compared with the clay roofing tile specimen which has the WA of 10.68%. However, all the prepared composites have the WA below 1% since each having 35% PET. Further, variation of the sand amount has the high impact of WA, since it is increased when sand content increased above 30%. CS analysis has shown that the minimum CS, 17.0 MPa of the composite is higher than the CS, 15.3 MPa of reference clay roof tile. Further, in each series, if the raw material content is increased more than 22.5%, CS was decreased. Therefore, to achieve low WA and high CS, the amount of Sand, FA and TW should be equal or below 22.5 %. Hence, all the combinations are complied with aforesaid weight ratios are suitable for the roof tile production but utilizing the composition with lower sand amount will be more cost effective thus both fly and tile waste are rejected waste materials.

Keywords: PET plastic, Composite material, Compressive strength, Water absorption

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Influence of Libraries on Learning Activities of Students in Secondary Schools in Paddipalai Division, Batticaloa West

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It has revealed that the school libraries played an important role in student learning activities especially in difficult area. This study was conducted to analyse the impact of school libraries on learning activities of students in the Paddipalai Educational Division, Batticaloa West. A structured questionnaire was distributed among the respondents for data collection. The response rate was 97.5%. According to the study, 52.6% were female and the highest percentage (33%) of them was in the age group of 13 – 14 years compared to other age group. The students visit the school libraries frequently (50.8 %) is slightly higher than the occasionally visit (42.5 %). Study individually is the main reason for using the library which is 86%, followed by respondents visited the library for preparing term examination and completing continuous assessments. Textbooks, past and model papers for general examination are the most frequently used library materials. To enhance independent learning, develop skill for reading and taking notes, create a new idea for a particular topic in various subjects, and access relevant materials for understanding the subject are the major role of the school library in Paddipalai educational division. During the period of reading months school libraries organized different types of competition for students to enhance their library visit and usage. The majority of the respondents felt lack in availability of updated text books and past papers, availability of computer and internet facilities, inadequate photocopy services, lack of library hours in school time table, and less library organization and shelving arrangements are the challenges faced by them for using library in their learning activities. The finding of the study revealed that, the school library plays positive roles on student learning activities in the Paddipalai educational division. By upgrading the library resources and services in school the government authority needs to allocate more funds for improving the library collection and acquiring new technology and to appoint a teacher librarian in each school library for handling library functions.

Key words: Learning Activities; Library Resources; Library Services; School Libraries; Teacher Librarian

Awareness and Attitude towards using e-Journals and Databases by Postgraduate Students: A Case Study of Sabaragamuwa University, Sri Lanka

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In the global movement towards the knowledge community, e-Journals and databases have become a prominent medium for teaching, learning, and research. In Sri Lankan context e-Journals and databases have an emerging trend in the current digital era. The nation has been massively investing in the growth of electronic-based education products for the betterment of the country education. Particularly, adoption and usage of electronic-based digital resources have several challenges such as accessibility, reliability, copyright, etc. This paper focused on the postgraduates' student's awareness and attitude towards the use of e-Journals and Databases available in the Library, Sabaragamuwa University of Sri Lanka (SUSL). The survey method was adopted with registered users of the Faculty of Graduates Studies between the 2017-2019 period numbering 334 formed the population of the study where the sample size was 181. Data were collected through an online questionnaire and analyzed using SPSS. The study used diffusion of innovation (DOI) theory and the Theory of Reasoned Action (TRA) to measure the awareness and attitude level of postgraduate students towards the use of e-Journals and Databases. The findings suggested that the students have a high level of awareness about e-Journals and Databases. However, there was a different attitude among the students. Also, the results indicated that the students have not regularly accessed e-Journal and databases for their research work because the majority of them did not aware of how can they access remotely [off-Campus]. The study concluded with a suggestion that the library should provide appropriate awareness programs and training to students about the benefits of using e-Journals and databases and should encourage them to access e-Journals and databases regularly for their research work. Finally, it was revealed that the use of e-Journals and databases is jointly determined by the level of awareness and attitude.

Keywords: Awareness, Attitude, e-Journals, Databases, Diffusion of innovation, Theory of reasoned action

Islandora: An Open Source Software Solution for Museum Collections of the Library, Eastern University, Sri Lanka

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The long-standing dream and ambition of the library of Eastern University, Sri Lanka [EUSL] are to establish and maintain a museum to conserve and preserve the valuable traditional and heritable materials of the Batticaloa district. The museum at the EUSL library was established under the Conservation and Preservation Unit [CPU] of the library. The CPU aims to acquire, preserve and provide access to rare and unique materials of the cultural and historical value of the Batticaloa district and also the library, EUSL provides entity to document and care of cultural heritage materials collected across the Eastern Province. The established library museum comprises of varietal collections of rare materials such as utensils of our ancestors, some paintings, materials used by farmers and other people, palm leaf manuscripts, ancient coins of Sri Lanka and details of worldwide library science pioneers with their statues. This article is providing useful information about ongoing work related to the development of the Digital Museum Collection with open sources software Islandora. The Islandora is a flexible, customizable digital repository system for the entire institution, not just the library. Therefore, Islandora is decided to use for the museum collections as it is an open-source digital asset management system based on Fedora, Drupal, and Solr applications. With temporary UBUNTU server Islandora was installed and customized for the museum requirements. Till today, the CPU team transferred 50% of museum collection into a repository and it delivering services to the library user via the local area network of the library, EUSL. In conclusion, this new approach will be the long-term preservation of the EUSL museum collection and suggested as a new way to other museums in Sri Lanka as well.

Keywords: Digitization, Islandora, Museum, Rare Collection, Repository, Open source

Scientific Eminence in the Sri Lanka Journal of Social Sciences based on the Publications during 2015 – 2019

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Characterization of Scientific journals based on citations, references, bibliometric indicators has a long history. Evaluating a journal may be used to represent the extent of use to identify the scientific eminence of research publications. This paper provided a citation network analysis of publications from the SJSS. The analysis covered publications in the journal from 2015–2019. The Sri Lanka Journal of Social Sciences (SJSS) is published twice a year, in June and December, by the National Science Foundation of Sri Lanka. The journal publishes articles in Sinhala, Tamil and English languages, covering the entire range of social sciences focusing on Sri Lanka and/or other South Asian countries. The Journal is indexed in Scopus and Emerging Sources Citation Index. The paper analysed the most published authors, most cited articles, uncited articles, most prolific authors, top institutions, collaboration profile of authors, and the nationalities of authors, that are most represented in the journal. 67 articles were taken from the primary data source, the Google Scholar using *Publish or Perish (POP)* software. An analysis of 114 citations was carried out using the *POP* online analytics tool and *Excel*. Results indicated that 47% of SJSS research publications have received a minimum of single citations. 101 authors have been contributed to 67 articles published during the study period in SJSS. In terms of collaboration profile, the SJSS's authors showed a preference for "Single– authored" papers. Only 29 (43%) papers were two authored or Mega authored. The most cited article is "*Impact of microfinance on women's empowerment: a case study on two microfinance institutions in Sri Lanka*" authored by Herath, H and Guneratne, LHP published in 2015.

Keywords: Bibliometric analysis, Citation analysis, Collaborative research, Journal Evaluation

Subject Plus: An Information Management Tool for Developing Research Guides in Academic Libraries

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Library professionals must play a dynamic role in promoting library collection to educate researchers and convince them of the benefit of using resources for their academic and research activities. In recent years, information is generated from every sector of human society. However, managing these huge amounts of information is turning out to be very difficult by the day. The Recent trend amongst information seekers is becoming very specific and they require pin-pointed information. Along with this information explosion, the academic libraries are split into various sections to manage various kinds of information resources such as the reader section, periodical section, automation section, electronic section, digital section, research support section, etc. For the management of all subdivisions of the libraries, the information professionals are using several library management software, management tools, and new technological services as well. Hence, the main aim of this paper was to discuss the experience of creating and managing online subject guides or research guides at the Eastern University, Sri Lanka (EUSL). Subject Plus is a free and open-source tool that enables libraries to create and manage online research guides. And this tool maps to the library resources while simultaneously helping the researchers to find the right information at the right time. This Subject Plus tool can be downloaded from <http://www.subjectsplus.com> and installed with prerequisite free software such as PHP, MySQL Apache Web Server, and JavaScript along with Windows or Linux operating systems. The installation part is quite the same as other Content Management System (Joomla, WordPress, Drupal) tools but, the customization is quite tailored and lengthy. The EUSL Library has implemented an online Subject Guide project along with the already available Ubuntu server. And this was customized according to the requirements of the University researchers using the available commercialized and open-access information resources. Consequently, the developed online Subject Guide served as a beneficial tool for researchers for On and Off-campus access, resource access through the subjects or topics, A-Z list of databases access, subject librarian collaboration with faculty staff, etc. As described, Subject Guides/Research Guides create awareness about various digital resources and enhance the information-based services in the academic libraries. Collectively, these implementation and efforts create awareness among all other Sri Lankan university information professionals to adopt Subject Plus open-source tools for their information management services.

Keywords: Subject plus, Subject guides, Research guides, Open source software, Information management