



IRCUWU2021

5th INTERNATIONAL RESEARCH CONFERENCE

2021
1-2, July

“Exploring Potentials in Challenging Periods”

Uva Wellassa University of Sri Lanka



IRCUWU 2021

5th International Research Conference - 2021

"Exploring Potentials in Challenging Periods"

July 1-2, 2021

Uva Wellassa University
Badulla
Sri Lanka

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Acknowledgments

The Uva Wellassa University's 5th International Research Conference (IRCUWU2021) is a two-day virtual conference in which the inauguration session preceded three technical sessions. It would not have been possible without the help, contributions, devotion, and well wishes of a number of people.

The Vice Chancellor, Chairman of the Research Committee, and Organizing Committee of IRCUWU2021 express their heartfelt gratitude to the Chief Guest, Senior Professor Sampath Amaratunge, Chairman of the University Grant Commission of Sri Lanka, as well as keynote speakers Professor Ramesh G. Mani, Georgia State University, Atlanta, USA, and Professor Yuansong Wei, University of Chinese Academy of Sciences, Beijing, China, for their contributions.

All ten-track coordinators, panel members, and track hosts deserve special thanks for their invaluable contributions to this strenuous event. Furthermore, the authors and presenters are deserving of endless praise for their contributions and for sharing their important research findings in a variety of methods.

Without the fast and dedicated cooperation of the Editorial Board members and Reviewers, this work would not have reached the intended audience. They also made a vital contribution to maintaining accepted standards in scientific publications.

Special thanks and appreciation are also extended to Uva Wellassa University's IT and Audio-Visual Unit for their exact and cutting-edge efforts to live stream the event, allowing for uninterrupted online conferencing.

A heartfelt appreciation must be extended to the sponsors, who consistently supported this event during a tough time.

Last but not least, grateful gratitude is extended to all Uva Wellassa University academic, administrative, and non-academic members, as well as all parties that actively participated in the IRCUWU2021's success.

IRCUWU2021

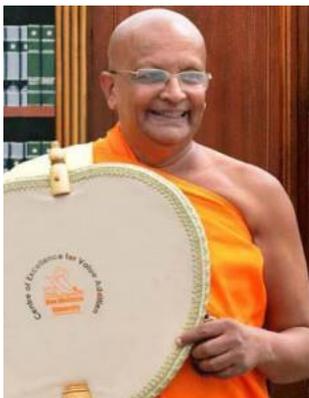
Uva Wellassa University of Sri Lanka has built an exemplary studios milieu for the nation driven by the unique theme, "Value Addition to the National Resources Base," as the country's first Entrepreneurial and Technopreneurial University. UWU has contributed immensely to explore avenues of value addition to Sri Lankan resources through its past conferences.

The 5th International Research Conference of Uva Wellassa University of Sri Lanka-IRCUWU2021 focuses on exploring new horizons to combat difficulties by opening it under the theme "Exploring Potentials in Challenging Periods" at a time when the entire world is facing one of the most significant challenges in human history, the COVID-19 pandemic. Due to the pandemic situation, the IRCUWU2021 will conduct as a virtual conference. IRCUWU2021 encourages and facilitates national and international academics, researchers, scientists, industrialists, professionals, graduates, and undergraduate students to discuss, share and disseminate their novel and innovative ideas and research findings published across ten thematic areas;

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

Following a comprehensive evaluation process, researchers will present 288 selected research findings in ten theme areas, all as oral presentations. The IRCUWU2021 presenting abstracts are archived in the university web system as an electronic archive.

Chancellor's Message



It is a great pleasure to convey my wishes to the 5th International Research Conference of Uva Wellassa University (IRCWU2021), organized under the theme of "*Exploring Potentials in Challenging Periods*".

Considering the present-day context, when the whole world faces one of the greatest challenges in human history, the Covid-19 pandemic, IRCWU2021 focuses on exploring new horizons to combat difficulties and look for viable solutions for issues in Science, Engineering, Technology, and Management.

Being the pioneer Entrepreneurial as well as Technopreneurial University in Sri Lanka, UWU has generated an exemplary studious milieu for the nation inspired by the unique theme, "Value addition to the national resources base". UWU has contributed immensely to explore avenues of value addition to Sri Lankan resources through its past conferences. The IRCWU2021 provides a marvelous platform for bringing scholars together to share their ideas, perceptions, and research findings. This prestigious event offers opportunities for scientists, industry personnel, and international delegates to unite and present their scientific innovations and discuss global trends in different fields

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

Thero Chancellor

Uva Wellassa University of Sri Lanka

Vice Chancellor's Message



With great pleasure, I send this message on the occasion of the IRCUWU2021, organized by the Uva Wellassa University of Sri Lanka. Indeed, IRCUWU2021 is a special occasion since UWU organized this conference as an online conference for the second consecutive year. I warmly welcome our chief guest chairman University grants commission, Senior Professor Dr. Sampath Amaratunge. Further, I welcome two keynote speakers, Professor Ramesh G. Mani from Georgia State University, USA, and Professor Yuansong Wei from the Chinese Academy of Sciences, joining us online; other invites, and all the presenters.

We all know that international research conferences are great opportunities for researchers, scientists, policymakers, and other stakeholders. International research conferences allow us to connect with researchers and scholars with different perspectives and views to learn from them and have relationships. Especially, the international research conferences where the international researchers and scholars participate give opportunities to initiate new collaborations for further research work.

The Covid 19 global pandemic has changed human life's entire landscape but opened the gaps in human knowledge, processors, and technology. The current situation reiterates the need for the generation of new knowledge to answer the problems that have occurred recently and its dissemination and applications. In this context, the theme of today's conference, "Exploring Potentials in Challenging Periods," becomes important. I firmly believe that the IRCUWU2021 will provide a fruitful platform to share the research findings and exchange views for further collaboration and research among scholars from different countries, despite the restrictions imposed due to the pandemic situation.

I congratulate all the presenters who will share their findings at IRCUW2021 and contribute to the research by creating new knowledge.

Finally, I would like to thank the organizing committee of the IRCUWU2021 as well as all the members of the UWU family for their untiring efforts to make this IRCUWU2021 a success, despite the travel restrictions and other health guidelines during this pandemic. I wish you all a very happy and productive conference.

Professor Jayantha Lal Ratnasekera

Vice Chancellor

Uva Wellassa University of Sri Lanka

Research Committee Chairman's Message



As the Chairman of the Research Committee of Uva Wellassa University, I take pride in forwarding this message on the occasion of the 5th International Conference of Uva Wellassa University (IRCUWU2021). With the inception of this University in the year 2005, Uva Wellassa University (UWU) has contributed immensely for the development of the nation in numerous ways. The Annual Research Conference conducted by UWU can be considered as one of such precious contributions to the nation.

This year, our International Research Conference would be conducted online for the second consecutive year under the theme "Exploring Potentials in Challenging Periods". The entire world is in a critical situation with the outbreak of Covid-19 pandemic and its effect is reflected in almost all sectors. It is high time to move forward, keeping the "new normal" in mind. This particular theme of the IRCUWU2021 focuses on such ways and means to combat the current challenging period.

IRCUWU2021 will provide a platform for national and international researchers, scientists, industrialists, professionals, graduates, and undergraduates to share, discuss, debate, and disseminate their findings, ideas and knowledge.

I take this opportunity to extend my gratitude to the members of the Organizing Committee of IRCUWU2021 for their hard work, commitment, and dedication. Their support was a great strength in making this event a success.

On behalf of the Research Committee, I wish all the participants of IRCUWU2021 to have a productive and informative conference.

Professor H.M.J.C. Pitawala

Chairman

Research Committee

Uva Wellassa University of Sri Lanka

IRCUWU2021 Coordinator's Message



On the occasion of Uva Wellassa University's 5th International Research Conference, it has been a great honor and privilege for me to send this message (IRCUWU2021). "**Research is the foundation of Knowledge**" The knowledge created through research should be shared with the entire world to make it worthwhile for others. The Uva Wellassa University of Sri Lanka has identified international research conferences as a platform for disseminating knowledge to the world. Throughout the last decade, Uva Wellassa University has conducted six symposia and four international research conferences.

In keeping with tradition, UWU planned to have a conventional International Research Conference in 2021. However, due to the current global pandemic situation, We had to progress with a virtual conference. We set our theme as "Exploring Potentials in Challenging Periods," aiming to uncover new avenues for combating current local and global challenges. One objective of selecting such a theme is to be a beacon awakening our capacities in such a difficult period. IRCUWU2021 organizing committee accepted its first challenge of having an international conference even in a critical pandemic situation. As the Coordinator IRCUWU2021, I must express my most profound appreciation and gratitude to the Vice Chancellor of UWU, Chairman and Members of the Research Committee, Chief guest, and Keynote speakers other parties for their invaluable contribution to make this event a great success.

Even though this is a challenging period for the entire world, it seems like the researchers have overcome it very well. Because we received more than 550 abstracts from the researchers under ten thematic areas, among those submissions, after a competitive review process, we choose about 280 abstracts to present in the IRCUWU2021. Today is the culmination of all our efforts; the researchers will present 280 research findings as oral presentations. The specialty of IRCUWU2021 is all the selected papers will be presented as oral presentations. During the presentations, we will choose the best research work using specific evaluation criteria. I appreciate all the parties for being with us and congratulate all the presenters and authors. I hope you will be enjoying the conference.

Dr. M.A.R.L. Samaraweera
Coordinator / IRCUWU2021
Uva Wellassa University of Sri Lanka

IRCUWU2021 Secretary's Message



It gives me the utmost pleasure to welcome you all to IRCUWU2021, the 5th International Research Conference of the Uva Wellassa University of Sri Lanka. This conference, themed "*Exploring Potentials in Challenging Periods*," is the ideal venue for bringing together a diverse range of stakeholders to discuss potential solutions during a difficult period for scientists, academics, professionals, and researchers due to Covid-19.

We were excited and thrilled at the end of last year when we were given the task of organizing this conference. However, we encountered numerous issues along the way due to Covid-19 situation. However, with the help of our advisers and colleagues and we are confident that we will be able to complete this journey and meet the expectations of our valued stakeholders. Our teams of organizers have continued to work rigorously to meet the challenges and to excel despite practical difficulties. We should all be proud of where we are now, and we should be ecstatic about everyone involved with IRCUWU2021.

I would like to thank our Guest of honor, Prof. Sampath Amarathunga, the Chairman, University grants commission of Sri Lanka, as well as two keynote speakers, Prof. Yuansong Wei, Research Center for Eco-Environmental Science, Chinese Academy of Sciences, Beijing, China, and Prof. Ramesh G Mani, Georgia State University, USA, for their insightful speeches. Vice Chancellor of the UWU, the chairman and members of the research committee, reviewer and members of the editorial board, chairpersons and panel members of technical sessions, all sponsors, media personnel, all members of UWU family, particularly the organizing committee, and all other numerous contributors are thanked for their contributions to the success of the event

I would like to thank each of you for attending IRCUWU2021 and contributing your expertise to this awesome event. You, as researchers, have the vision, the knowledge, the resources, and the experience to *Explore Potentials in Challenging Periods*. I wish you all a productive conference.

Dr. Titus Cooray

Secretary / IRCUWU2021

Uva Wellassa University of Sri Lanka

Chief Guest's Message



We are in a pandemic condition, and how does our higher education function today? When the first pandemic period came in March 2020, we had zero online classes or examinations. Within the period of the first wave, we had online teaching, and the participation was also significant. During the second wave, considerable development has taken place in online education. In the 25th week of 2021, we are currently conducting roughly 0.8 million sessions with 1.7 million participants weekly. Here we have to compare this with zero online teaching sessions in March 2020. This information shows how our education copes up and continues during the pandemic period. This is why we have finished the final years last year and were inaugurated for the first year. This data

demonstrates the strength of our educational sector. All credit must go to the sixteen national universities, including LEARN, our premier service provider.

Next, what is the research publications statistics of Sri Lankan universities? We can compare the statistics of all leading publishers regarding the research publications of all prominent universities. The data exhibits that the University of Colombo and the University of Peradeniya are well-positioned in the rankings, and annually they publish above 400 high quality, high standard full papers. The University of Moratuwa was in the range of 100 to 150 annual publications until about 2015 and showed a sudden development during last year by reaching 600 yearly publications. The University of Moratuwa shows the highest rate of growth of publications, which is about a sixty-eight percent increase. The main reason is when the University of Moratuwa conducts conferences; they link it with Scopus or other publishers. The universities like the University of Kelaniya, the University of Ruhuna, and the University of Sri Jayawardanapura publish about 150 papers per annum. Uva Wellassa University also maintains its research culture well, with about 88 publications per annum. The critical point is that Uva Wellassa University understands how to achieve rankings. Several methods, such as research awards, must be introduced to improve the research in the university.

When we look at how each institution contributes to the number of publications it produces by subject area, interdisciplinary research is the most important contributor in most state universities. We have to strengthen this area further. Except for the University of Moratuwa, other universities like the University of Jaffna, the University of Peradeniya, and the University of Ruhuna show the heights in interdisciplinary research. On the other hand, social sciences provide the smallest contribution and come in the latter part. Medicine also contributes significantly to the number of publications in Sri Lankan universities, while second, third, and fourth contributions mainly come from science-based research.

Furthermore, about 2260 circulars have been issued regarding the universities so far; however, only two circulars have been issued regarding university research operations. Among those two circulars, one of which is for research allowances. This number indicates how much we promote research in Sri Lankan Universities, and no directives and proper management. The biggest problem in our system

is, there are no dedicated authorities to manage research. In this regard, the University Grants Commission discusses whether all universities should establish research faculties to execute research. These faculties will allow to collect information, promote individuals to bring down foreign collaborations, etc., to encourage research. Finally, based on the webometrics data during the last five years, Uva Wellassa University shows a considerable improvement in research placing nine thousand in the world ranking. Further, Uva Wellassa University ranked ninth in the country. I believe that these kinds of research conferences not at the domestic level, always inviting foreign speakers, researchers, and links with top-level publishers, will place Uva Wellassa University in a better place in the future.

Senior Professor Sampath Amaratunge

Chairman

University Grant Commission

Keynote Speech

Experiences of Water Pollution Prevention and Control in China during 40 years.



The United Nations published seventeen "Sustainable Development Goals" in 2015. SDG 6 relates to providing safe drinking water, adequate and equitable access to hygiene, water pollution prevention and control, water recycling, reuse, harvesting, and recharge technologies, among others. As a result, SDGs can provide valuable and practical guidance for our future. Water availability, both in terms of quality and quantity, is a major issue in the modern world due to unequal distribution of water resources. Around 60% of the world's population lives in Asia, but only 36% of the world's water is available. When compared to North

America, where the population is less than 10% and water availability is over 15%, this demonstrates the uneven spatial and temporal distribution of water sources. When it came to water quality, OECD (Organization for Economic Cooperation and Development) countries had lower BOD loading in global waterways compared to non-OECD countries, owing to a higher percentage of waste water treatment.

Water consumption has increased by 100 times in the last 100 years, a 1 percent increase per year. Population growth, urbanization, and climate change will all have a significant impact on water resources, resulting in severe water shortages in some areas. In that context, wastewater may be a more reliable source of water security than finding clean water. The majority of waste water in developing countries is currently untreated. As a result, wastewater treatment has a lot of potential to provide water resources and improve their quality. The two most important factors affecting water quality are population density and economic development. River water quality in Africa, Asia, and Latin America is deteriorating, while increased nutrients and pathogens in water bodies pose a global threat. Increasing available water quantity and increasing both water quality and quantity have been used in the past to address global water scarcity. Non-conventional water sources, such as rainwater, wastewater, and seawater desalination, can now be effectively used to improve both the quality and quantity of water.

Current Status of water resources & use in China

There are seven major watersheds in China, which cover about 43% of the country's land area. China's population was 1.41 billion people by 2020, with 64 percent of them living in cities. The country's GDP is also rising, and water demand is rising at a rapid pace. Water resources per capita in China are typically 2000 m³/person. However, it is around 114 m³/person in Beijing, which is a very low figure. However, in China, piped water supply coverage is very high, especially in cities (nearly 100 percent), but not that high in rural areas. Waste water treatment is also very high in cities. Water production capacity, water supply pipeline length, daily water supply quantity, and per capita water consumption have all increased over the last 40 years (1978-2019).

History of Environmental Protection in China

The history of China's environmental protection can be divided into five stages, with the main goal of achieving the Beautiful China target by 2035. To materialize this target China has done many activities like, develop a master plan, introduce laws, regulations, guidance and standards, develop management strategies, establish technology, develop equipment and methods. There were few activities prior to 1971. Environmental protection was declared a basic national policy in China from 1972 to 1991, but only preliminary progress was made. Between 1992 and 2000, a sustainable development policy was implemented, bolstering pollution control in key watersheds and regions. Environmentally friendly policies were implemented from 2001 to 2012, implementing pollution/emission control and demonstrating eco-provinces and eco-cities. Since 2013, the Chinese constitution has been amended to include the Ecological Civilization Policy and Beautiful China. Every five years, China creates a five-year plan, which includes key environmental protection activities such as establishing regulations and reducing pollution.

Key challenges of water pollution control in China

Water pollution sources were divided into two categories to address aquatic eco system degradation: point pollution from industrial and domestic sources and diffuse pollution from urban, agricultural, and rural sources. Major water pollutants found at those sites were previously classified as COD, total nitrogen, and total phosphorus, but now include toxic pollutants (POPs, PTS, heavy metals), as well as biological pollutions (pathogens, ARGs).

In summary, due to the government's five-year plan policy, China has made significant progress in infrastructure development, technological achievements through research and development, and the establishment of policies and laws over the last 40 years.

Current status of freshwater environment in China

In China, surface water is divided into five classes; by 2019, the better-quality water classes (I, II, and III grades) had improved by roughly 75%, which is a significant improvement over the water quality in 2005. River basin water quality has also greatly improved. In particular, seven major watersheds. Many people in China rely on surface water as a source of drinking water. Nitrate pollution of surface water has received a lot of attention, and it's becoming a serious problem in China. Around 8% of the samples taken from 71 major rivers in China exceeded the national nitrate standard (45 mg/L) for drinking water. Manure, septic waste, inorganic fertilizer, and soil organic matter are the primary sources of nitrates in river water. According to a study, China's gray water footprint and surface water pollution levels decreased between 2003 and 2018, based on four pollutants: COD, NH₄⁺, N⁻, TN, and TP. Because of increased nitrogen application in China, low TN reduction capacity of wastewater treatment plants, and better comprehensive utilization of livestock and poultry manure, the PWP (primary water pollutants) was changed from COD to TN in 2007.

Current status of wastewater / sludge treatment in China

Between 1978 and 2019, China's urban drainage and wastewater treatment have increased nationwide. During the years 1991 to 2019, wastewater treatment in urban areas increased from 14.86 percent to 96.81 percent. While Beijing is making progress, more work is needed in China on

wastewater reuse. China has much lower CSS (combined sewer system) rates than developed countries. So, in future this also needs to improve. In China, 5476 municipal wastewater treatment plants were operational by the end of 2019, resulting in an annual sludge productivity of 40 million tones, or 80 percent of the water content. Land application accounted for 29.3 % of sludge disposal, with incineration (26.7 %) and sanitary landfills accounting for the remaining 26.7 %.

Assessing the total factor performance of wastewater treatment

China faces a significant challenge in addressing water scarcity and protecting water resources. Inadequate WWT is the most significant impediment to regional water pollution control and long-term economic development. Type I cities have high technical efficiency and WTFP growth, Type II cities have high technical efficiency but low WTFP growth, Type III cities have low technical efficiency but high WTFP growth, and Type IV cities have low technical efficiency but low WTFP progress. Policymakers and managers can use the evaluation of WWT efficiency and WTFP change to improve the performance of WWT over time.

MBR in China and World

The first MBR was created in late 1960, and development continued until 1990. MBR applications first appeared in China in the year 2000, and the technology's adoption is growing at a rapid pace. MBR implementation varies from country to country, despite the fact that global growth rates are generally high. Legislation, local water scarcity, return on investment, environmental impact, and public and political acceptance are all global key drivers for MBR. China has an MBR implementation growth rate of over 50%, while some European countries have a rate of over 20%. Beijing is home to the world's largest MBR treatment plant, with a capacity of 200 000 m³/day. The number and size of MBR applications increased dramatically. Membrane retention, enhanced biodegradation due to increased biomass, and an acclimated microbiological community ensure COD removal rates of over 95% in MBR. Most MBR-based wastewater treatment processes achieved high NH₄⁺-N removal rates of over 95 percent, TN removal rates of over 80 percent, and TP removal rates of over 80 percent. The MBR process was more effective at removing pathogens and viruses than the CAS process. Because of its water mitigation strategy and conservation efforts, China has risen to the top of the global MBR application rankings.

Future of water pollution prevention & control in China

In the future also, China will face many challenges in the water treatment sector, and the government is working to overcome those obstacles in order to meet the Beautiful China target by 2035. China has identified that integrated watershed management, including aquatic eco system health, transboundary river basin water pollution prevention and control, and prevention and control for complex pollution in the water environment, should be improved by 2035. The protection of key waterbodies and the need for enhancement has been identified as a challenge, including major lakes and rivers such as the Yangzi and Yellow Rivers, the urban water environment, and the protection of drinking water sources. Rural and urban diffuse pollution, including agricultural diffuse pollution, should be enhanced and improved in terms of diffuse pollution prevention and control. Using risk management, pollution source management, smart system for monitoring and alerting, and water system prediction, the integrated management system for aquatic ecosystems should be improved.



The 14th five-year plan outlined long-term goals for 2035 in order to achieve ecological civilization and progress toward a beautiful China. China promises to reach carbon neutrality in 2060 and a carbon peak in 2030. The Beautiful China concept is based on integrated watershed management, scientific management of rivers, lakes, urban water bodies, and drinking water sources to improve water quality and aquatic ecosystem health. Controlling pollutant discharge in a comprehensive manner while also continuously improving water ecological environmental quality and finally, improving water ecological environmental management and sewer systems.

Professor Yuansong Wei

Research Center for Eco-Environmental Sciences

Chinese Academy of Sciences

Beijing, China

Keynote Speech

Potential future applications of graphene; Detection of spin resonance in epitaxial graphene



Today, we live in a world full of electronics; we are surrounded by cell phones, video cameras, GPS systems, tablets, even light bulbs, and so forth. All these things are possible modern electronics. There are a lot more electronics in our lives than we realize. Further, energy harvesting devices like solar cells are a green solution that provides energy without creating pollution. Also, many electronics in the modern automobile are filled with sensors, such as the transmission sensor, the wheel speed sensor, the throttle position sensor, etc. All of these things have electronic devices. The standard materials for these electronics have been silicon for a long time. In 1969 the standard size for a wafer was 2 inches, and today its size is up to 18 inches. Silicon has many advantages in

terms of processing technology, ease to handle, and hard material. But the material does have disadvantages; it is inflexible, the bandgap is not direct, and the performance degrades at higher temperatures.

In addition to silicon, several other materials help complement its capability and things that silicon can not do; for example, gallium arsenide is suitable for integrated microwave circuits, infrared LED solar cells, laser devices, etc. Gallium Arsenide has a bandgap of 1.42 eV, and this material is good because it can be used to produce lasers detectors and modulators. There is also getting phosphide which has a bandgap of 2.26 eV. The phosphide material is interesting because it can be used to build up green LEDs. Human eyes are most sensitive to green light, so green is an integral part of the spectrum, and phosphide helps build these devices.

Moreover, there is also gallium nitride material, which has a larger bandgap of about 3.39 eV. That means we can make optical devices with a shorter wavelength. For example, if you want to fabricate blue LED for high-power electronics, nitrides can do that. These materials have been able to support the world of electronics. Further, many other desired properties would like to have in electronic materials that we do not have so far, and between that, we would like to have it. These properties include transparency, high electrical and thermal conductivity, flexibility, less weight, etc. These properties will lead to a group of new materials that are not available in nature. We know that we have materials that do a lot of things for us, but there are a lot of other things that we would like to do. People imagine a future with electronic devices that we can imagine these days, like wearable electronics clothes, devices, extremely high efficiency solar cells, etc. Also, there are new applications like virtual reality, robot driving cars, artificial intelligence, etc.

When we talk about novel materials, there is graphene which is the modern wonder material. Graphene has many properties that people have been seeking; for example, it is super strong, amazingly thin, almost completely transparent, very light, and an excellent conductor of heat and electricity. One attractive property of graphene is that one can cover a football field with a sheet of

graphene weighing less than a gram. In graphene, electrons are more mobile. The electronic devices using graphene could work faster, even with less power than many other materials that we know today. Further, graphene provides new properties, which are the properties expected in systems exhibiting quantum mechanical characteristics.

What is graphene? We are already familiar with it since we know graphite. Graphene is just the layer of carbon that makes up graphite. So if you want graphene, one can peel off one of these layers from a piece of graphite. Graphite and graphene are significant materials for this conference because graphite has been linked with Sri Lanka for a long time. Hundreds of years ago, people first discovered graphite in Sri Lanka, and they called it "Ceylon graphite". Ceylon Graphite is some of the purest graphite you can find in this world. It is 95% to 99% pure carbon. But it does not account for less than 1% of the world's graphite production. The graphite in Sri Lanka was known even back in 1635 when the Dutch governor recorded its existence.

Sri Lankan graphite has been used for a long time in batteries. Now it is also being used in lithium-ion batteries. It will be even more important in the future because shortly all cars are supposed to be fully electric. The vehicles like Tesla use lithium-ion batteries. It takes 20 to 30 times more graphite than lithium to make a lithium-ion battery, so a fully electric automobile uses about 100 lbs. Electric cars are popular, but some people are hesitant to buy them because the battery does not hold much energy, and it takes a long time to recharge and creates a lot of heating. Hence, it is not possible to store much energy. So, people say that if you use graphene and its other forms in these battery anodes, you can get up to 10 times faster recharge rate by improving electron and ion transport. If the battery charging is ten times faster, many more people are willing to buy these electric cars. We know that graphite can give us graphene, which is the sheets of graphite. There are other forms of carbon compounds; if you take a piece of a graphene sheet and roll it into a tube, that is called a nanotube, which was discovered in 1991. Further, if one rolls a sheet to form a ball, that is called a fullerene, which was found in 1995.

Therefore, graphene has given us a new concept, and this is the concept of 2D atomic layer materials. For example, in addition to graphite, many other materials can provide 2D layered structures. The materials like hexagonal Boron nitride (hBN), molybdenum disulfide (MoS₂), and tungsten diselenide (WSe₂) are sheets that loosely bound together. We can use these materials to peel off layers with one atomic layer thickness. Suppose you isolate atomic sheets of these different materials, and then you stack them as you would like to stack based on the theoretical expectations. Then this would lead to materials with properties that you know can not be realized in nature. Perhaps you have engineered new materials. These materials that build up by stacking these atomic layers are going to be flexible and transparent with advanced properties.

There are different ways of fabricating graphene. If you apply scotch tape onto a piece of graphite and peel off the tape, there will be some graphene on the tape called exfoliated graphene. Exfoliated graphene samples tend to be few microns in size. Secondly, people use methane to grow graphene on copper at about 1000 °C using the chemical vapor deposition-CVD method. The CVD technique yields graphene layers of dimensions of few centimeters. Also, graphene can grow epitaxially on silicon carbide surfaces, called epitaxial graphene. Some other methods, such as chemical methods,



are available to prepare graphene or forms of graphene-like graphene oxide. We prepared epitaxial graphene using silicon carbide as the substrate. Our first detection of full spin rest and its electrical depiction technique of graphene was published in nature communications (Link: [Observation of resistively detected hole spin resonance and zero-field pseudo-spin splitting in epitaxial graphene | Nature Communications](#)).

Professor Ramesh G. Mani

Department of Physics and Astronomy

Georgia State University, Atlanta, USA

Members of the Research Committee

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Vulnerability of Commercial Scale Agriculture Farmers to Marketing Aspects during Covid-19: A Case Study of Selected Districts in Sri Lanka

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COVID-19 does not only impact public health, but also it triggered a major economic recession which negatively influenced all the sectors of the economy. The agricultural sector and agricultural markets are no exception. Although agricultural activities are supposed to be smoothly continued, COVID-19 containment measures cause a huge impact on food production and distribution in Sri Lanka. Small and Medium Enterprises (SME) including commercial scale farmers were among the most affected group. This study was designed to investigate the impact of COVID-19 on the marketing aspects of commercial farmers and their coping strategies. Forty agribusiness entrepreneurial farmers in *Ratnapura, Kandy, Nuwara Eliya* and *Badulla* Districts were selected by snowball sampling technique. Telephone and online questionnaire surveys were conducted to gather primary data. Data analysis was done using descriptive and inferential statistical methods. According to the results, respondents largely grow five types of vegetables: Salad cucumber (*Cucumis sativus*) (70%), Bell-pepper (*Capsicum annuum*) (32.5%), Tomato (*Solanum lycopersicum*) (45%), Lettuce (*Lactuca sativa*) (13%) and Chilli (*Capsicum annuum* 'Serrano') (2.6%). The main markets for their produce were hotels (56%), nearby restaurants (24%), dedicated economic trade centers (17%) and retails (3%). Reduction in sales was reported by 90% of respondents who were in the harvesting stage and Paired t-test confirmed a significant reduction in sales ($t=4.267$, $p<0.05$). The causes were identified as lack of transport facilities (92%), closure of hotels, restaurants and dedicated economic trade centers (88.6%) and inability to deal with middlemen (12.3%). A few amounts of the harvest have been sold by market alteration into direct selling home delivery vehicles (78%) and nearby fresh markets (12%). Although the government permitted to transport of vegetables during curfew hours, respondents have experienced a 50-60% of post-harvest loss during transportation. Further, a price reduction was reported for certain varieties of vegetables grown by these commercial farmers and the paired t- test confirmed the farm gate price reduction as significant ($t=3.89$, $p<0.05$). As for coping strategies, farmers have adopted new market orientation, nearby supermarkets, (75%), orientation for new dealers (70%) and home consumption of the produce (30%). The study recommended the need for a smooth continuation of market-related aspects and practices to strengthen the commercial scale farmers in Sri Lanka.

Keywords: Agriculture; Commercial farmers; COVID-19; Marketing; Sales

Analysis of Allelic Diversity of Drought Responsive ERF Genes in Sri Lankan Rice Germplasm

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Ethylene response factor (ERF), is a prominent transcription factor gene family that governs numerous abiotic stress-related physiological activities in plants. Drought is the foremost yield-limiting factor of the second-largest staple crop of the globe. Bioinformatics tools provide a robust platform to investigate the genetic characteristics towards rice plant drought responses. The present study aimed to analyze the allelic variations of *OsEBP89*, *OsERF101*, *OsERF71*, *OsERF48*, *OsERF12* and *OsLG3*; drought-responsive ERF genes *in silico* within the Sri Lankan rice pool. Genes were selected from the Rice Annotation Project (RAP) database concerning *Oryza sativa* sp. japonica cv. ‘Nipponbare’ as the reference genome. Selected gene sequences of 47 Sri Lankan rice varieties were retrieved from the Rice SNP-Seek database and allelic variation was assessed concerning the corresponding gene sequences of Nipponbare using MEGA 7- Clustal W method. Present Results revealed several InDels and SNPs: 6 SNPs in *OsEBP89* (A/G at 15nt, G/T at 380nt, C/T at 381nt, T/A at 555nt, C/T at 709nt and G/T at 951nt), 1 InDel and 3 SNPs in *OsERF101* (C/A at 87nt, A/G at 687nt and C/T at 725nt), 8 SNPs in *OsERF71* (C/A at 118nt, G/A at 360nt, C/T at 623nt, G/A at 742nt, G/T at 849nt, C/T at 867nt, T/C at 939nt and G/A at 981nt), 1 InDel and 5 SNPs in *OsERF48* (C/G at 655nt, G/Tat 768nt, C/G at 812nt, C/T at 1112nt and G/C at 1162nt), 1 InDel and 5 SNPs in *OsERF12* (G/T at 41nt, C/T at 150nt, G/A at 336nt, C/G at 365nt and C/T at 957nt) and 3 SNPs in *OsLG3* (C/T at 293nt, C/T at 487nt and A/G at 810nt). The MEGA 7 assisted phylogenetic analysis unveil apparent allelic variation within the Sri Lankan rice germplasm. The encoded proteins of *OsERF101*, *OsERF48* and *OsERF12* genes were subjected to secondary structure prediction and physicochemical analysis. The Physicochemical properties varied among structures of corresponding proteins. However, major differences in folding patterns were not observed. Functional characterization and phenotypic validations are essential to investigate the potential of these genes in drought-tolerant rice improvement programs.

Keywords: Allelic variation; Drought stress; Ethylene Response Factor; Rice

Modified Planting System for the Quality Improvement of Cinnamon Quills

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Though Sri Lanka is the largest supplier in the global cinnamon market, majority of exported cinnamon quills are categorized as lower grade with lower export value. Export earnings can be enhanced by increasing the production of higher grade quills. By altering the current production system, stems suitable for higher grade quills (medium girth, long and straight) can be produced. This study was conducted to identify the effect of spatial pattern, type of planting material and harvesting interval on stem structure of cinnamon in order to produce higher grade quills. Seedlings and vegetatively propagated plants (VP) of cinnamon; variety Sri Gemunu were planted under three spatial patterns as (A) 1.2×0.6 m with three plants per hill, (B) 1.2×0.4 m with two plants per hill and (C) 1.2×0.2 m with one plant per hill at the Faculty of Agriculture, University of Ruhuna, Sri Lanka. Stems were harvested in two planting intervals as 6 and 8 months and height, top diameter, bottom diameter and average diameter were recorded. Study was conducted under 3 factor factorial split plot design with 4 replicates. The results revealed that, interaction effect among 3 factors was not significant ($p < 0.05$) for stem height or diameter. Interaction effect of spatial pattern and planting material along with planting material and harvesting interval were significant ($p < 0.05$) for stem height. Height of seedlings harvested in 8 months interval (2nd harvest: 205.61 cm, 3rd harvest: 235.14 cm) was significantly higher ($p < 0.05$). Simultaneously, seedlings established in spatial pattern C were produced significantly longer stems (2nd harvest: 202.72 cm, 3rd harvest: 238.99 cm) ($p < 0.05$). Any interaction effect or main effect were not significant ($p < 0.05$) for top diameter of stems. Bottom diameter of stems harvested in 8 months interval during 2nd harvest (24.44 mm) were significantly higher ($p < 0.05$) than plants harvested in 6 months interval (21.31 mm) though the effect was not significant during the 3rd harvest. VP produce stems with significantly higher ($p < 0.05$) bottom diameter (2nd harvest: 26.87 mm, 3rd harvest: 33.75 mm) than seedlings (2nd harvest: 18.88 mm, 3rd harvest: 29.78 mm). Average diameter of VP (2nd harvest: 26.71 mm, 3rd harvest: 28.80 mm) was significantly higher ($p < 0.05$) than seedlings (2nd harvest: 18.31 mm, 3rd harvest: 23.76 mm) while average diameter of stems harvested in 8 months interval (2nd harvest: 23.97 mm, 3rd harvest: 27.90 mm) were significantly higher ($p < 0.05$) than stems harvested in 6 months interval (2nd harvest: 21.07 mm, 3rd harvest: 24.66 mm). Findings of this study can be used for production of higher-grade cinnamon quills and further quality enhancement studies of cinnamon.

Keywords: Cinnamon; Higher grade quills; Seedlings; Spatial pattern; vegetatively propagated plants

Evaluation of Anti-oxidant Properties of Four Sri Lankan Traditional Red Rice Varieties

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Rice grains with red pericarp tend to present relatively higher antioxidant activity than those with light brown pericarp colour because of their rich anthocyanin and proanthocyanidin content. Currently, large numbers of local rice breeders and consumers are interested in red rice varieties due to their potential health benefits provided through strong antioxidant properties. The current study aimed to assess the antioxidant properties of four selected traditional red rice varieties in Sri Lanka, namely, *Pachchaperumal*, *Kaluheenati*, *Suduheenati* and *Madathawalu*. The extracts obtained from rice brans were examined for their total phenolic content, DPPH radical scavenging activity, total proanthocyanidin content, total flavonoid content and total anthocyanin content. Total phenolic content was examined in both soluble and bound fractions using the Folin-Ciocalteu's method. DPPH radical scavenging activity from bound fraction was assessed using 0.1 mM DPPH solution. The results were analyzed using One-Way Analysis of Variance (ANOVA) followed by Turkey's pair-wise test as the post-hoc analysis. The amounts of phenolics in the soluble fraction were much higher than those in the bound fraction of these four red rice samples. According to the results, *Kaluheenati* showed the significantly highest value ($p < 0.05$) for total phenolic content (soluble: 54.49 mg gallic acid equivalents /100g; bound: 24.31 mg gallic acid equivalents /100g) and total proanthocyanidin content (138.15 mg catechin equivalent /100g), while *Madathawalu* showed the significantly highest ($p < 0.05$) value for DPPH radical scavenging activity (73.5 %) and total anthocyanin content (24.57 mg cyanidin-3-glucoside equivalents /100g). The highest value for total flavonoid content was examined in a variety of *Pachchaperumal* and it was 183.59 mg quercetin equivalents/100g. According to the present results, it could be speculated that *Pachchaperumal* may contain a higher amount of other flavonoids compared to anthocyanins. And also the promising contribution of total anthocyanin content and proanthocyanidin content for higher antioxidant activity was indicated by the present results. In conclusion, according to the present study, both *Kaluheenati* and *Madathawalu* exhibited the highest overall antioxidant properties, than the other tested varieties. Further studies are required to conduct with increased sample sizes along with different extraction systems, to explore the nutritional values.

Keywords: Anthocyanins; Antioxidant; Proanthocyanidins; Traditional red rice

Different Organic Sources as Germination Enhancers of Selected Seeds and as Components of Fertilizer Formulation for a Test Crop

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Farmers tend to use inorganic fertilizers in excess amount for getting high yield. Excess application of inorganic fertilizer is detrimental. In this background a study was undertaken to formulate a low-cost organic fertilizer and examine the effectiveness of Spirulina, Azolla and formulated organic fertilizer (FOF) on germination and seedling vigor of Curry Chilli, Green Chilli, Water spinach and Sugar graze and to evaluate the effect of FOF on growth and yield of Sugar graze. The organic fertilizer was formulated based on nutrient analysis, using dry powders of Spirulina, Azolla, and three underutilized resources, namely Palmyrah leaf, Coconut leaf and Banana pseudostem. The germination experiment was carried out with three replicates in Complete randomized design (CRD) with five treatments namely T1 - FOF, T2 - dry Azolla powder, T3 - dry Spirulina powder, T4 - live Spirulina culture and T5 - Control (Distilled water) . A pot experiment was conducted in net house to find the response of Sugar graze for different fertilizer combinations. Treatments were T1 - control (no fertilizer), T2- 100% inorganic (NPK-2.7, 1.8, 0.9 g/pot), T3 - 50% inorganic(NPK-1.35, 0.9, 0.45 g/pot), T4 - 100% organic (cattle manure - 540 g/pot), T5 - 50% organic (cattle manure - 270 g/pot), T6 - 50% inorganic (NPK-1.35, 0.9, 0.45 g/pot) + 270 g FOF and T7 - 50% organic (cattle manure - 270 g/pot) + 270 g FOF. Design was CRD with two replicates. Nutrient uptake of the plants, plant height and yield were measured. The recorded data were statistically analysed using Analysis of Variance and treatment means were compared using Duncan's multiple range test. Result showed that soaking with Spirulina, Azolla and FOF improves the germination (5 -15%) and seedling vigour (12-53%) compared to control in all selected seeds. T6 (50% inorganic + FOF) and T2 (100% inorganic) recorded the same average value in height (210 cm), which was the highest among treatments. T4 (100% organic) recorded the highest value in potassium (34.34 g/plant) uptake. T7 (50% organic + FOF) recorded the highest values in nitrogen (0.82 g/plant) and phosphorous (2.18 g/plant) uptake and fresh biomass yield (158 g/plant) and dry biomass yield (41 g/plant). This finding indicates that by substituting 50% of organic or inorganic fertilizer with FOF, either similar or higher performance of sugar graze compared to 100% organic or inorganic treatments can be obtained.

Keywords: Azolla; Formulated organic fertilizer; Seed vigour; Spirulina; Sugar graze

Effects of a Novel Starter Feed on Growth Performances of Underweight Broiler Chicks

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This study was carried out to evaluate the effects of a novel starter feed for underweight broiler chicks to achieve the expected growth performances and feed conversion ratio (FCR) than the available commercial starter ration. The novel starter feed was formulated with addition of 3% digestible lysine, Bioplex organic mineral and organic acid (Avila Zn) at a rate of 750 g and 330 g per metric tons of feed respectively with other essential amino acids compared to Pussalla Feed Broiler Starter Crumble. The control feed was basically formulated with corn and soya bean meal without addition of organic mineral and organic acid. In this present study, a feeding trail was conducted using underweight (32.48 ± 1.79 g) day old Hubbard Classic chicks (1200) by providing *ad libitum* of two types of starter feed to each 12 groups having 50 birds. The two groups of underweight chicks were fed with two starter feed up to 14 days and the Pussalla Feed Broiler Finisher Pellet was fed on 14-33 days to both groups. Daily feed intake, weekly body weight, FCR and mortality of underweight broiler chicks were recorded during the experimental period. The experimental design was Complete Randomized Design and data were analyzed by using one way ANOVA. Proximate analysis, sugar, starch and metabolizable energy were not different ($p > 0.05$) in two starter rations. The results revealed that the novel starter feed directly influenced to higher weekly weight gain of broiler chicks at 7 and 14 days as 11.70% and 21.95%, respectively while lower FCR at 7 and 14 days as 20.48% and 13.33%, respectively compared with the control group ($p < 0.05$). The novel starter fed chicks had lower ($p < 0.05$) mortality ($3.0 \pm 0.01\%$). Thus, it can be recommended as a solution for low growth performance of underweight chicks and reduction of profit losses of Pussalla Broiler Farm in economically when compared to previous farm records of growth performances.

Keywords: Feed conversion ratio; Feed intake; Growth performance; Starter feed; Underweight chicks

Rice Industry in Sri Lanka: Challenges, Opportunities, and Implications

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Sri Lanka provides an interesting example of a country with a long-standing, national self-sufficiency policy that has generally been aimed at improving all food crops and particularly for rice production. Although the country is currently able to meet domestic demand for rice, there is a considerable importation that has been highly volatilizing during the past years due to some uncertain reasons. It is unclear whether the country can further rely on domestic production due to projected population growth and change in preferences. On the other hand, current rice yields are also approaching the highest crop yield that a farmer can attain in each climate using conventional technologies. Therefore, it is important for the country to take stock of what the projected demand may be and whether rice production can respond to meet this demand. The aim of this study is to assess the future of the rice industry through production, consumption, export, and import during the last two decades to evaluate the challenges, opportunities, and implications in policy changes and development of the rice industry in Sri Lanka. Data were collected through three secondary sources: the U.S. Department of Agriculture, the International Rice Research Institute, and the Food and Agriculture Organization of the United Nations. The relationship of rice production and total consumption with the time was analyzed by using the goodness of fit for both the long and short run. A polynomial quadratic equation was used to analyze the trends in production, consumption, export, and imports. Based on the results, rice production is decreasing while the long-run consumption is increasing. Subsequently, the forecasted values for imports were increasing too. This is a kind of vicious cycle to be broken through the high production of demanded rice varieties. A major reason for the rice importation is not just the low production, but the lack of production of high demanded rice varieties which are not much produced in Sri Lanka. Therefore, identifying demanded varieties, favourable conditions, imposing import barriers, and shifting consumer preferences towards domestic varieties through marketing strategies are also crucial decisions to be taken.

Keywords: Forecasting; Rice import and export; Rice production and consumption; Rice self-sufficiency

Repellent Effect and Qualitative Phytochemical Analysis of Lemongrass (*Cymbopogon citratus*) and Waterhyacinth (*Eichhornia crassipes*) against Cowpea Beetle (*Callosobruchus maculatus*)

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Cowpea (*Vigna unguiculata*) is the most economically important leguminous crop in the worldwide, it is vulnerable to the infection of seed by cowpea beetle (*Callosobruchus maculatus*) in storage. The application of synthetic insecticide for the control of such insect pest leads to numerous hazardous effect of environment and human. Thus aim to identify the botanical products to control the *C.maculatus*. Lemongrass widely used as a medicinal herb in Sri Lanka. It has a subtle citrus flavor and can be dried and powdered or used fresh. In Sri Lanka water hyacinth (*Eichhornia crassipes*) is most problematic invasive aquatic weed. Therefore the study has been conducted to confirm the presence of insecticidal properties in this weed in order to use the weed in a beneficial manner rather destructing without any benefits. The purpose of this research is to do the phytochemical analysis and compare the secondary metabolites present in both plants and the repellency ability of powder and methanol extract of both plants. Selected plants were sun dried and pulverized into fine powder. Powders were dissolved in methanol to produce the extract. The powder and methanol extract were used for the bioassay. All the experiments were done at the laboratory condition at 28-30^oC temperature and 74-80%RH. Repellency was evaluated by observing the behavior of beetles exposed to treated and untreated seeds in choice chamber and using petridish method. All this extracts and powders showed varying degree of repellent activity against cowpea beetle. However lemongrass methanol extract showed significantly higher repellent activity against beetles in choice chamber method (1.66) and petridish method (0.00), during storage time. The phytochemical analysis stated that the methanol extract of lemongrass had more phytochemicals, namely phenols, tannin, terpinoids, quinones, steroids, glycosids, reducing sugar, and flavanoids than the water hyacinth methanol extract.

Keywords: Cowpea beetle; Lemongrass; Water hyacinth; Methanol form; Powder form

Phytochemical Profile and Repellent Potential of Selected Medicinal Plants against Pulse Beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae)

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The present study was conducted to screen the secondary metabolite constituents and to evaluate the repellent potential of selected medicinal plants against the *C.maculatus* infesting the stored seeds of green gram under laboratory condition ($30 \pm 2^{\circ}\text{C}$ and $70 \pm 5\%$). Repellent potential of 1% *Acorus calamus* L. rhizome powder, 1% *Piper longum* L. fruit powder, and 1% *Aloe vera* L. aqueous extract were tested according to a free choice bioassay method. The plastic vial fixed at one end of the straw was supplied with treated seeds and the other end supplied with untreated seeds. The hole in the middle portion of each straw, 5 pairs of 1-2 days old *C.maculatus* introduced and covered with adhesive tape. The experiment was laid out in a complete randomized design consisting of three treatments with seven replications. The results revealed that almost all treatments had significant ($p < 0.05$) repellent potential against *C.maculatus* infesting green gram seeds. Among them, *P.longum* powder treated seeds revealed higher mean repellent potential (81%) against the *C.maculatus*. *A.vera* aqueous extract showed least mean repellency (18%) and their repellency rate was 5% after 5 hours of introduction. Phytochemical screening of the aqueous extract of *P.longum* and *A.calamus* revealed the presence of alkaloids, flavonoids, steroid, triterpenoid, cardiac glycoside, saponin, and tannins except phenols, and anthraquinones while *A.vera* showed the presence of alkaloid, phenol, and cardiac glycoside. *P.longum* fruit powder possessed the highest repellent potential and will be more effective in control and management of *C.maculatus*. However, further studies are necessary to identify the biologically active components which are responsible for the repellent potential of these selected medicinal plants.

Keywords: Repellent potential; Free choice bio assay; *Callosobruchus maculatus*; *Piper longum*; *Acorus calamus*; *Aloe vera*.

Impacts on Leaf Area Index, Plant Dry Weight and Yield as Influenced by Salinity Stress in Brinjal (*Solanum melongena* L.) Cultivars

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Brinjal is an important vegetable which is quite popular and widely cultivated crop, mostly grown in the rainy season. In Sri Lanka, brinjal is commonly cultivated in Jaffna, Batticaloa, Polannaruwa and Moneragala districts. In the Batticaloa district, brinjal is widely grown in Kaluthavalai, Vaharai and Eravur areas. Large extent of brinjal cultivation in Kaluthavalai area is affected by salinity. The literature that exists on egg plant's tolerance to soil salinity is contradictory; some are classified as moderately sensitive, whereas others reported that it is sensitive to water stress caused by salinity. Considering this, an experiment was conducted in the Sandy Regosols of the Batticaloa district to evaluate salinity response of 'Thirunelvely Purple', 'Palugamum White' and 'Padagoda' brinjal cultivars on the Leaf Area Index (LAI), plant dry weight and yield. A concentration of 100mM NaCl solution was applied for the treated plants and distilled water used as control treatment. The treatments were 100mM NaCl solution for the 'Thirunelvely Purple' (T₂), 'Palugamum White' (T₄) and 'Padagoda' (T₆) brinjal cultivars and distilled water for the 'Thirunelvely Purple' (T₁), 'Palugamum White' (T₃) and 'Padagoda' (T₅) brinjal cultivars were applied to Field Capacity at 3 days interval during the experimental period. This experiment was laid out in the 3 x 2 factor Factorial Randomized Complete Block Design with four replicates. The results showed that salt stress significantly ($p < 0.05$) reduced the LAI of all the tested brinjal cultivars. The highest LAI (0.55 ± 0.02) was obtained in the 'Thirunelvely Purple' and the lowest (0.23 ± 0.01) was found in the 'Palugamum White'. Salt stress significantly ($p < 0.05$) reduced the plant dry weight of the tested brinjal cultivars. The highest plant dry weight (126.4 ± 1.52 g) was found in the 'Thirunelvely Purple' and the lowest (79.8 ± 0.92 g) was recorded in the 'Palugamum White'. Salt stress significantly ($p < 0.05$) reduced the yield of the brinjal cultivars. The highest yield (20.1 ± 0.34 t/ha) was obtained in the 'Thirunelvely Purple' and the lowest (11.3 ± 0.21 t/ha) was found in the 'Palugamum White'. Therefore, this study concludes that 'Thirunelvely Purple' brinjal cultivar exhibited the highest growth performance under saline condition and was identified as the most salt tolerant cultivar compared to the other tested ones.

Keywords: Brinjal; Leaf Area Index; Plant dry weight; Salt stress; Yield

Effect of Seaweed Extract (*Sargassum wightii*) on Seedling Growth Promotion in the Long Bean (*Vigna unguiculata*) Hawari verity

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Growth in the human population urges the need for increment in food production. This leads to indiscriminate use of synthetic and chemicals for their agricultural lands resulting are highly toxic to the environment and soil. Our study aims to develop a seaweed extract from commonly available seaweed *Sargassum wightii* to enhance the plant growth promotion in the Hawari verity Long bean (*Vigna unguiculata*). The seaweed extract was treated at six different levels of T₁ – 0%, T₂ – 5%, T₃ – 10%, T₄ – 15%, T₅ – 20%, and T₆ –25% for long bean Hawari verity. The extraction was used to check the seed germination percentage and shoot length, root length, the number of leaves was measured at 4th, 8th, 12th and 16th days after transplanting. The highest seed germination percentage of 94.44% was observed in T₄ whereas the lowest of 56.64% was observed in T₆. The highest shoot length of the seedling was observed in T₅ and lowest in T₁. Similarly, the highest root length (7.07±0.42 cm) was observed in T₅ and the lowest (6.00±0.51cm) in T₁ on the 16th day. The highest (6.46±0.51) and lowest (5.46±0.51) number of leaves were observed in T₅ and T₁. The results suggest that 20% *Sargassum wightii* extract enhances the germination and growth of Hawari verity seedling on *Vigna unguiculata*. *Sargassum wightii* extract can be used in organic agriculture.

Keywords: Long bean; Organic fertilizer; Seaweed extract; Seed germination; Seedling growth

Entrepreneurial Skills of Vegetable Farmers on Farming Performances in Polgahawela Divisional Secretariat Division in Sri Lanka

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Agriculture is a dominant field in Sri Lanka as the vegetable cultivation is a major part of it. This study was conducted to find out the relationship between entrepreneurial skills and the farmers' performance which are measured by productivity and financial performance. This is a quantitative research and accordingly, deductive approach has been applied in the study. A survey method was employed. Researchers administered questionnaire was used in the data collection process from 7th September 2020 to 20th September 2020. Simple random sampling was used as the sampling technique. Polgahawela DS division in Kurunegala district is the study area of this research. Vegetable farmers in Polgahawela DS division were selected as the target population and five Grama Niladari divisions (GN) were selected randomly from the study area. Hundred farmers who cultivate vegetable were selected and it consists of twenty (20) vegetable farmers from each GN division. SPSS statistical software was used to analyze the data and Reliability Analysis, Multiple Linear Regression Models including Diagnostic Tests were used as analytical techniques. Reliability Analysis represents the internal consistency of the likert scale items and Cronbach's Alpha was applied. Multiple regression models were applied to test the effect of entrepreneurial skills of farmers on farming performances and to test their individual and joint effect. Several diagnostic tests were applied to test the validity of the regression results and they are Heteroscedasticity, Multicollinearity, Normality and independent of the residuals. According to the results opportunity seeking, risk taking and decision making are highly significant and they are influencing positively on farmers' performance. Decision making ability is the most influencing factor. Secondly opportunity seeking and thirdly risk taking skill effect on farmer-performance. Innovation was individually insignificant and it influenced jointly with other factors on farmers' performances. Higher entrepreneurial skills give higher performances. Researchers suggested that authorities of agriculture in Sri Lanka should take necessary initiatives to improve and develop farmers' entrepreneurial skills to enhance the farmer-performance in Sri Lanka.

Keywords: Agriculture; Entrepreneurial skills; Farmers; Performance; Sri Lanka

Phytochemical Screening, Quantitative Analysis and *In Vitro* Cytotoxic Potential of *Justicia adhathoda* Leaf Extracts

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Justicia adhathoda L., also known as “*Adhathoda*” is one of the widely used medicinal plants in indigenous medicinal systems in Sri Lanka and India. Previous studies have found several beneficial effects of different solvent extracts of this plant. However, the best solvent to extract much of the phytoconstituents has not been studied. Therefore, the present study was focused on identification, quantification of phytoconstituents in different crude extracts and *in vitro* cytotoxic effect of *J. adhathoda*. Plant leaves were collected from Ambilipitiya, Sri Lanka. Ethanol (EE), hexane (HE) and water (WE) extracts were prepared by adding 1 g of powdered leaf samples to 25 mL of ethanol (99.9%), *n*-hexane and distilled water, separately in triplicates. Preliminary phytochemical screening was performed according to the Harborne method. Total phenolic content (TPC) was measured spectrophotometrically by Folin-Ciocalteu assay and total flavonoid content (TFC) was determined using aluminum chloride colorimetric assay. To identify the toxicity level of *J. adhathoda*, different concentration of the WE were exposed to 3T3-L1 cells, a well-established cell culture model that is extensively used to study adipogenesis. The treatment was carried out for 8 days and performed MTS assay to determine the suitability of the WE consumption. Phytochemical screening results showed the availability of flavonoids, terpenoids, steroids, anthocyanins, alkaloids and coumarins in the WE. In contrast, tannin and alkaloids were abundant in the EE. TPC in the WE was 8-fold higher than the EE. The TFC in the EE was 20-fold higher than HE, and marked the highest. Collectively, the best solvent to extract the maximum amount of phytoconstituents was found as distilled water. The WE showed no toxicity below 500 µg/mL against 3T3-L1 adipocytes. The presence of high content of different phytoconstituents in WE of *J. adhathoda* is a great advantage to gain the health benefits as herbal tea or herbal porridges. These results provide referential information to identify the medicinal value of *J. adhathoda* and to be utilized in screening novel target compounds to treat various diseases.

Keywords: *Justicia adhathoda*; phytochemical analysis; Medicinal plant; TFC; TPC; 3T3-L1

Systematic Review of Rooftop Agriculture in South and South East Asia: A Means to Achieve Urban Sustainability

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Humanity in the 21st century deliberately evolves them as urban species resulting pressing issue of food security during a time where available fertile land is minimal. Rooftop gardens are gaining relevance at such phase as they have the potential to meet the growing demand of nutritional needs in cities and enhance the ecosystem services along with the social capital. Yet, there is no adequate researches done and research literature available to understand how cities can achieve sustainability via urban rooftop agriculture. Our primary intention was to do an in-depth analysis of how South Asian and South East Asian countries have achieved urban sustainability through rooftop farming interventions. Ergo, thirteen parameters were used to evaluate three bottom lines of sustainability. Thirty papers were selected from the digital databases of Science Direct, Elsevier, and Academia Education for this systematic review. Selected literature comprised of studies from Bangladesh, India and Nepal representing South Asia and Malaysia, Singapore and Vietnam representing South East Asia. Regardless of region or country, findings revealed that the selected research literature supports more environmentalism aspects signifying the reduction of carbon foot print followed by food security cum self-reliance and climate change adaptation. Overall sustainability was best achieved by India showing the highest achievement in all the above dimensions. Environmentalism accounted for 43% of overall rooftop sustainability providing a strong sense of environmental security for both humans and the natural environment. Our in-depth analysis done at the regional level indicated that South Asia is achieving much from rooftop agriculture to enhance food security and self-reliance while South East Asia is concentrated on economic gain specifically focusing on extra cost saving through rooftop agriculture practices. The way forward promoting rooftop farming in cities need outreach programs, capacity development and policy interventions and nations must foster research partnerships, collaborations and investments. Moreover, it is essential to have a productive mechanism to disseminate the regional success stories and best practices among local urban communities to transform their rooftops into more conducive communal spaces.

Keywords: Rooftop agriculture; South and South East Asia; Urban; Sustainability

Managerial Implications of Product Harm Crisis: A Review

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A product-harm crisis is one of the worst nightmares prevailing in the market place that creates a threat to human lives as well as the company reputation and equity of brands. Therefore, the whole world struggle with how to best manage the product harm crisis. Hence, a systematic review of scientific articles was conducted using popular bibliographic databases by capturing relevant empirical studies which evaluating the product harm crisis management practices utilized to mitigate societal damages and to secure intangible assets. The study suggests that implementing a total quality management system (TQM) and organizational complaint management, developing online software to monitor customer response, reengineering the company work and building cross-functional teams, learning and evaluating the past and envisioning the future while detecting the weak signals become fruitful strategies to mitigate societal damages. Accordingly, global crisis management involving three phases including the pre-crisis phase, crisis phase and post-crisis phase in order to efficient management of product harm crisis. Past literature directs that protecting loyal consumers via building customer satisfaction, initiating customer relationship management (CRM), developing 3Vs' approach that includes defining the value of customer segment, proposition and the network that will deliver will secure the brand equity and company reputation. Moreover, specific managerial implications concerning the valuation of Consumer Based Brand Equity in a product harm crisis, customer-oriented bottom-up approach and the consumer's sense of control yield productive results in the management of product harm crisis. Most interestingly, past scholars have repeatedly documented that product harm crises are ethical issues and consumers' cultural variation is of utmost importance in crisis response strategy in particular. Finally, maintaining efficient financial records and pre-planned crisis agendas seem vital to the management of financial status in the product harm crisis context. However, the study concludes that further efforts are required to establish a holistic framework applicable to all cultures which is vital from a managerial perspective and managers should treat a product harm crisis as an ethical issue and attempt to understand moral perceptions of consumers by implementing moderating roles of brand attitude, brand trust and perceived quality of the brand.

Keywords: Brand Equity; Management Implications; Product Harm Crisis; Reputation; Societal Damages

Assessment of Compost Quality Produced with Municipal Solid Waste and Dewatered Fecal Sludge: A Case Study

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Application of Municipal Solid Waste (MSW) and Dewatered Fecal Sludge (DFS) compost for agriculture is promoted in many countries as a waste management strategy. The quality of any compost type and its suitability for agricultural application is mainly determined by its physical and chemical properties and the absence of risk factors such as heavy metals and pathogens. In this study, MSW and DFS compost samples collected from the Kuliyaipitiya Municipal Council of the North Western Province of Sri Lanka were subjected to quality testing using standard methods. The results were compared with the standards specified under SLS 1635: 2019 for MSW compost and with the reported information for the other locally available organic manure types. The acidic pH of DFS compost reported in this study indicates the risk of its direct use as a soil amendment while the MSW compost showed a satisfactory pH, suitable for soil application. The macro nutrient contents (Phosphorus, Potassium, and Magnesium) of both compost types were very low except for Nitrogen and Calcium. Micro nutrient levels in both compost types were satisfactory where DFS compost was rich in Iron, Zinc and Copper indicating its potential to be used as a micro nutrient source with further development. High sand percentage in MSW compost and the presence of weed seeds in DFS compost reduces the overall quality of both compost types. The organic carbon (OC) content in MSW compost was at a satisfactory level but the DFS compost had a low OC content. Pathogens were not detected in both compost types. MSW compost showed lower levels of heavy metals than the permissible standard limit defined for MSW compost. However, DFS compost showed higher level of Mercury than the permissible standard limit for MSW compost which highlights the risk of its use as an agricultural soil amendment. In contrast, with its satisfactory OC content and the pH and the absence of pathogens and viable seeds, MSW compost has the potential to be used as a soil conditioner for soil quality improvement, but not as a nutrient source, as it has a low macro nutrient content.

Keywords: Dewatered Fecal Sludge Compost; Heavy metal content; Municipal Solid Waste Compost; Macro and micro nutrient contents

Effect of Temperature on Mono and Dual Species Biofilms Formed by *Salmonella*, *E. coli* and *Proteus* spp.

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Biofilms are microbial communities encased with self-producing extracellular matrix, composed with polysaccharide, DNA and protein. Persistent survival capability of these biofilms in food contact surfaces cause contamination of food batches and pose health risk among the public. The biofilm formation is affected by several environmental factors such as temperature and humidity etc. This study was conducted to investigate the effect of temperature on biofilms formed by *Salmonella*, *E. coli* and *Proteus* spp. when they are present as mono species and in combinations. Organisms were incubated at two different temperatures (28^oC and 37^oC) for 120 hr and biofilm formation was quantified using microtiter plate method at different time points as 24 hr, 48 hr, 72 hr, 96 hr and 120 hr. Biofilm formation at 24 hr by *Proteus* spp. with *Salmonella* and *E. coli* (i.e. *Proteus* with *E. coli* and *Proteus* with *Salmonella*) were higher in the temperature of 28^oC compared to 37^oC. There was no significant effect of temperature on mono species biofilm at 24hr incubation period. At 48 hr, biofilm formation by *Salmonella* together with *Proteus* and *E. coli* (*Salmonella* with *E. coli* and *Proteus* with *Salmonella*) and by *Salmonella* alone was higher at 28^oC than that of at 37^oC. At 48 hr, *Proteus* and *E. coli* alone did not exhibit significant ($p > 0.05$) difference in biofilm formation at 28^oC and 37^oC. At 72 and 96 hr, the biofilm formation by *Proteus* and *Salmonella* alone and *Salmonella* together with *Proteus* (*Proteus* with *Salmonella*) showed higher biofilm formation at 28^oC than at 37^oC. But *Proteus* with *E. coli*, *Salmonella* with *E. coli* or *E. coli* alone did not exhibit any significant ($p > 0.05$) effect of temperature. At 120 hr, all the organisms alone and their combinations showed significantly higher biofilm formation at 28^oC than at 37^oC. This study concluded that temperature and time significantly ($p < 0.05$) affect on biofilm formation by *Salmonella*, *E. coli* and *Proteus* spp. individually and as combinations. This study revealed that biofilm formation at 28^oC is higher than their optimal growth temperature (37^oC).

Keywords: Biofilm; *E. coli*; *Proteus*; *Salmonella*; Temperature

The Evidence of Agricultural Self-Employment Decisions Making in Sri Lanka

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Development of self-employment in agriculture sector is one of the critical pathway to achieve sustainable economic growth and alleviate poverty in Sri Lanka. Distinguishing the importance, Sri Lankan government's policy framework is designed to supports the domestic agricultural sector especially, agricultural self-employment. However, the employed worker population in non-agriculture sector has surpassed the agriculture sector by absorbing the agriculture workers to both industry and service sectors. In consequence, there is a potential for these policies promoting agricultural self-employment might fail to generate the expected results. Therefore, this study was designed to determine factors influencing choice of occupation in agriculture self-employment. A sample of 9,531 self-employed individuals were isolated from the nationally representative, Household Income Expenditure Survey in 2016. A multinomial logit model was estimated to analyze different occupational choices of agriculture self-employment. Results revealed that males are highly tend to be self-employed in farming and fishery sector while females are in animal husbandry and value-added food processing. Well-educated individuals are less inclined to choose agricultural self-employment with the aim of engage in high paid-employments in both agriculture and non-agriculture sector. In addition, increasing members of household inversely influenced on choice of agricultural self-employment. Married women are more likely to be self-employed in value-added food processing. With the existing higher uncertainty, relative investment of owned tenure on agriculture self-employment is very low. However, except farming sector, land holdings showed strong negative relationship with self-employment in fishery, animal husbandry and value-added food processing. In addition, as household expenditure increases, the probability of choosing agriculture self-employment reduces. Moreover, being in a low financial position & inability to obtain required credit facilities are the main hurdles to be faced in land acquisition for the agriculture self-employment. Therefore, the study suggests that the priority given for the agricultural self-employment when implementing national policies is limited despite the overarching considerations and should consider enhancing access to agricultural lands, rehabilitation of left alone agricultural lands and facilitating credit especially to the new labor market entrants.

Keywords: Agricultural self-employment; Choice of occupation; Determinants of agriculture self-employment; Multinomial logit model

Effect of Different Fertilizers on Growth Performance and Yield of Lanka Sour Tomato (*Solanum lycopersicum* L.)

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Tomato cultivation in Sri Lanka is an intensive and highly commercialized system. The continuous application of inorganic fertilizers leads to a decline of soil characteristics, accumulation of heavy metals in plant tissue, and harm to human health. Application of organic fertilizers a noble and eco-friendly practice to maintain sustainable soil fertility. Currently, there is an emerging trend towards the consumption of organically produced fruits and vegetables. The present study was performed to study the effect of different fertilizers on the growth and yield performance of Lanka Sour tomato, a traditional tomato variety, which has been poorly studied in Sri Lanka. Tomato was cultivated inside a protected house at Uva Wellassa University, Sri Lanka. The experiment was laid out in a Completely Randomized Design with five treatments and five replicates. The treatments consisted of control (No fertilizer) (To), inorganic fertilizers (Urea, TSP, and MOP according to Department of Agriculture recommendations) (T1), compost (T2), poultry manure (T3), and cow dung (T4). Topsoil and sand (1:1) were used as the potting mixture. The pH, electrical conductivity, available nitrogen (N), phosphorus (P), and exchangeable potassium (K) were analyzed in the potting media. The compost consisted of cattle manure, green manure, coir dust, dolomite, hay, and gliricidia. The highest nutrient composition (N-3.3%, P-4%, and K-3.1%) was recorded in compost. Under growth parameters, plant height, number of leaves, number of branches, stem girth, chlorophyll content of leaves, root dry weight, and root length were measured. The number of flowers per plant, number of fruits per plant, fruit weight, fruit pH, and total soluble solid of fruits were taken as yield parameters. Significantly ($p<0.05$) highest growth performances {plant height (81.10 ± 3.83 cm), number of leaves/plant (841.4 ± 81.0), stem girth (3.86 ± 0.15 cm), and root weight (28.04 ± 10.12 g)} were observed in compost treated plants. Moreover, the application of compost significantly ($p<0.05$) increased the number of flowers/plant (27.8 ± 6.6) and fruit yield/plant (731.8 ± 55.6 g) in tomatoes. Results of the study indicated that Lanka sour tomato well responds to organic fertilizers, and compost application had promising effects on both growth and yield performances. Therefore, the present study suggested that there is a high potential to cultivate Lanka sour tomato under organic fertilizers.

Keywords: Compost; Fertilizers; Growth; Organic; Tomato; Yield

Exploring the Potential of Coconut Water as a Liquid Fertilizer for Greenhouse Tomatoes (*Solanum lycopersicum* L.)

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Coconut water (CW) is one of the world's most versatile natural products rich in essential minerals and growth hormones. Despite its potentials, large quantities of coconut water remain unutilized at the industry and household levels as waste in the Sri Lankan context. Therefore, the present study investigates the potential of coconut water as a liquid fertilizer for greenhouse tomato production. For this purpose, different combinations of coconut water (CW) and Albert's solution (AS) were evaluated under controlled environment conditions using tomato cv "Thilina" in grow bag culture. The experiment was laid out in a Complete Randomized Design with five treatments replicated thrice, viz., T1 (100% CW), T2 (100% AS + CW spray), T3 (75% CW + 25% AS), T4 (50% CW + 50% AS) and T5 (100% AS at recommended dosage) as the control. Growth and yield parameters were measured at 45 and 60 days after transplanting (DAT). T4 and T5 (control) treated plants recorded statistically similar values, which were significantly higher ($p < 0.05$) than the others for plant height (98.7 ± 4.7 ; 95.3 ± 2.4 cm), number of flower clusters/plant (16.3 ± 1.8 ; 16 ± 1.2) and number of flowers/plant (78 ± 8.7 ; 76.7 ± 2.2) at 45 DAT, respectively. A similar pattern was observed at 60 DAT for plant height (139.3 ± 8.1 ; 138.7 ± 0.7 cm), number of flower clusters/plant (23 ± 1.5 ; 21.7 ± 1.5), number of fruits/plant (76.3 ± 6.4 ; 77.7 ± 4.3), average fruit weight (87.7 ± 0.6 ; 81.7 ± 0.4 g) and total yield/plant (1755.1 ± 8.9 ; 1753.4 ± 14.1 g) in T4 and T5 respectively. There was a significant difference ($p < 0.05$) in pH and TSS (°Brix) among treatments. pH value ranged from 5.12 in T5 to 5.33 in T3. The highest TSS (°Brix) value (5.67 ± 0.33) was recorded by T4. Plants treated with 100% CW (T1) showed a 13% total yield reduction per plant compared to the control, possibly due to low nitrogen content. In conclusion, coconut water has a potential to be developed as a liquid fertilizer for greenhouse tomatoes partially replacing the requirement of Albert's solution (AS) which is more cost effective. Further studies are recommended to evaluate the possibility of using 100% coconut water with supplementary organic sources of nitrogen.

Keywords: Albert's solution; Coconut water; Growth and yield; Tomato

Taxonomic Identification of Cinnamon (*Cinnamomum zeylanicum* Blume) Leaf Miner in Sri Lanka

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Cinnamon leaf miner is a minor pest in cinnamon cultivations of Sri Lanka, but causes severe losses in cinnamon nurseries resulting considerable expenditure for its management. Present study was undertaken to identify the larval taxonomy and adult morphology of cinnamon leaf miner, as the first comprehensive research in Sri Lanka. The study was conducted at National Cinnamon Research and Training Center of Sri Lanka. Insects reared both under field and laboratory conditions were observed under the microscope. Published taxonomic keys were referred to identify the larva and external morphology of the adult was compared with the previous reports of the experts. The initial instars of the larva were transparent, whitish in colour and it was changed to a glittering red towards the pupation. Larva was characterized by the strong and sclerotized mandibles which enable it to vigorously devour plant tissues. Antennae were short, three segmented and located towards the front of the head. Unequal, five stemmata were located laterally and posteriorly to the antennae. Four segmented strong thoracic legs ended with a claw. Abdomen consisted of 8 segments while pseudo legs were located on the iii, iv, v and x abdominal segments. Equal crochets were in a complete circle. The larva made an irregular shaped tunnel inside the immature leaf of cinnamon and continued to grow up to a length of 5mm inside the mine before pupating in an external cocoon of 6mm. The adult was a greyish moth of 3 to 5mm in length with a wingspan of 7 to 9mm. Wings are entire, scaled, lack stigma on front wing between C and R. Hind wings are fringed. Filiform antenna not knobbed at the tip with more than 41 segments longer than forewings. Proboscis coiled. Tibial spurs are conspicuous. Basal segment of antennae enlarged forming an eye cap. Present study confirmed that the Cinnamon leaf miner belongs to the *Acrocercops* spp. under Order Lepidoptera, Family Gracillariidae and Subfamily Gracillariinae. This study laid foundation to further studies on biology and management strategies of Cinnamon leaf miner in Sri Lanka.

Keywords: *Acrocercops* spp.; *Cinnamom zeylanicum*; Gracillariidae; Taxonomy

Impacts of Rainfall Shocks on Tea Production: Evidence from Plantations of Uva Region

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Tea is a major perennial plantation crop in Sri Lanka because of its significant contribution to the national economy. Tea plants are generally grown in rainfed systems and rainfall pattern and distribution are key factors on the variability of tea production. In recent years, there has been an increase in the frequency of extreme weather events. According to the Sri Lanka country report on climate change, it was reported that the extreme rainfall events will increase as a result of climate change. This study estimates the impact of rainfall shocks on tea production of Uva region based on monthly panel data from 12 different tea estates in Uva region over a 19-year period (2000-2018). The fixed-effect model was chosen for the analysis based on the Hausman specification test. The deviation of the monthly average rainfall from the long term mean in the respective period was used to define positive and negative rainfall shocks. Tea production was regressed along with weather and non-weather variables as predictors. The diagnostics checks were done and cross-sectional time series feasible generalized least squares regression results were used for the interpretation. A statistically significant relationship between rainfall shocks and tea production was seen in the Uva region. Results revealed that both positive and negative rainfall shocks negatively affect tea production. Thus, the impact of negative rainfall shocks was higher than the impact of positive rainfall shocks on tea production.

Keywords: Climate change; FGLS regression; Panel data; Rainfall shocks; Tea production

Estimation of Water Footprint of Black Tea Production: A Case Study in Madulsima Plantations PLC, Badulla, Sri Lanka

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Water is an economic commodity as the availability of clean fresh water in short supply. Most water resource experts now agrees that inadequate water management , rather water shortage, is the primary cause of water conflicts. Meanwhile the virtual water concept has become popular in estimating the amount of water used in the production of goods or services, linking framework to find potential solutions and contributing to improved water resource management. Water footprint is a tool to calculate the amount of water that is consumed and polluted in all stages of a production process. Generally, three types of water are considered in water footprint calculations; green water, blue water and grey water. The present study was conducted to estimate the water footprint of black tea production at two tea estates of Madulsima Plantations PLC. Green water footprint of tea was calculated using CROPWAT 8.0 model. Blue and grey water footprint of black tea were calculated following the guidelines in the Water Footprint Assessment Manual. The results revealed that, the virtual water content of black tea production of Madulsima Plantations PLC was 4270.69 m³/ ton / year. Further the green water footprint for evapotranspiration of tea was 1090.7 mm / year. The total green water content in black tea of the studied two estates was 3227.68 m³ / ton and it is three times less than that of the average value of Sri Lanka while much less than those of China, India, and Kenya as available in the scientific literature. Further the blue water footprint of black tea production of these estates was 1.23 m³ / ton and it is negligible when compared with China and India. The grey water footprint of tea cultivation practices in these estates was 1041.78 m³ / ton and it is also less than those average values of the Sri Lanka and China. However, the grey water footprint of the studied two estates can be potentially reduced by incorporating organic cultivation concept in the long run.

Keywords: Black tea production process; CROPWAT 8.0 model; Cultivation practices; Virtual water content; Water Footprint Assessment Manual

Factors Affecting Land Productivity of Proprietary Tea Estates in Badulla District

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The tea industry of Sri Lanka has made a significant contribution to the country's socio-economic status since its' history. The sustainability of the tea industry in Sri Lanka is at a critical juncture since it faces many challenges like the rising cost of production, declining productivity, shortage of labor, and climate changes. Proprietary Tea Estates are considered middle-level tea estates that may have a range of tea land extent between 10 to 50 acres (4 to 20 ha). The total land extent of proprietary holdings accounts for 14710 ha of land which is represented 6.6% of the total tea land extent of Sri Lanka. The main objective of this study was to identify the factors that affect the land productivity of proprietary tea estates in the Badulla district and to propose strategies to optimize the land productivity for its long-term sustainability. A conceptual framework and research methodology were developed according to the information gathered from focus group discussions held with key experts attached to public institutions and few proprietary holdings in the Badulla District. A cross-sectional survey using a pretested structured questionnaire was held for the collection of primary data. The stratified purposive sampling method was performed to select 33 proprietary tea estates in four tea inspector's ranges in the Badulla District. Secondary data were gathered. Descriptive statistics were used to analyze the socio-economic factors of the estates. Multiple linear regression analysis was used to analyze the effect of independent variables on land productivity. 87.9% of the variance of land productivity was explained by the independent variables ($P = 0.000$, $n = 33$). The findings of this study concluded that although the proprietary tea estate owners were experienced with sound knowledge on recommended agricultural practices, the major constraints for improving land productivity of the estates are inadequate opportunities to access to formal extension services in order to get technical, input, and financial assistance on required time. Thus, this study would be useful for relevant authorities to implement strategies to optimize the land productivity of proprietary tea estates in the Badulla District.

Keywords: Tea Industry, Proprietary Tea Estates, Land Productivity, Regression Analysis

Unravelling the Impact of Coconut Production Declining in Sri Lanka on the Kernel-based Export Products and Coconut Oil

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Coconut is one of the most commercially important crops in Sri Lanka, and the country requires around 3,600 million nuts per year to function properly upon the current demand. However, the current volume of the nuts produced annually is only between 2,500 and 3,100 million nuts. The production data reveals that there is a shortage in nut production. The main objective of this study is to unravel the impact for declining the production of coconut in Sri Lanka on kernel-based export products and coconut oil (excluding export). This study utilized both primary data which was collected through a cross sectional survey conducted by interviewing 120 kernel-based exporters, palm oil importers, and dehydrated chips importing millers using three semi-structured questionnaires. Apart from that, secondary data which was gathered from the Coconut Development Authority. The ARIMA (2,1,1) model was used to predict whether coconut production in Sri Lanka would fluctuate between 2500-3000 in the next 5 years. According to the model, nut production will be 2,626, 2,833, 2,978, 2,850 and 2,761 million nuts, respectively. The Friedman test confirmed that there was a significant difference ($P<0.05$) among the statements which were related to the sustainability of raw material supply and sustainability of final product supply of kernel-based products to export market. According to statistical analysis, production of the kernel-based export companies would be affected with the decrease of annual nut production. However, they would continue to export even when the annual nut production decreases because of their strong supplier base. It was also, found that there was a significant difference ($P<0.05$) among statements which were described the impact of dehydrated chips importation. The findings reveal that due to the influx of most of the existing coconuts switching into the milk industry, millers could not meet the demand for coconut oil as a result of the unavailability of the required raw material. According to the findings, importation of quality palm oil and dehydrated chips would mitigate the impact of declining nut production and help to meet the local oil demand as well as boost the industry.

Keywords: Coconut; Decline; Impact; Production; Unravel

The Competitiveness of Sri Lankan Tea: A Policy Analysis Matrix (PAM) Approach

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Tea production in Sri Lanka seems to be distorted in recent decades due to government intervention through different taxes and subsidies. In addition, Sri Lankan tea industry is facing enormous challenges such as low productivity, low replanting rate, high cost of production, and shortage of labor. Moreover, Kenyan and Chinese teas are becoming rapidly popular in the world market, while Sri Lankan tea is losing its market share by 1.2% during the pandemic situation. The study aims at undertaking a detailed analysis of policy support for tea production in Sri Lanka for the period of 2006-2019 using Policy Analysis Matrix (PAM) Approach. The study is based on the secondary data obtained from the Sri Lanka Tea Board, Department of Census & Statistics, Trade map Web, Central Bank of Sri Lanka and Ministry of Plantation. The Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), and Domestic Resource Cost (DRC) are estimated using PAM approach. Study results indicate that the values of NPC, EPC, and DRC are less than one for the period of 2006-2019. Hence, study suggests that Sri Lankan tea industry is not protected through the policy interventions while the available resources are efficiently and effectively utilized and there is a vast scope for Sri Lankan tea in terms of export to the countries. Additionally, DRC values indicate that the use of domestic factors are socially profitable in Sri Lanka despite increase cost of production over the years. However, tea production and export in the country will be negatively affected in the coming years due to recent government policy changes, such as the import banning of chemical fertilizer and other agro chemicals, as well as increased Cess tax. Therefore, the Sri Lankan government needs to consider about increasing input subsidies and other agricultural subsidies, which could affect competitiveness in tea industry in the country. Furthermore, lowering export Cess tax and establishing trade agreements with other nations will help to raise tea's export share in the global market.

Keywords: Cost of production; Domestic resource cost; Effective protection coefficient; Nominal protection coefficient; Policy Analysis Matrix (PAM); Tea industry

Effect of Feeding Silage Incorporated Ration on Production Performances of Temperate Crossbred Dairy Cows in Dry Zone of Sri Lanka

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Forage scarcity during the drought seasons has a negative impact on productivity of dairy cows reared in the Dry Zone of Sri Lanka. Therefore, utilization of conserved forages (i.e., silage) was identified as a reliable solution for this. Current study was conducted to assess the effect of commercially available silage on production performances and profitability of temperate crossbred dairy cows reared in Dry Zone, Sri Lanka. Fourteen multiparous, temperate crossbred (Jersey × Friesian) dairy cows with 430.1 ± 4.01 kg average body weight were used for the experiment. Cows were divided in to two groups considering the provision of a forage-based ration (Control) and a forage & silage (30% fresh matter) mixed ration (Treatment). Silage utilized in the study was a commercially available corn-based silage product. Cows were fed for 5 weeks during the months of February and March. The experiment was on a randomized complete block design with two treatments (i.e., forage-based diet alone and forage & silage mixed diet) and the lactation stage was considered in blocking the animals (early lactation and mid lactation). Body weight, fresh matter intake, individual milk yields were recorded. Ration samples were collected and analyzed for dry matter, ash, crude protein, crude fat, acid detergent fiber content and neutral detergent fiber content. Benefit Cost ration (B:C Ratio) was calculated to assess the profitability of the feeding regimens. Cows fed with corn silage had recorded significantly higher ($P < 0.05$) per day milk production compared to cows did not receive a corn silage-based ration. As such, silage feeding resulted 23.57 L/cow higher ($P < 0.05$) cumulative milk production at five weeks compared to their counterparts (104.96 vs. 81.39 L/cow). Silage feeding did not indicate any significant ($P > 0.05$) effect on fresh matter intake and body weight gain of the experimental cows. Further, both control and treatment rations indicated B:C ratios higher than one (01) throughout the experimental period. It indicated that both rations were profitable to be utilized in proper circumstances. Considering the increment of milk production and the profitability, silage feeding could be recommended as a promising solution for forage scarcity faced by dairy farmers during the drought seasons.

Keywords: Corn silage; Dairy cows; Drought season; Milk production

Association between Body Weight and Gait Score of Broiler Meat Chicken

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The global demand for chicken meat is increasing and new poultry strains have been developed by genetic improvement targeting production traits to fulfill the higher demand. Since, genetic improvements have not focused on improving skeletal confirmation in parallel to production traits; birds can get leg deformities disturbing their walking pattern which can manifest as higher gait score (GS). Study focused to identify the association between body weight (BW) and GS in broiler chicken. A total of 100, day-old Cobb chicks (76-female; 24-male) were randomly selected and managed conditions. GS with 0(zero) to 5(severe) levels and BW of the birds were recorded separately at the age day-14, day-21, day-28 and day-35. Spearman correlation was calculated between BW and GS at each sampling day using MINITAB-17 and mean BWs difference of birds in each GS category was obtained by repeated measures of ANOVA (RMANOVA) using SAS-9.2. Frequency of birds in each GS category was obtained. Significant weak positive correlation between BW and GS is reported only at day-35 (Spearman-Rho=0.289; P<0.05). When consider the sex, similar significant weak positive correlation is observed in females (Spearman-Rho=0.364; P<0.05) at day-35 reflecting correlations observed in whole flock at day-35, may have mainly contributed from females. RMANOVA revealed a significant effect of time and GS×time interaction on BW (P<0.05). Significantly higher BW (P<0.05) has observed in birds belonging to the higher GS categories at day-35 (GS0=1660.83±59.13; GS2=1796.49±38.65; GS3=1913.39±30.16; GS4=1803.00±111.18) indicating BW of birds has directly affected on their walking pattern. Frequency of birds belonging to GS-0 is continuously declining from 99% at day-14 to 15.2% at day-35. Further, more than 50% of birds showed GS-3 (48.5%) and GS-4 (3%) at day-35 reflecting without external visible changes in the skeletal confirmation; birds are suffering from pain in walking which is an important animal welfare issue. None of the birds reported GS-5 throughout the experiment. It can be concluded that increase BW leads to chronic pain which reflects as higher GS. At slaughtering age, birds are suffering from pain in walking without changes in external skeletal confirmation. Future research can be focus on genetic improvement of skeletal confirmation of birds to tolerate increased BW.

Keywords: Body weight; Broilers; Chicken; Gait score

Development of an Appropriate Micro Propagation Protocol for *Nymphaea* × *erangae*

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The *Nymphaea* × *erangae* Yakandawala, Guruge & Yakandawala is one of the most conspicuously attractive and eye catching plant which has high demand in local and export markets. However the production of these plants takes a long time where wild collection is not sustainable and cannot cater the demand. Micro propagation is one of the best techniques which can be practiced in commercial production of *Nymphaea* × *erangae* plants. The studies on *Nymphaea* × *erangae* are very limited and the contamination rates is very high when the mother plants collected from muddy soil media, can easily exposed and contaminated by microbes. This research study focuses to investigate the ability to use soil less culture system for mother plants of *Nymphaea* × *erangae* to minimize contamination in micro propagation. Three treatments (duration of 1, 2, and 4 weeks maintenance of mother plants in soil less culture system treated by 0.5g/1L Albert solution and 1g/10L Fungicide in twice a week) were tested and plants were maintained in muddy soil were used as the control. The leaf blade and rhizome buds were used as explants. The results revealed *Nymphaea* × *erangae* tissue culture in MS media, which were placed for a week in the soil less culture system showed significantly higher ($p < 0.05$) survival rate and 25 % of non-contaminated surviving culture vessels after two months, compared to control and other treatments, which is suitable for micropropagation of *Nymphaea* × *erangae* in commercial scale.

Keywords: *Nymphaea* × *erangae* Yakandawala, Guruge & Yakandawala, Soil less culture system, MS medium, Albert solution, Fungicide

Evaluation of Seed Dormancy, its Associated Seed Morphological Characteristics, and Seed Vigor of Improved Rice Varieties in Sri Lanka

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Improved rice varieties may have different durations of seed dormancy and level of seed vigor, but no proper information is available to make use of them for farmers. This research was conducted at the Rice Research and Development Institute, Bathalagoda during 2020/2021 *Maha* season to identify the dormancy period, seed characteristics associated with dormancy and vigor of improved rice varieties in Sri Lanka. The experiment design was a completely randomized design with three replicates. Varieties were categorized by maturity period and seeds of 56 varieties were obtained from one week after harvesting. The dormancy period of each variety was considered from one week after harvest until it reached 85% germination as determined by weekly germination tests. Seed vigor was determined by % germination using cold test. Thousand-grain weight, maturity age, seed shape and pericarp color were recorded. Significant variations were observed for the dormancy period and seed vigor among varieties. Ld 355, At 401, Bw 363, Bg 94-1, At 362, Bw 452, Bg 250, Bg 400-1, Bg 454, At 308, Bg 292-6b, Bg 455, Bg 450, and Bg 310 overcame the dormancy at t third week. Bg 359, Bg 357, At 353, Bg 358, At 453, Bg 364, Bg 379-2, Bg 90-2, BG 11-11, Bw 372, Bg 305, At 309 and At 451 lost dormancy in fourth week. Bg 352 showed the longest dormancy breaking period (eight weeks) followed by Bg 252, Bg 403, and Ld 371 (seven weeks). Bw 400 had no dormancy period. Bg 407-H, Bw 351, Ld 356, Ld 365, Ld 408, Bw 301 and At 405 had a shorter dormancy period (two weeks). Bg 454 showed the highest vigor (93.3%), while At 402 (90.7%), At 309 (90.7%), Bg 11-11 (90.7%) and Bg 371 (86.7%) also had comparatively high vigor. Bg 379-2 showed the lowest seed vigor (8.0%) followed by At 401 (15.3%), At 405 (11.3%), Bw 351 (8.7%) and Ld 356 (10.7%). The relationships between dormancy period and thousand-grain weight, maturity days, pericarp color and grain shape were not significant ($p \geq 0.05$). The results of this study will help farmers to determine the sowing time after harvesting and to select suitable varieties under stress conditions.

Keywords: Breaking dormancy; Germination; Improved rice varieties; Seed characters; Vigor

Comparison of Growth Performance, Yield Parameters and Nutritional Composition of Two Hybrid Napier (Pakchong-1 and CO-3) Cultivars Propagated at Boralanda Farm

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The objective of the current study was to determine the best forage cultivar of the two Hybrid Napier (Pakchong-1 and CO-3) cultivars that well-suited to the prevailing agro-climatic conditions of the Boralanda Farm, Welimada, Sri Lanka based on the growth performance, yield parameters and nutritional composition. The experimental design was a randomized complete block design (RCBD) having 6 blocks, 2 treatment plots in each block and 10 replicates in each plot. After field preparation, blocks were arranged according to the slope of the land. A soil analysis was conducted to determine the soil quality gradient across the blocks and basal fertilizer application was conducted after the land preparation. Two node cuttings of two cultivars were planted following standard recommendations. All the other agronomic practices following planting were kept constant across treatments. The number of leaves per plant, plant height and stem diameter were recorded weekly as growth parameters and plants were harvested 45 days after planting to record the fresh matter yield, plant height and leaves per plant. Further, the proximate composition of two forage cultivars was analyzed. The results revealed that the cultivar Pakchong-1 showed the highest growth performance having a higher number of leaves (53 Vs. 44), higher plant height (105 cm Vs. 90 cm) and larger stem diameter (21 cm Vs. 18 cm) compared to CO-3 ($p < 0.05$) at 45 days after planting. As a result of the higher number of leaves and plant height, Pakchong-1 showed significantly higher fresh matter yield (2.742 kg/m^2) than CO-3. Although dry matter, crude fiber and ash contents were not different among the two cultivars, Pakchong-1 contained higher contents of crude fat (28.6% vs. 15.7% DM basis) and crude protein (20.5% Vs. 16.4% DM basis) ($p < 0.05$). In conclusion, Pakchong-1 could be considered as the most suitable forage type among two cultivars in terms of growth characteristics, forage yield and nutritional composition to be used for ruminant feeding at Boralanda Farm.

Keywords: Pakchong-1; CO-3; Fodder; Dairy

Impact of Brand Awareness on Consumer Purchase Intention with Special Reference to Sri Lankan Tea Brands

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Tea is the most widely consumed, most popular, and lower-cost beverage in the world next only to water. Sri Lanka is one of the top tea-producing countries in the world. Apart from the export market, the local market is also critical to sustain the tea industry. At present, a number of tea brands are available in the local market creating huge competition among them. The purpose of this study was to investigate the impact of brand awareness on the consumer purchase intention of local consumers. Referring to the literature, the brand equity model that explains the relationship of brand awareness, brand loyalty, brand association, and perceived quality with the purchase intention was selected as the conceptual framework of this study, and a structured questionnaire was developed accordingly. In this study, the primary data were collected from 200 consumers in the Colombo district of Sri Lanka selected via non-probability convenience sampling. Data were analyzed using descriptive and regression analysis. The regression results showed that brand awareness and perceived quality have a positive significant relationship with purchase intention whereas brand loyalty and brand association do not. According to the results, the study stresses the importance of creating brand awareness, thus the tea traders should use appropriate marketing communication tools to raise brand awareness. Further, the perceived quality of tea revealed to be significant so that the tea traders take this into account in developing their products.

Keywords: Brand Awareness; Brand Association; Brand Loyalty; Local Tea Market; Purchase Intention; Perceived Quality

Analysis of Consumption Patterns of Probiotic Incorporated Fermented Dairy Products in Sri Lanka

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Probiotic dairy foods are considered as one of the major functional food substances in the world. Consumers have been more health conscious in recent years, and as a result, they are seeking more information on how to live a healthy life consuming good food. Probiotic and probiotic products are having the possibility to attract those health-conscious consumers because of their health promoting effects and lower cost. To our knowledge there are no studies that analyze the consumer demand for probiotic fermented dairy products in Sri Lanka. This study focused on analyzing the consumer knowledge, attitudes, socio-demographic and economic factors that affect the consumption pattern of probiotic fermented dairy products in Sri Lanka. A total of 405 households from all nine provinces in Sri Lanka were surveyed with an online questionnaire. According to the results, 46% of the respondents have awareness of probiotics. Probiotic consumption was categorized into 4 levels as not at all, low, medium, and high based on the probiotic consumption per week. The study showed that 53% of the respondents belongs to low-level consumption category, 27% have medium level consumption, 9% are in high-level consumption category and 11% of the responders never consumed probiotic incorporated dairy products. An ordered logistic regression model was employed to analyze the relationships between probiotic consumption level and the number of demographics, socio-economic characteristics of consumers such as gender, age, marital status, household size, presence of children, household income, locality, education level, attitudes on health and nutrition aspects, attitude on sensory aspects, advertisement aspects and poor availability of probiotic dairy products. The results reveal that probiotic consumption level is significantly and positively influenced by gender, marital status, household income, advertisements, and consumer's attitude on health and negatively influenced by household size and poor availability. Findings of this study give useful information to producers for their production and marketing strategies which are most suitable to fit with the demand characteristics and consumer expectations.

Keywords: Probiotic; Dairy Products; Consumption Patterns; Ordered Logistic Regression; Sri Lanka

The Effectiveness of Farmer Field School Approach for Dissemination of Technologies to Seed Potato Farmers in Badulla District

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Although farmers in Badulla district can gain higher income by cultivating potato compared to other crops they have to face more challenges as the potato requires intensive and costly inputs for its cultivation in comparison with other field crops. Thus, the main objective of this study is to investigate the effectiveness of the Farmer Field School (FFS) Approach as an agricultural innovation and dissemination platform for improving farmers' knowledge and adoption of appropriate cultural practices and thereby improving land productivity and profitability of the seed potato cultivation. The stratified purposive sampling technique was performed to select 40 seed potato farmers who participated for the FFS program (considered as FFS group) conducted in four AI ranges (Perahettiya, Halpe, Etampitiya, and Mirahawatta) in Badulla district and another 40 farmers who were not attended for the same program [considered as NFFS Group]) and living in same locations. A cross-sectional field survey administering pretested structured questionnaire and focus group discussions were undertaken to collect primary data on socio-economic status, knowledge, adoption level, yield and cost of production, and farmers' attitude towards the FFS approach. A scoring system and 5 point Likert scales were developed to measure the above criteria and index. Descriptive analysis, hypothesis testing, and Ordered Logistic Regression model were applied to measure variables and explain the relationship among the tested parameters using SPSS statistical package. The result show that there was a significant difference between FFS and NFFS seed potato growers on knowledge ($t = 11.64, p < 0.000$) and adoption of agricultural practices ($t = 7.94, p < 0.000$), productivity of land ($t = 4.039, p < 0.00$), and cost of production ($t = -5.729, p < 0.000$), and these findings reveal that FFS group are far advanced in reference parameters compared with NFFS group. Findings of the Ordered Logistic Regression model reveal that the model as a whole is fitted significantly ($P < 0.05$). R square of the model expresses that 26.75% proportion of the variance in adoption level significantly improved the recommended cultural practices as explained by seven independent variables (education, experience, and indexes of social participation, group dynamic, satisfaction, and sustainability). The findings of this study proved that FFS approach is as an agricultural innovation and dissemination platform for improving farmers' knowledge and changing their attitude on adoption of appropriate cultivation practices, and thereby improving land productivity and profitability, and living standard of self-seed potato farmers in Badulla district.

Keywords: Badulla District; Effectiveness; Farmer Field School; Seed potato

Effect of Gamma-Irradiation on Microbiological and Physiochemical Properties of Ceylon Cinnamon (*Cinnamomum zeylanicum*) Powder

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Ceylon cinnamon (*Cinnamomum zeylanicum*), commonly known as the “True cinnamon” has dominated the international spice market due to its high cinnamaldehyde content, strong aroma and rich flavor. Sri Lanka is the leading producer and exporter of Ceylon cinnamon. The initial microbial load in spices and herbs, in particular spore-forming bacteria, could be a serious threat for the hygienic safety of final processed products. Gamma-irradiation is a novel technique and it is more effective than ethylene oxide fumigation for sanitation of spices in controlling microbial contamination without adverse effect. Therefore, the present study was carried out to evaluate the effects of different doses of gamma-irradiation on microbiological and physiochemical properties as total plate count (TPC), yeast and mold count (YMC), total flavonoid content, total phenolic content, reducing sugar content, antioxidant activity, pH, color and water activity of Ceylon cinnamon. Cinnamon samples were collected from the local market and subjected to five doses of irradiation as 1, 3, 5, 7 and 10 KGy using an industrial Co⁶⁰ gamma irradiation source. Non-irradiated cinnamon sample was used as the control. There was a significant reduction (100%) in TPC and YMC with increasing the irradiation dose up to 10 kGy. Results of physiochemical properties, antioxidant activity and color values did not showed significant difference in treatments and control samples. However, significantly lower levels of total flavonoid content, total phenolic content and reducing sugar content were observed in treatment with 10 kGy irradiation dose compared to control. The proximate composition of cinnamon treated with 10 kGy did not showed any significant differences in crude protein, crude fat, crude fiber and ash content compared to control while moisture content was significantly lower than the control. In conclusion, the 10 kGy gamma-irradiation dose was not adversely affected on quality of Ceylon cinnamon.

Keywords: Spices; Ceylon cinnamon; Gamma-irradiation; Dose

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Socioeconomic Issues Related to the Spiny Lobster Fishery in Mirijjawila Village, Hambantota District, Sri Lanka

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Spiny lobster fishery is a well-established reef associated income generating fishing activity in the southern coast of Sri Lanka. As there is a high demand on spiny lobsters in local and export market they faced to a high risk of overexploitation. As such suitable management plans are needed to ensure the sustainability of this spiny lobster fishery. In order to develop a proper management plan, it is compulsory to have a clear understanding of the socioeconomic issues faced by the lobster fisher folk in the area. With this point of view, a survey on the reef associated fisher folk was carried out at Mirijjawila Village, Hambantota district from 16th of January 2020 to 16th of January 2021, in order to obtain their views on the current socioeconomic issues and trends related to spiny lobster fishery. Data were collected via pre-tested semi-structured questionnaire formal and informal discussions and field observations. Results indicated that the major socio-economic issues related to this industry were the lack of a fixed price system for spiny lobsters, lack of a well-defined existing property right for fisher folk in the area and illegal activities done by fishermen and collectors, access of unauthorized people to the fishery, prevailing COVID 19 situation, alternative livelihood during the spiny lobster fishery. This study suggests that these issues are needed to be addressed to formulate a local level sound fisheries management plan with continuous monitoring studies.

Keywords: Spiny lobsters; Socio-economic issues; Fisheries management; Sri Lanka

Extraction of Bone Powder from Yellowfin Tuna (*Thunnus albacares*) and Swordfish (*Xiphias gladius*) Bones & Analyse their Mineral Content

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Fishbones are one of the main sources of Calcium and other minerals. During fish processing, nearly 30-60% of fish body weight discard as head, skin, viscera, backbones, and fins. The objective of the present study was to the extraction of bone powder from Yellowfin Tuna (*Thunnus albacares*) and Swordfish (*Xiphias gladius*) bones & analysis their mineral contents. Yellowfin Tuna and Swordfish bones were collected from a local fish processing company. Frozen bones were thawed for 16 hours at 20°C to remove ice. Large flesh parts were removed from bones and cut into 10cm size pieces and the remaining minor flesh particles were removed by soaking in 2M NaOH for 24 hours at room temperature. Bones were first washed with tap water to remove fat, dissolved protein, aroma, and to remove microorganisms bones were kept in 0.1% citric acid (bone material to citric acid ratio of 1:5 (w/v) for 0.5 h) and 5% H₂O₂ (bone material to H₂O₂ ratio of 1:5 (w/v), twice for 1 h) respectively. Further washed with tap water, dried, and grounded. Moisture and ash contents were analyzed by moisture meter (KERN, DBS60-3) at 105°C and Muffle Furnace (Labtech, LEP-P Type) at 550 °C for 16 hours respectively. Yellowfin tuna bone powder has 1.44% ash and 6.57% moisture content and Swordfish bone powder have 1.59% ash content and 6.35% moisture content respectively. P percentage was measured by Spectrophotometric Vanado Molybdate Method and Ca and other minerals were analyzed by Atomic Absorption Spectrophotometry after dry ashing. Dried Yellowfin tuna bone powder has Ca-15.5±0.45%, P-8.0±0.36%, Zn-8.3±0.4mg/kg, Fe-46.0±0.20mg/kg, Mn -7.3±0.46 mg/kg, Na-1.5±0.06%, Mg-0.25±0.03%, K-357±1.73mg/kg. Further, dried Swordfish bone powder has Ca-13.2±0.25%, P-7.8±0.25%, Zn-8.0±0.15mg/kg, Fe-10.7±0.25mg/kg, Mn-2.0±0.17mg/kg, Na-1.25±0.02%, Mg-0.25±0.03%, K-454±2.65mg/kg. The results of the present study shows Ca:P of the yellowfin tuna and sword fishbone powder nearly similar to the Ca:P of the human bones(2:1). The present study concludes that Yellowfin tuna and Swordfish bone powder are rich in Ca, P, and other microelements and can be used for the preparation of inexpensive and environmentally friendly value-added products such as Calcium tablets and diet supplements.

Keywords: Fish waste; Value-added products; Bone powder; Economy

Quantifying Selected Nutritional Composition of *Siganus lineatus* Fish Bone from Waters Around Jaffna Peninsula, Sri Lanka

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Family Siganidae is considered to be an economically and nutritionally important species in Sri Lanka. The knowledge on their chemical composition of bone could help us to cure various diseases such as Osteoporosis as it could be applied as an ingredient of indigenous medicine. The studies related to the proximate and mineral composition of fishbone of *Siganus lineatus* are meagre in Sri Lanka. Hence, the present study was aimed to analyze the proximate and mineral of the fishbone powder of *S. lineatus*. 20-25cm total length of fish samples were collected from the Jaffna Lagoon from December 2019 to February 2020. The samples were cleaned, boiled and treated in order to achieve treated fish bone for production of powder form. The proximate compositions such as ash, protein, moisture and lipid content of the *S. lineatus* bone were determined by the standard AOAC methods. The mineral compositions such as Calcium (Ca), Sodium (Na) and Potassium (K) were determined by digital flame photometer and Phosphorus (P) by multiparameter photometer by the standard AOAC methods. The ash, protein, moisture and lipid content values were 50.74±0.65%, 22.07±0.29%, 6.29±0.35% and 3.50±0.16% in fishbone of *Siganus lineatus* respectively. The mineral composition of Ca, P, K and Na were 12.5%, 7.66%, 0.42% and 0.36%, respectively and the ratio of calcium: phosphorus is found to as 2:1. The present study showed relatively higher ash content. Therefore it is one of the method could be used to analyze the mineral content from fishbone. The results demonstrated that the fish bone powder was nutritious and can contribute towards the calcium deficient diseases and can be recommended for the clinical research studies as an important human health monitoring agent, in the future.

Keywords: Calcium deficient disease; Digital flame photometer; Fish bone; Multiparameter photometer; *Siganus lineatus*

Cetacean Diversity, Encounter Rates, and Behavior in Whale-Watching Waters off Southern Sri Lanka

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Data on the diversity, encounter rates, and behavior of cetaceans is vital to the conservation and the management of whale-watching activities. The southern coast of Sri Lanka is distinguished with a continental shelf, extremely steep slope, and deep submarine canyons. Though cetaceans are known to be abundant in these waters, there is a dearth of up-to-date data pertaining to the relative abundance, and species occurring in the whale-watching waters off Mirissa. Data collected during rapid boat-based cetacean surveys following the random line transects from January to May 2017 were analyzed to investigate the diversity, encounter rates, and behavior of cetaceans in the waters off Mirissa, covering a total of 788.9 km² survey area. During the 55 survey days, nine species were recorded: *Balaenoptera musculus*, *Balaenoptera omurai*, *Balaenoptera edeni*, *Stenella longirostris*, *Physeter macrocephalus*, *Tursiops truncatus*, *Globicephala macrorhynchus*, *Peponocephala electra*, and *Orcinus orca*. The Simpson diversity index for the entire study area was 0.5 and the encounter rate for the entire study area was 16.5 sightings per 100 km. Traveling and foraging behavioral states were frequently observed in large whales while socializing was observed in small toothed whales and the dolphins in the present study. Additionally, it is noteworthy that the temporal changes of the sightings of small toothed whales and the large whales were inverse, reflecting sequential use of the Mirissa waters by different species to reduce interspecies competition. However, the study also found differential regional preferences among cetaceans as common bottlenose and spinner dolphins being sighted mostly in inshore waters (< 500 m isobaths), while large whales (blue whales and sperm whales) being more frequently sighted along the continental slope (> 500 m isobaths). It was also observed that blue whales were feeding along the outer shelf and high slope waters where a major shipping route is crossing. This study further recommends that implication of proper management strategies for conservation and sustainable whale-watching activities are needed.

Keywords: cetaceans; encounter rates; diversity; Sri Lanka; diversity index

Fisheries Status of Valaichchenai Lagoon, Sri Lanka

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Valaichchenai lagoon is one of the major inland fishery sources in the Batticaloa district where productivity has been estimated approximately 3482.21 kg ha⁻¹ yr⁻¹. However, status of fishery information were lacking in literature. Therefore, this study aimed to fulfil this research gap. Piolet survey was conducted, then as primary data, including fishing practices, species, marketing system and supply chain, catch per unit effort, sustainable fishery constraints, and environmental impacts of fishing & related activities were collected using a questionnaire from 242 individuals, group and individual interviews, and direct field observation from January to May 2021. Secondary data were obtained from Fisheries Department of Batticaloa and journal articles. Data were statistically analyzed. SWOT analysis & Fish Bone analysis were also performed. The study revealed that a total of 12 types of fishing gears and the outrigger lagoon canoes (Thoni) were used for fishing. Total number of 38 species were identified during study period. Higher percentage of fishermen sell their harvest to intermediate vendors and a very small percentage, directly sell fish catch to final consumers. Supply chain includes both local and foreign market interventions. Fishermen caught 0.009 to 0.027 kg/net square meter/day, and 0.75 to 3.1 kg/day using a gill net and cast net, respectively, on average. Regulations for mesh sizes and certain unauthorized activities, licensing system, and seabass cage culture for sustainable fisheries have been imposed in Valaichchenai lagoon, but there were no species/size limitations, off-season/time limitations with prevailing irresponsible fishing (IUU), seagrass/benthic environment destruction, shrimp farm effluent discharge, waste disposal from cage cultures, fishing harbor & adjacent boat repairing centers, oil spilling from canoes/boat and, sound pollution issues. It can be suggested that introducing co-management system, implementing voluntary code of conduct, proper rules & regulations, frequent monitoring, conducting awareness and training programmes for Valaichchenai lagoon fishery sustainability.

Keywords: Valaichchenai lagoon; Fishery sustainability; Catch per unit effort; Supply chain; Co-management.

A Preliminary Study on the Status of the Valithondal Coral Reef in Northern Sri Lanka

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Coral reefs are one of the most important marine habitats in shallow tropical seas. However, there are no proper scientific records on the status of the Valithondal coral reef in Northern, Sri Lanka. Therefore, the present study was carried out to identify the abundance and diversity of Valithondal coral reef at Northern coastal waters of Sri Lanka from January 2021 to May 2021. Coral Video Transects (CVT) method was carried out for sampling at the selected location assigned by the criteria of the species abundance and water clearance where water depth less than 5m by snorkelling over 100m transect lines, which covered 10m x 100m area. Altogether 69 macro-species were recorded comprising twenty-three species of hard corals, seven species of soft corals, nine species of green seaweeds, seven species of brown seaweeds, five species of red seaweeds, thirteen species of fishes, and five species of molluscs. Species richness, Shannon-H index, and Simpson's diversity index were 29, 3.113, and 0.9428 respectively. Comparatively, a medium diversity of coral families were recorded. Families Faviidae, Merulinidae, Acroporidae, Montastraeidae, Pocilloporidae, Leptastrea, and Poritidae are the hard corals. There is one soft corals under the family Alcyonidae. Green, brown, and red seaweed species were identified under three, two, and three families respectively. The families of the green seaweeds were Caulerpaceae, Halimedaceae, and Ulvaceae, brown seaweeds were Dictyotacea and Sargassaceae, and red seaweeds were Liagoraceae, Gracilariaceae, and Halymeniaceae. Identified fishes were included under six families; Chaetodontidae, Lutjanidae, Pomacentridae, Serranidae, Acanthuridae, and Haemulidae while molluscs are included in five families which are Buccinidae, Terebridae, Mactridae, Trochidae, and Muricidae. The highest species diversity was observed in the family Merulinidae (12.72%), Caulerpaceae (10.90%), and Alcyonidae (7.27%) and followed by Chaetodontidae (5.45%). The most abundant species were *Acropora cytherea* and *Porites lobata* in hard coral species, which is contributed to reef recovery in Sri Lanka. The other high abundant species are *Lobopyton* sp. and *Sinularia* sp. in soft coral species, *Caulerpa imbricata*, *Caulerpa lentillifera*, *Caulerpa parvula*, *Canistrocarpus crispatus*, *Padina boergesenii* and *Halymenia durvillei* in seaweed species, Chaetodontidae and Pomacentridae in fish species. The results highlighted that the high biodiversity and abundance of macro-species recorded in the Valithondal coastal waters, which would be protected by forcing effective management practices. Further studies are also needed to the sustainability of the coral reef ecosystem.

Keywords: Corals; diversity indices; hard coral; macro-species; molluscs; seaweeds; soft coral

Growth Performance of *Panulirus ornatus* (Spiny lobster) with Three Different Feeds in Indoor Culture in Jaffna, Sri Lanka

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Indoor fattening practices of *Panulirus ornatus* (spiny lobsters) operated in Jaffna, Sri Lanka practicing with typical trash fish feeding. Effect of growth was evaluated with different feeds and water quality of *P. ornatus* culture and suggest a proper feed among the aquafarmers for *P. ornatus* due to unaware about feeds. Study entailed Completely Randomized Design with three different feeds (trash fish, crab meat, and clam flesh) and three replicates, 45 wild-caught *P. ornatus* of mean body weight 440.91 ± 29.11 g mean carapace length 8.00 ± 0.37 cm were stocked at the rate of two per m², cultured for 11 weeks, fresh chopped flesh fed at optimum rate of 5% of body. Water quality including temperature, pH, salinity, Dissolved Oxygen, nitrate, nitrite and total ammonia and growth performance indicators of Average Daily Weight gain (ADW), Average Daily Length gain (ADL), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR) and survival rate were examined and proximate analysis was done. *P. ornatus* had grown best on clams which containing highest crude protein $70.26 \pm 13.26\%$ lowest fat $0.60 \pm 0.18\%$, indicating highest SGR as $0.19 \pm 0.02\%$ where trash fish and crab fed lobsters showed lowest SGR $0.16 \pm 0.02\%$ and $0.13 \pm 0.04\%$ with the crude protein, and fat levels of $18.13 \pm 4.64\%$, $8.58 \pm 1.09\%$ and $10.66 \pm 1.77\%$, $1.64 \pm 0.22\%$ respectively. Highest ADW was recorded from clam fed lobsters as 0.94 ± 0.11 , 0.77 ± 0.11 and 0.58 ± 0.15 g day⁻¹ for lobsters fed with trash fish and crabs respectively. Lowest FCR of 1.42 ± 0.05 showed with clam fed lobsters, crab and trash fish fed lobsters showed relatively high FCR indicating 2.76 ± 1.37 , 1.63 ± 0.37 respectively. Growth significantly ($P < 0.05$) affected by water quality and maximum growth occurred at 29 - 30°C temperature, 0.01 - 0.02 mg L⁻¹ of Ammonia, 6.5 - 6.9 mg L⁻¹ of the Dissolved Oxygen levels. Survival rate was similar as 100% in all treatments. Findings show that spiny lobsters grow well when fed clams high in protein and lowest fat indicating suitability in lobster farming industry.

Keywords: *Panulirus ornatus*; SGR; Growth performance

Impact of Corona Virus Disease 2019 on Aquaculture and Inland Fisheries Sector with Special Reference to Trincomalee District in Sri Lanka

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Corona virus disease (COVID-19) is an infectious disease spreaded rapidly across the borders creating pathetic health, economic and social impacts on each and every country in the world. In fact, aquaculture and inland fisheries is one of the industries which has been affected drastically. COVID-19 first time recorded in 2020 in Sri Lanka. This study aims to analyze the impacts of COVID-19 pandemic situation on aquaculture and inland fisheries sector in Trincomalee district focusing on the impacts on the inland capture fisheries and aquaculture community along with production dynamic during the period of 2019 and 2020. Mixed method and Purposive and stratified random sampling techniques have been employed as major methods of sampling during the data collection where a total of 155 individuals who are engaging in aquaculture and inland capture fisheries activities operated under the monitoring of National Aquaculture Development Authority in seven Divisional Secretariat divisions; Kuchchaveli, Morawewa, Trincomalee Town and Gravets, Thambalagamuwa, Kinniya, Muthur, Kanthale located in Trincomalee district. Pre-tested and structured questionnaire was used to collect the primary data from respondents while secondary data were collected from Trincomalee National Aquaculture Development Authority and mainly descriptive analysis was applied by using Microsoft excel to compare the situation before and during COVID-19 in order to accomplish the objectives of the study. The results indicated that Trincomalee district inland fisheries total production was 9% lower in 2020 with compare to the 2019. Apart from that, the study also confirmed the livelihood, education, health & food security, well-being, and happiness of aquaculture and inland fisheries community have been severely affected by the COVID-19, especially during lockdown period. Hence, this study emphasizes the necessity of providing livelihood assistance to such affected household in order to enhance their living standard and need to provide Advice with business continuity planning and Advice on how to prevent infections while maintaining business operations.

Keywords: COVID-19; Aquaculture; Inland fisheries; Livelihood; Socio-economic impacts

Socio-economic Status of Small Scale Fishery in Koggala Lagoon, Sri Lanka

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Small scale fisheries in Sri Lanka make an important contribution to the livelihood, protein nutrition, and food supply as a developing country. Koggala lagoon in Southern province of Sri Lanka was selected as a study site due to lack of published research work on this regard. The objectives are studying status related to socio-economics of small scale fishermen, constrains of small scale fishery on the study area and to suggest an optimum management strategy. Fifty fishermen were interviewed using pre-tested structured questionnaire by using convenience sampling method from January to May 2021. The sample size was selected from five areas in order to scatter around the lagoon. Primary data and secondary data were collected from personal interviews and field observations, past research articles respectively. Descriptive statistics were used to analyze data. According to variables of fishermen information, 100% male fisherman represented in the area. 52% were middle aged fishermen, 36-50 years old. 84% of fishermen were married. 40% fishermen educated up to grade ten. According to job-related variables, 48% fishermen had 16-32 years of fishing experience. 42% fishermen had a monthly income range between LKR 20,001- LKR 30,000. 36% fishermen had hired work as an alternative income source other than lagoon fishery. According to information of family, 45% fishermen had medium size family include 4-5 members. According to the study, constrains that related to livelihood were increasing tourism activities, decrease vegetation coverage area around lagoon, increase illegal fishing activities and increase of crocodile population. Study revealed that most fishermen partially depend on fishing. Results proved fishermen had satisfactory wealth condition according to monthly income even though lagoon condition became poorer. Based on currently studied constrains that related to livelihood, there is an urgent need for conservation of Koggala lagoon sustainably, while enhancing fishermen livelihood. It can be recommended immediate implementation of optimum management strategy addressing aforementioned issues with further research and make aware lagoon associated stakeholders, including government and non-government authorities.

Keywords: Small Scale fisherman; Koggala; Coastal Fishery; Socio-Economic Status

An Analysis of Supply Chain of Small-Scale Fisheries in Loggal Oya Reservoir in Badulla, Sri Lanka

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Loggal Oya Reservoir is one of the minor perennial tank located in Badulla District, which has higher production rate compared to other minor perennial tanks in the area. However, the supply chain performance, fisheries activities and livelihood condition are not up to the standard level. The current study attempts to recognize the present condition of the fisheries supply chain along with its main stakeholders and their selected socio-economic characteristics. Moreover, the study also focuses on recognizing the constrains and opportunities related to small scale inland fishery supply chain in Loggal oya reservoir. Primary data were collected using a questionnaire from 59 individuals and while qualitative data was collected through Key Informat Interviews (KIIs) and Focus Group Discussions (FGDs). Additionally, secondary data from various source have also been used and mainly descriptive analysis was employed to accomplish the objectives of the study. Specifically, BCG Matrix, SWOT analysis and Fishbone analysis were used to analyze the supply chain while the Warwick – Edinburgh Mental Wellbeing Scale were used to examine the Wellbeing of the stakeholders. The study reveals that the Loggal Oya fishery supply chain consists of four main stakeholder groups such as fishermen, wholesalers, retailers, and consumers. It is observed that 64% fishermen sell their catch to wholesalers, whereas 34% directly sell their catch to consumers and 2% of the fishermen sell their catch to small scale value added producers. In contrast, the study reveals that 60% wholesalers sell their fish to retailers, while 40% sell and transport their fish catch to local markets located in Badulla and Mahiyangana. 100% retailers directly sell their fish to consumers. The majority of the stakeholders had a moderate wellbeing in the study area. The analysis further highlighted constrains such as depletion of fish stock, lack of financial availability, lack of training, knowledge and new technologies, and lack of infrastructure facilities in the fisheries supply chain in Loggal oya reservoir. The study emphasizes the requirement of providing appropriate trainings, credit facilities and funds, infrastructure facilities and inputs, improve market facilities, enhance security around the lake and awareness programs as remedies to the recognized constrains. Moreover, the study also recommends promoting value-added production based on fish in order to improve the supply chain and livelihood condition of the stakeholder.

Keywords: Supply chain analysis; Small-scale fisheries; Inland fishery; Wellbeing

An Overview on Behaviors of Fishing, Fish Consumption and Preservation Techniques of Indigenous Community in Sri Lanka. With Special Reference to ‘Dambana’ Indigenous Community

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Indigenous communities can be identified as culturally distinct ethnic groups who are native to a particular place. The Veddas, the indigenous community of Sri Lanka are numerically small people verging on extinction (0.20%). Dambana, the most renowned original settlement of the Veddas in Sri Lanka has been arguably considered as the hub of Veddas over the past half a century. Food consumption patterns of the Veddas had been greatly altered during the recent past with the dynamic process of modernization and also with changing nature of lifestyle. An adequate and updated attention has not been paid by the existing literature on the consumption of fish along with the processing techniques of the indigenous community of Sri Lanka. Hence, this study examines the level of fish consumption and preservation methods practiced by the indigenous community in Dambana region in Sri Lanka. A structured questionnaire based interviews with the indigenous people were conducted along with Key Informant Interviews (KIIs) and a desk review to collect the required data while a descriptive analysis employed to accomplish the objectives of the study. The study observed that a higher preference on fishing (85%) compared to hunting. Previously, the indigenous community used the pots made by crushing the wild herbs, spikes made of iron and wood for fishing. Currently, several fishing gears (net gear and spears) are being adopted to increase the quantity of catching which is required for their growing consumption. Moreover, the results indicate that their fish consumption has increased approximately by 95%. Furthermore 65% of them consume fish mostly at once/twice a week. Moreover, the study examined that traditional techniques used for cooking, processing and preservation of fish (specific woods such as *Cassia fistula* and *Manilkara hexamer*) have been gradually altered and being used modern technology such as refrigerators. Additionally, preference on different fish species in the market has been enhanced (20%). Under this scenario, the study emphasizes the need of protecting traditional fishing and preservation method while facilitating in order to increase the level of fish consumption of the indigenous community through appropriate strategies.

Keywords: Fishing; Fish Consumption; Indigenous community; Preservation Methods; Veddas

Applicability of Brown Seaweed Species (*Sargassum crassifolium*) for Treating Lobster Farm Wastewater

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Wastewater generation in aquaculture farms, including all lobster culture practices is a serious issue in the industry. The present study was carried out at lobster farm located at Northern Province in Sri Lanka. Approximately 756,000 L of wastewater is generated on this farm annually and discharges wastewater without proper treatment to the natural environment. The wastewater discharged from lobster farm consists of organic and inorganic chemical components that can be caused potential environmental problems. Present study focused to investigate applicability of Brown seaweed *Sargassum crassifolium* biomass to efficient removal of nutrients (nitrogen and phosphorous) from the lobster farm wastewater. The *Sargassum crassifolium* is an abundant species in Northern Province, Sri Lanka. Seaweed biomass optimization was performed using three different seaweed biomasses, viz 20 g, 30 g and 40 g and 20 g (1 g L⁻¹) identified as the efficient seaweed biomass. Wastewater initial physicochemical parameters pH (7.9 ± 0.02), Temperature (29 ± 0.04 °C), Salinity (36 ± 0.03 ppt), Dissolved Oxygen (3.58 ± 0.02 mg L⁻¹), Biological Oxygen Demand (115 ± 0.05 mg L⁻¹), Ammonia (1.37 ± 0.01 mg L⁻¹), Nitrite (0.143 ± 0.00 mg L⁻¹), Nitrate (0.243 ± 0.01 mg L⁻¹) and Phosphate (4.760 ± 0.02 mg L⁻¹) were analyzed using the standard methods. Then wastewaters were collected from the farm and transferred to six glass tanks of 50 L capacity each. The seaweed was used at 1 g L⁻¹ density in each tank except in the control tank. Complete randomized design was used to the experiment. Three replicates were used. Ammonia, Nitrite, Nitrate and Phosphate were analyzed once in three days from beginning to the end of the treatment period (28 days) to investigate the initial wastewater qualities and quality changes after Phycoremediation. After phycoremediation physicochemical parameters pH (7.4 ± 0.06), Temperature (29 ± 0.03 °C), Salinity (36 ± 0.05 ppt), Dissolved Oxygen (5.74 ± 0.04 mg L⁻¹), Biological Oxygen Demand (95 ± 0.03 mg L⁻¹) were analyzed in wastewater. *Sargassum crassifolium* removed 1.19 ± 0.34 mg L⁻¹ of Ammonia, 0.12 ± 0.03 mg L⁻¹ of Nitrite, 0.14 ± 0.04 mg L⁻¹ of Nitrate and 2.40 ± 0.72 mg L⁻¹ of Phosphate. Nutrient removal amounts were significantly differed (P<0.05) between control and treatment tank. The weight gains *Sargassum crassifolium* during the study period was of 8.7 g thus, the seaweed has been utilized the nutrients present in the discharged waste waters. The results of the study concluded that the nitrogen and phosphorus in the lobster farm waste waters, can be effectively removed through *Sargassum crassifolium*.

Keywords: Lobster, *Sargassum crassifolium*, Seaweed, Phycoremediation

Investigation of Disease Incidence and Management Practices to Build a Database to Fill the Knowledge Gap of Ornamental Fish Farmers in Sri Lanka

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The freshwater ornamental fish industry is one of the economically important, home entertainment industry in the world. During the last few decades, the ornamental fish industry in Sri Lanka has become one of the highest potential exporters in the global market. However, fish diseases are one of the major constraints to the failure of the ornamental industry. To avoid economic losses and to prevent disease outbreaks proper identification and diagnosis of fish diseases are crucial. Hence, this study was aimed to evaluate the present status of farmer's knowledge of fish disease; management measures to avoid disease outbreaks and prevalence of fish diseases with seasonal and regional variation in the freshwater ornamental fish industry. Sixty farmers cultivating various ornamental fish were selected using stratified and simple random sampling techniques from the National Aquaculture Development Authority (NAQDA) website. Data were collected using a telephone-interviewed method through a pretested questionnaire survey. Collected data were analyzed using the descriptive statistical methods in SPSS. . Major disease incidence caused by parasites (33.57%), followed by bacterial (23.57%), fungal (16.43%), viral (5%), and non-infectious diseases (21.43%). The most frequently observed disease was white spot disease (11.4%), followed by *Columnaris* (10.8%), *Dactylogyrus* sp. (9.5%), and fin rot (8.9%). The prevalence of fish diseases varied with season. The average prevalence of fish diseases was highest in the southwest monsoon period (49%). Common treatment methods that farmers used to treat the diseases were isolation (20.9%), water exchange (19.9%), adding salt (15.7%), methylene blue (13.6%), copper sulphate (11.5%), and antibiotics (7.1%). However, most of the farmers were able to identify diseases by using behavioral changes (40.5%) and symptoms (37.3%) although they were incapable of recognizing the disease-causing agents. Preventive and prophylactic measures were practiced by 91% of the farmers, the majority of them tend to find solutions through online sources, and some of them get advice from either colleagues or veterinarians. Furthermore, insufficient materials or lacks of awareness regarding fish diseases prevent farmers from gaining new reference knowledge. Thus, the results obtained from this study can be used to fill the knowledge gap by developing an awareness tool that enhances their knowledge on fish health management.

Keywords: Ornamental fish; Fish Disease; Seasonal variation; Awareness tool

The Effect of *Coriandrum Sativum* as Feed Additives on Growth Performance, Immunity and Disease Resistance of Southern Platy Fish (*Xiphophorus Maculatus*)

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Ornamental fish production and trade is a profitable alternative in the aquaculture industry. Nutrition is one of the key factors to obtain a higher productivity while maintain immunity of ornamental fishes. These fishes live in an environment surrounded by stress factors. Increasing immunity via feed additives may help them to thrive such stressors. Therefore, this study was carried out to assess the effect of coriander as feed additives and immune enhancers, on growth performance, immunity and disease resistance of southern platy fish (*Xiphophorus maculatus*). Sixty healthy platy fish, of 2 months old with an average weight of 0.17 ± 0.01 g were used in the experiment. Fish were fed with coriander incorporated commercially available feed for one month. The experiment was triplicated and controls were also maintained without incorporating coriander to commercially available feed. The weight gain, length and specific growth rate (SGR) were measured. The infection trial was carried out using *Aeromonas hydrophila*. Immune response and disease resistance of fish were determined by analyzing white blood cell (WBC) count. Results revealed that the, mean length and SGR obtained from coriander fed fish were significantly higher than the control ($p < 0.05$). The fish fed with Coriander incorporated feed obtained 20% of neutrophil count while fish fed without coriander incorporated feed obtained 10% of neutrophil count. In conclusion, there was a positive effect on disease resistance and immunity by the coriander incorporated feed on southern platy fishes and significant length and weight gain indicated the feasibility of using coriander as feed additives and immune enhancers in aquaculture.

Keywords: *Coriandrum sativum*; Disease Resistance; Innate Immunity; Ornamental fish; Specific Growth Rate; White Blood Cell

Effect of Aquaponic System in Increased Stocking Densities of Guppy Fish (*Poecilia reticulata*) at Grow-out Phase One

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Guppy (*Poecilia reticulata*) is one of the widely marketed ornamental fish. Fry rearing density recommended by NAQDA, Sri Lanka for grow-out phase one was 20 fish ft⁻². However, grow-out farmers are using different stocking densities. Production efficiency of existing facilities can be enhanced by increasing the recommended stocking densities. Therefore, identifying possibility of enhancing stocking density is vital for increasing production. Current study was focused to improve the efficiency of grow-out rearing of Guppy by incorporating aquaponic system using water spinach (*Ipomea aquatica*). Guppy juveniles with mean body size of 2.63±0.06 cm were stocked in similar glass tanks at three different stocking densities as 20 fish ft⁻² (T1), 25 fish ft⁻² (T2), and 30 fish ft⁻² (T3), with three replicates. NAQDA recommended stocking density was used in T1 and increased densities were used in T2 and T3. Fish were fed three times a day with commercial larval rearing feed at 10% of their mean body weight. A mixture of sterilized brick-lets and coconut coir were used as media for the grow bed with 10.6 cm thickness. Six plants of same size and age were introduced to each aquaponic system. Temperature, pH, dissolved oxygen level, nitrate, nitrite, and phosphate concentrations were tested. Growth performance was determined using Mean Length Gain (MLG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), and condition factor (K). Collected data were subjected to one-way ANOVA and Tukey's pairwise comparison at a significance level of $p < 0.05$, using Minitab 17 software. T3 showed significantly lowest MLG and SGR, whilst T1 showed the highest. However, T1 and T2 did not show significant difference. Significantly highest FCR was observed in T3. Condition factor did not show significant difference and no mortality was observed. Nitrate, nitrite concentrations were significantly high in T3 whilst other parameters did not vary significantly among treatments. According to the results obtained, the medium stocking density of 25 fish ft⁻² can be suggested as the optimum stocking density for guppy grow-out phase one for aquaponic coupled rearing facilities as it allows medium level stocking density while obtaining satisfactory growth and maintaining favorable water quality.

Keywords: Aquaculture; Aquaponics; Fish growth performance; Ornamental fish

Determination of the Effect of Papaya (*Carica papaya*) Leaf Powder as a Low Cost, Immunogenic, Herbal Feed Additive on Zebrafish (*Danio rerio*)

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Fish diseases including bacterial diseases cause significant loss in aquaculture. Antibiotic treatments are expensive and lead to antimicrobial resistance. The objective of this study was to identify the potential of a low cost herb which enhance fish immunity using *Carica papaya* leaf powder as a feed additive on zebrafish infected with bacteria and determined the effect on immunity. Ninety healthy fish were divided into three groups with three replicates (30 fish per group) exposed to *Aeromonas hydrophila* in water for a week followed by feeding trial. Three groups were fed with commercial (control), antibiotic and papaya leaf incorporated fish feed with 2% of body weight per day. Differential white blood cell (WBC) count was taken to identify the effects on disease response. Antibiotic susceptibility test was performed to identify, antibiotic resistance of bacteria and antibacterial activity of aqueous papaya leaf extract. Growth parameters and growth performances of experimental fish were calculated. WBC counts were measured before exposure to bacteria, one week after infectious challenge, one week after feed trial. One way ANOVA followed Tukey Pairwise comparison test used for data analysis. Fish exposed to *A. hydrophila* showed haemorrhages on the base of pectoral fin, fin rot and body discoloration. As per the results, monocyte count was decreased and lymphocyte count was increased in all three tanks after infection but one week after receiving the antibiotic and papaya feed, lymphocyte counts were decreased significantly compared to the control, while monocyte count and neutrophil counts were increased compared to the control. Accordingly, initial increase of lymphocyte count was observed due to immune response against bacteria as they involved in antigen-antibody reactions. Lowered monocyte count was observed due to recruit them for wound healing. Lowered lymphocyte count was observed due to the reduction of pathogens in response to antibiotic and papaya feed. Neutrophils play a role in phagocytizing bacteria, increased in papaya fed fish indicated a positive immune response. The results indicated that papaya leaf incorporated feed increased the immune response of zebrafish against *A. hydrophila*, which can be used as a low cost, herbal feed additive in ornamental fish industry.

Keywords: Zebrafish; *Carica papaya*; *Aeromonas hydrophila*; Immunity; Herbal antibiotic

A Review on Ornamental Shrimp Industry in Sri Lanka

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Ornamental shrimp industry in Sri Lanka is developing rapidly within last few years. However, Sri Lanka is still in a developing stage of ornamental shrimp industry and needs to fulfil some gaps in the sector. Species identification is one of the major challenges in exportation as well as conservation viewpoint to reduce the biopiracy. Therefore, this study was aimed to identify the status of ornamental shrimp export industry, develop a user-friendly identification guide for exporting and protected shrimp species, and develop a database on ornamental shrimp industry. Available digitized export data were obtained from Sri Lankan customs and, reliable secondary data such as legal framework, morphological features, taxonomic levels, water quality requirements, lifespan, disease were collected. However, only 2017 and 2018 export details were available in digital format. Published research articles and taxonomic identification guides were studied and body type, body color, color of the maxillipeds, telson, chelae, abdomen, carapace, nature of the pleopods, significant body color spots and strips were identified as key characteristics and easy identification guide was developed using these morphological features. Percentage of export quantities were calculated using export data for each species and family. Nineteen species belong to eight families were identified as commonly exporting species. Family *Hippolytidae* had the highest export demand. 88.05% and 89.50% were represented by this family in total export quantities in 2017 and 2018, respectively. *Hymenoceridae* had the lowest demand of 0.01% in 2017 and no export in 2018. Percentage of *Lysmata amboinensis* is 66.83% in 2017 and 57.88% in 2018 and *Lysmata debilius* 22.11% in 2017 and is 29.14% in 2018. These species were the two major exported shrimp species out of all 19 species of family *Hippolytidae*. Bright colors and tank cleaning ability are major reasons for this high demand. Moreover, selected secondary data and results obtained were compiled into a database in MS Excel format and willing to be published as online database including identification guide, to improve the awareness of the common public in Sri Lanka. Further, easy identification guide will make identification of prohibited shrimps easy, and it will support to reduce biopiracy.

Keywords: Shrimp Export; Dichotomous key; Protected shrimp species; *Hippolytidae*

Impact of Covid-19 Pandemic on Fish Consumption Patterns in Sri Lanka

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The COVID-19 which was originated in Wuhan, China has been rapidly spreading across the globe and consequently the World Health Organization has announced a global emergency condition. The pandemic has drastically changed the dietary and lifestyle patterns of people and specifically consumption of freshwater fish and sea food has been considerably reduced in terms of frequency and level of consumption. The aim of this study was to examine the food fish consumption patterns, production of inland food fish and price variation of fish before and during the period of the COVID-19 in Sri Lanka. A hybrid survey (both online and physical) was carried out in 13 districts and collected primary data from 711 respondents. The Wilcoxon test was employed to compare the selected variables before and during the COVID-19 using in Statistical Package for the Social Sciences (SPSS, version 25). The study found inland fish consumption has increased by 13.81% as frequently consuming fish type during COVID-19 pandemic when comparing before COVID-19. Moreover, type of fish, processing methods of fish, fish purchasing places, affordability to buy fish per month, fish purchasing frequency, fish consumption frequency and the amount of fish consumed by family per month were also analyzed and there was significant difference ($p < 0.05$) during the pandemic, compared to before 13th march 2020. Moreover, it was examined 78% of the consumers were aware of the process of cleaning, storage and preparation and also 58.74% of them have changed their pre COVID cleaning and storage process during COVID-19 period. The average retail food fish price and inland fish production was increased at the end of the lockdown period after first wave of COVID- 19 pandemic from May 2020 when compared to year 2019. The study identified the differences of the pattern of fish consumption; fish consumption frequency, preference for freshwater food fish during COVID-19 pandemic compared to before COVID-19 pandemic.

Keywords: COVID-19; Protein; Dietary pattern; Food price; Fish production

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A Systematic Literature Review for the Development of a Conceptual Model based on the Theory of Buyer Behaviour for Purchase Intention

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Gem and jewellery industry earns foreign exchange. In this context relationship between identity-based consumer behaviour and purchase intention of gem and jewellery and the variables that moderate and mediate the results of this relationship are important. Gender identity moderately impacts the relationship. Product involvement intervenes the relationship. The Howard and Sheth model recognizes the components interaction and the iterative decision-making process relevant to luxury purchase intention. The study aims to introduce a conceptual model based on the theory of buyer behaviour that facilitates empirical testing of the impact of gender identity on the relationship between identity based consumer- behaviour and purchase intention of gem and jewellery. This relationship is affected by product involvement. Also, the paper contributes to the existing body of knowledge to understand and analyze the outcomes resulting from the impact of gender identity on identity-based consumer behaviour and purchase intention which is affected by product involvement. This exercise is based on a systematic literature review of prior research publications and empirical research. Further this review was explored on impact of gender identity on identity- based consumer behaviour and purchase intention of luxury and the role of product involvement as a mediator. The objectives of the study are to determine the dimensions of gender identity with the identity- based consumer behaviour and dimensions along with the product involvement which intervene the relationship of purchase intention; to identify theoretical explanations that underlie the impacts of gender identity on identity- based consumer behaviour and purchase intention that is effected by product involvement,; and to understand the conditions postulated in literature as positive of purchase intention of gem and jewellery. These objectives were identified in this planning stage of the literature review.

Keywords: Gender identity; Identity-based consumer behaviour; Product involvement; Purchase intention of Gem and Jewellery; Theory of buyer behaviour

Intellectual Capital Disclosure and Firm Performance: An Evidence from Sri Lankan Listed Banks

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The demand for disclosure of non-financial information, including the disclosure of intellectual capital, has been increased by its wider users. However, those disclosures are still voluntary since their benefits are vague. The study aims to identify how intellectual capital disclosure influences the firm's financial performance of Sri Lankan listed banks. Intellectual capital is a vital element to service providing organization since it determines the service quality of the firms. Many firms nowadays voluntarily disclose their intellectual capital to signal the market and get legitimacy from society. Therefore, it could improve the firm performance. To ensure that, the study computes the intellectual capital disclosure index of all 11 listed banks throughout 2015-2019 based on the information gathered from annual reports and website. Firm performance was measured in two ways. Return on asset was used to measure the firm financial performance, while Tobin's Q was employed to measure the firms' market performance. Multiple linear regression was used to test the hypotheses of the study. The result reveals that ICD positively influences the return on asset and Tobin's Q. The finding of the study is significant to the policymakers of the banks to ensure the sustainability of the banks, which is vital to the national economy. Besides, knowledge of the benefits of ICD assists the policymakers to develop a framework for ICD to initiate the mandatory practices. Further, it provides evidence to the managers about the positive side of ICDs, which encourages them to focus on more IC development and disclosure. This study also contributes to the existing literature mainly based on the developing context. This study is new since it studied how ICD enhance financial and market performance, especially in the listed banks in Sri Lanka.

Keywords: Listed banks; Firm performance; Intellectual capital; Intellectual capital disclosure

Do Larger Firms Comply More with Corporate Governance Best Practices Compared to Smaller Firms? Evidence from Firms Listed in Colombo Stock Exchange

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Corporate governance as a monitoring mechanism has gained renewed attention following a series of corporate failures across the globe that are directly attributable to agency issues. Firms with higher corporate governance compliance have often recorded higher performance, higher stock liquidity and increased investor protection. Nevertheless, literature shows that smaller firms do not adopt corporate governance practices as often as larger firms do. This study examines whether larger firms comply more with corporate governance best practices than smaller firms using a sample of 100 firms listed in the Colombo Stock Exchange (CSE). The firms were selected based on the systematic sampling technique so that the sample evenly spreads across different firm sizes. The sample was split into two equal subgroups as larger and smaller based on their firm size measured using total assets. Compliance with corporate governance practices was measured using a corporate governance index constructed with equally weighted 18 board related best practices based on the data collected for the period ranging from 2018 to 2020. Three separate independent-samples t-tests were used to assess the difference in corporate governance compliance between larger and smaller firms during each year. The results suggest that corporate governance compliance in larger firms was significantly higher compared to the smaller firms. This situation can be mainly attributed to the higher cost of implementing corporate governance best practices, which is not affordable to smaller firms. Moreover, smaller firms might have considered compliance as less relevant. In contrast, larger firms are motivated to comply with corporate governance best practices even at a higher cost since they can benefit from the reduced agency cost and increased attractiveness for investors. Therefore, it would be more appropriate to identify these differences in compliance and make appropriate policies flexible enough in the application based on the firm's specific characteristics, such as the firm size. This is mainly because the literature has documented that only some corporate governance best practices are effective and relevant in each context.

Keywords: Agency conflict; corporate governance; Colombo stock exchange; Firm size

Effect of Working Capital Management on Firm's Profitability Evidence from Listed Insurance Companies in Colombo Stock Exchange

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Working capital management is considered to be a crucial element in determining the profitability of business firms. An optimal working capital management practices are contributing positively to the firm's profitability. In recent years many insurance companies in Sri Lanka have been an encounter many issues regarding working capital. Many research studies have been carried out to find the effect of the working capital on firms' profitability, but there were only a few studies carried out to investigate the effect of working capital on the profitability of the insurance companies in Sri Lanka. To fulfill this existing research gap, this study investigates the effect of working capital on a firm's profitability of all the listed insurance companies in the Colombo Stock Exchange (CSE) for the period of five years starting from 2015 to 2019. This study used Average Collection Period (ACP), Average Payment Period (APP), Current Ratio (CR), and Debt Ratio (DR) to measure the working capital while Return on Assets (ROA), Return on Equity (ROE), and the Profit Margin (PM) were used by the researcher to measure the profitability of the listed insurance companies in the CSE. Pearson correlation analysis was used to find the association between the working capital and the firm's profitability. Three random effect panel regression models were used to find the effect of working capital on a firm's profitability. The results of the study conclude that APP and DR have a negatively statistically significant effect with the ROA (Model 01), ACP has a positive statistically significant effect with the ROE (Model 02) and the CR has a positive statistically significant effect with the PM (Model 03) of the Sri Lankan listed insurance companies. In line with the above findings, it is recommended to adopt a conservative working capital strategy while paying higher attention to the ACP and CR as the most favorably affected factors to the profitability of the listed insurance companies in the CSE.

Keywords: Colombo stock exchange; Profitability; Profit margin; Return on assets; Return on equity; Working capital management.

Identifying the Impact of Glass Ceiling for Female Employees' Career Advancement in Insurance Sector (Special Reference to Colombo District)

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Glass ceiling refers to both visible and invisible barriers that stop female and minorities from their career advancing to the top positions. As the glass ceiling exists, identified that the low participation of female employees than minorities in the Sri Lankan Insurance sector according to the companies' annual reports. Previous researches were not touched in Insurance sector. Research formulated from various perspectives to have a more understanding of the exciting glass ceiling by using both quantitative and qualitative methods to conduct the research. The study has been completed with an empirical survey which was conducted using a self-administered questionnaire and semi-structured interview. And the sample consisted of eighty-five male and female executives and above employees to make knowledge about gender vice perception about the glass ceiling. The study was conducted with the aim of obtaining the level of glass ceiling factors, impact on female career advancement and identifying the strategies that used to overcome this glass ceiling obstacles in leading insurance sector employees in Colombo District. The hypotheses are developed to find out whether there is a significant impact of individual factors, organizational factors, family factors, and cultural factors on female career advancement. According to major findings of the study, female career advancement has a moderate positive impact from glass ceiling. Hence individual factors and cultural factors make significant positive impact on female's career advancement and family factors make significant negative impact based on statistical and interview performances. According to gender bias perspectives, female's also same with above results. According to males' perspective individual factors and cultural factors were only making positive significant impact to female employees' career advancement. In view of the findings, recommendations have been made towards career booming of females by breaking the glass ceiling. Finally, valuable suggestions for further studies on different dimensions and sectors and limitations of the study have been outlined.

Keywords: Female career advancement; Glass ceiling; Glass ceiling factors; Individual factors

The Impact of Internal Marketing Practices on Perceived Employee Engagement With Special Reference to Executive Level Employees in FMCG Sector Sri Lanka

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Internal marketing is one of the emerging concepts within the organizations that gives the solutions to the workplace conflicts. Conversely, employee engagement can be defined as the employees' emotional attachment towards their organizations. Previous scholars have expressed that the impact of internal marketing practices on perceived employee engagement may change based on the several factors such as culture, region, sectors and etc. Hence, this study has addressed the knowledge and empirical gaps by investigating the impact of internal marketing practices on perceived employee engagement of executive level employees in FMCG sector in Sri Lanka. Internal marketing has identified as a multi-dimensional concept. For this study it has been used three-dimensional model which is consisted with internal communication, training and internal market research to examine their impacts on perceived employee engagement separately. Population of the study has identified all the executive level employees working in FMCG sector. For this study data has been collected from 120 executive level employees in four FMCG sector companies using the convenience sampling technique. The quantitative research design has used for the study and descriptive statistics, Karl Pearson's correlation analysis and regression analysis has been used to analyze the gathered data. The findings of the study emphasized that the internal marketing practices has a significant impact on perceived employee engagement of executive level employees in FMCG sector in Sri Lanka. Further, it has concluded that all three dimensions of internal communication, training and internal market research are significantly and positively impacted on perceived employee engagement of executive level employees in FMCG sector in Sri Lanka. Finally, this study has recommended that managers can shape up organization internal marketing practices in proper manner to improve perceived employee engagement in executive level employees and internal communication, training and internal market research can take as suitable practices.

Keywords: Internal marketing practices; internal communication; Training; Internal market research; Perceived employee engagement

The Impact of COVID-19 on Stock Return in Asian Stock Markets

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The consequences of pandemic on global economy have been apparent throughout the history. COVID-19 emerged from China and rapidly outbreak across the globe, and hence the World Health Organization had announced a global emergency situation as well. Stock markets play a vital role in both individual and global economic contexts and however the stock markets are highly sensitive for any kind of shocks. Hence, this study attempts to examine the impact of COVID-19 on stock market of 15 Asian countries which represent developed, emerging, and frontier markets. Specifically, the study focuses on the impact of COVID-19 on stock returns of selected markets while observing the relationship between confirmed COVID-19 cases and stock return. The impact of COVID-19 on stock returns were analyzed using Event Study method by comparing the calculated abnormal return before and after the event under two event windows such as (0,10) and (10,20). Apart from that, OLS based panel regression analysis was carried out to observe the impact of the number of COVID-19 confirmed cases on stock return in selected stock markets. Daily closing price indices during the period of 1st January 2019 and 30th June 2020 were used to calculate the abnormal return and the empirical results of the event study reveal that abnormal returns after the event day are negative and therefore it is apparent that the COVID-19 outbreak has drastically affected the stock returns of selected stock markets of the Asian region. Specifically, two event windows indicates that COVID-19 has an immediate negative impact on all selected stock markets while long term negative impact has limited to emerging and frontier markets. Moreover, it is observed that COVID-19 confirmed cases negatively affect the stock return of all selected stock markets in Asian region. Hence, the current study recommends the importance of recovering from the pandemic and sustaining appropriate environment for the development and smooth running of stock markets.

Keywords: Asian stock markets; COVID-19; Event study method; Stock return.

Impact of Consumer Perception on Online Purchase Intention of Essential Goods during Covid-19 Outbreak With Special Reference to Working Age People in Matara District

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Online shopping has increasingly received attention since the consumers are unable to cater their essential goods during the COVID-19 (Coronavirus disease) outbreak period. Successful positioning of this concept has been achieved globally, most notably in developed markets. However, in the Sri Lankan context, this does not appear to be the case. To this end, research has been undertaken in order to better understand the current position of the online grocery shopping occupies in the minds of Sri Lankan consumers. Moreover, the Sri Lankan Fast Moving Consumer Goods sector has identified as an industry which more focus on online shopping in the COVID-19 context. Since these tools are new to the market, there is a significant lack of empirical research in relation to the area. Thus, the main purpose of this study is to explore and investigate consumer perception towards online purchase intention. In this study, consumer perception was conceptualized as a multidimensional variable comprised of risk, benefits, ease and, past experience of online shopping. The research was quantitative in nature and both primary and secondary data used for analyses. Primary data was collected through self-administrated questionnaires while secondary data collected from supermarkets of Matara District. 150 of Sri Lankan working-age consumers were selected as the sample of the study using convenience sampling. Simple linear regression was conducted to achieve the research objectives. Based on the research findings, the study concluded that there is a significant impact of consumer perception on online purchase intention of essential goods during COVID-19 outbreak and past experience has mostly influenced with online purchase intention in pre-COVID situation while ease of online shopping has mostly influence in during COVID situation. Further, the findings of the research recommend that organizations should promote this online essential goods selling and delivering within the market as it provides a number of benefits to both consumers and sellers.

Keywords: Online shopping; Consumer perception; online purchase intention; Essential goods

Mapping Challenges of Social Enterprises in Uva Province, Sri Lanka

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Today the social enterprises field in Sri Lanka faces numerous issues and challenges. It is rarely can find research about Social Enterprises in Sri Lanka. According to one amongst them, which had done by British Council, the geographical spread over the country of social enterprises in Sri Lanka, they are more clustered in the Western and Central provinces while they are less common in other provinces due to unable to access facilities and support service. Accordingly there is a gap to identify what the challenges are for the social enterprises which are in the provinces with the least number of social enterprises and why female social entrepreneurs are showing a dissimilar number of proportions within the urban area and non-urban area. In this study the researcher aimed the research population as the social enterprises in Uva Province which the less number of social enterprises are located, to map challenges of social enterprises and giving recommendations for further development of the social enterprises in Sri Lanka. Qualitative research was done under a purposeful sampling method by selecting the sample in accordance with the researcher's knowledge and satisfaction of achieving the objective of the research during the data collection process and the sample size was ten sample units of social enterprises in Uva Province. Through exploratory research, the data was collected by direct interview method and semi-structured open-ended questions were developed base on the research objectives of the study. In this study Thematic Analysis was used to analyze the data. Findings were main six challenges as "Institutional and operational challenges, Policy making and government-related challenges, the Governance structure related challenges, Locational and situational challenges, Diversity based challenges and Social, educational, and public awareness related challenges", and more specific challenges for Uva province are "Locational and situational challenges", "Social educational and public awareness related challenges" and "Diversity based challenges". As the recommendations, an exact policy regulation framework for the social enterprises in Sri Lanka is needed and the respectable parties should take actions to give solutions for the development of the social enterprises in Sri Lanka.

Keywords: Social enterprises; Social entrepreneurship; Mapping challenges; Thematic analysis; Diversity based challenges

Influence of Human Relations Movement on Employees’ Self-reported Productivity in Work from Home

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The COVID-19 pandemic is having a disastrous effect on employability. Employers in different sectors have taken challenging decisions to minimize the congregation of people by taking an abrupt shift to work from home (WFH). The current literature revealed, how the occupational incongruity determines the employee's ability to WFH. This paper further examines the influence of employees’ socioeconomic characteristics and interpersonal relationships on their self-reported productivity during WFH. Additionally, the employees’ preference for continuity of this “hybrid way of working” even after the Covid-19 crisis has passed in Sri Lanka. The survey data was collected using a google form over 150 employees using the Snow Ball Sampling method. The perception of self-productivity was evaluated using Five Point Likert Scale in view of relative time spent on completing a task. The comparative analysis conducted using descriptive statistic methods and the Chi-square test. The sample was compromised with 21% of Government, 17% of Semi-government, and 62% of Private Sector employees representing 59% of females and 41% of males. The result displayed, no significant relationship between employees’ gender and age with their self-reported productivity. However, the results interpreted a significant difference between marital status and employees’ perceived productivity ($p = 0.003$ ($\alpha < 0.05$)). Married employees manifested lower productivity than singles. Besides, this lower productivity is disproportionately affected by the presence of children. There is a significant difference between the presence of children with time spent on completing a task ($p=0.031$ ($\alpha < 0.05$)) and the presence of children with their perceived productivity ($p = 0.003$ ($\alpha < 0.05$)). The results further indicated interpersonal relationships with partners, management staff, co-workers and, customers were significant to employees’ performance and achieving job tasks effectively ($p=0.000$, $\alpha < 0.05$). The absence of motivation and positive interaction has limited their capacity leading towards lower productivity during WFH. However, 59% of employees preferred to continue WFH and 27% have responded as indifferent while 14% have stated their disfavor towards continuity of WFH even after the social distancing policies gone back to normal. The evidence dispensed in this study helps to inform policy-makers to understand that WFH is largely been beneficial if the main issues are being addressed accordingly.

Keywords: Perception on self-productivity; Work from home; Socioeconomic; Social distancing; Interpersonal relationship

Green Supply Chain Management Practices and Operational Performance of the Commercial Banks in Sri Lanka

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The recent trends in sustainability have reinforced the global attention on greening business practices. The concept of green supply chain management (GSCM) and operational performance is still budding stages in the research and academic arena. As far as the Sri Lankan business context is concerned there is less evidence in terms of adaptation of green supply chain management practices on the service sector performance. Sustainability supply chain management has become an increasing area of the today banking sector and the concept of GSCM is new to the Sri Lankan banking sector. The purpose of this study is to contribute significantly to the first wave of empirical investigations related to the service industry perspective within a supply chain context. The study sought to establish the impact of GSCM practices and operational performance of the commercial banks in Sri Lanka. A mixed-method was followed to determine the supportive nature of qualitative findings and quantitative findings. A simple random sampling method was employed to highlight the specific subgroup of 104 managers who are already working in domestic licensed commercial banks. Data was gathered by using an online survey questionnaire. GSCM and operational performance of the commercial banks in Sri Lanka assessed using the structural equation modeling method and thematic analysis. The findings of the study remained that different banks adopt different green supply chain practices depending on the activities that they are engaged in and the analysis revealed that environmental collaboration, green purchasing, legislation and regulation, and e-banking technology have a significant positive impact on the operational performance. It was also found out that eco-design and reverse logistics were insignificant towards operational performance. Among the findings most important factors are the achieve sustainability through environmentally, economically, operationally, and financially and most challengeable factors are the less customer support, knowledge, and attitudes have to face when implementing the GSCM in commercial banks in Sri Lanka. This study recommended that the banking sector consider the adaption of GSCM fully like the current and potential benefits to enhance the operational performance of the banking system. Outcome of this study will be beneficial to examine the new knowledge and upgrading the existing knowledge and beneficial for policymakers, governments, and other stakeholders to taking necessary decision.

Keywords: Green supply chain management; Green supply chain management practices

Exploring Open Innovation Practices in Social Enterprises

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In today's competitive era, merely innovating within firm itself is not enough to achieve the competitive edge. Rather firms need to collaborate with external sources beyond their organizations in order develop new products as well as solutions. Open innovation practices play a major role in nurturing different types of innovations within firms. Large scale firms highly adopt open innovation practices. In the context of social enterprises, their use of open innovation practices is still under researched. Main focus of this research is to identify the most important external sources used by social enterprises, most common ways of collaborating with external sources and to identify the different types of innovations which result from adopting open innovation practices. Sampling frame consisting of 10 social enterprises was drawn using maximum variation sampling technique. Primary data were collected using semi structured interviews. Based on the information given, the researcher has developed the research. The researcher has used thematic analysis method to analyze the data using NVivo 12 software. The findings reveal that social enterprises in Uva province commonly use employee involvement, inter organizational networking, outsourcing R&D, direct outreach, international exposure, participation in other firms and customer involvement in order to nurture innovations. Therefore, this research emphasizes that social enterprises can nurture innovations and several other advantages by using open innovation practices.

Keywords: Innovations; Open innovations; Open innovation practices; Social entrepreneurship; Social enterprises

The Effect of Reinsurance on Performance of General Insurance Companies in Sri Lanka

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The intense, risky climate tightens the Sri Lankan insurers to make less performance and lack confidence in their future existence. So, the insurance companies have to use a risk transferring mechanism to another capable insurer to get protection against their financial complications when in their business routine. Some insurance companies suspend and amalgamate with other insurance companies due to unexpected catastrophes and growing their liability in the current scenario. Thus, Government rules also are imposed to increase their reinsurance portion. By considering this situation, the researcher intended to examine the effect of reinsurance on the performance of the general insurance sector using evidence from Sri Lanka. The researcher used secondary data from 07 general insurance companies in Sri Lanka from 2010 to 2019 to carry out this study. ROA and Underwriting profit/loss ratio used as the proxies for the performance of the general insurance companies. The explanatory variable of the study was reinsurance measured by retention ratio, net claims ratio, net commission ratio, and ceded reinsurance ratio. Findings were obtained through the panel data regression, revealing that the net claims ratio has a significantly negative effect on the performance of general insurance companies. In contrast, Ceded reinsurance ratio has a significantly positive effect on the performance of general insurance companies. Further, net commission ratio carries the positive effect, while the retention ratio carries negative effect on the performance of general insurance companies. Although the effect is statistically insignificant in the Sri Lanka context. So, this study concludes that general insurance companies should effectively manage their quality of the underwriting procedures and claim cost to increase their performance.

Keywords: Reinsurance; Performance of general insurance companies; Net claims ratio; Ceded reinsurance ratio; Underwriting profit/loss ratio; ROA

The Impact of Emotional Intelligence and Quality of Work Life on Organizational Citizenship Behaviour (With Special Reference to Banking Employees)

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Organizational citizenship behaviour as an emerging concept concentrate on organizational effectiveness and success has been gained intense attention from scholars since the last decade Organizational citizenship behaviour (OCB) plays a crucial role in the service sector, and profoundly in the banking sector. The quality of work-life and emotional intelligence as the cannons of OCB act as the most influential factors in organizational effectiveness. However, the extant literature in this context is fragmented and limited. Therefore, the study overlooks the impact of emotional intelligence and quality of work-life on organizational citizenship behaviour. Accordingly, the study evaluated the perceptions of 150 employees who worked in state banks Sri Lanak by employing a quantitative research design. A self-administered 5 point Lickert scale questionnaire designed to measure emotional intelligence, quality of work-life and organizational citizenship behaviour.was distributed among the study sample following the convenience sampling technique. The gathered data were analysed incorporating Partial Least Square – structural equation modelling through PLS path modelling and SPSS. The findings ascertained a significant relationship between the quality of work-life, emotional intelligence and organizational citizenship behaviour. Moreover, quality of work-life determined as the most influential variable in establishing OCB. Thus, the study recommends a regulatory and policy framework to encapsulate these elements into Organizational Citizenship Behaviour.

Keywords: Banking sector; Emotional intelligence; Organizational citizenship behavior; Quality of work life

A Study on Factors Affecting Consumer Purchase Intention of Green Products and Services in Sri Lankan Event Planning Industry: From Event Planners' Perspective

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Industries around the globe have been the reason to emerge the natural disasters and calamities occurring from environmental greenhouse effects. Environmental preservation have been adopted by many organizations and the importance of the green revolution has been started to realize. But the event planning industry in Sri Lanka does not concern much about the environment and does not attempt to adopt green practices. The insights of this study lead to understand the factors that influenced the perception of the event planners in Sri Lanka. Particularly, these insights were depicted that awareness, environmental concern, green advertising, greenwashing, green product attributes, social norms and income were identified as key factors for generating the perception of event planners in Sri Lanka. The semi-structured in-depth interviews were conducted among the 05 most reputed event planners in Sri Lanka to derive research data and the narrative analysis method has been adopted as the data analysis method in this study. A qualitative approach was applied to determine the underlying influences on event planners' perceptions about eco-friendly events in Sri Lanka. Additionally, the impact of the perception of consumers about the green concept related to the events was explored in this study from the event planners' point of view. Findings of the study show that awareness, environmental concern and green advertising are the factors that mostly impact on the consumers' green purchase intentions. Further, social norms, product attributes and income were identified as the factors which impact the green purchase intentions of consumers to a considerable extent. These insights will be fruitful to event planners to identify the opportunities to further invent new green strategies for their businesses and will able to influence the purchase intentions of consumers to be more environmentally friendly.

Keywords: Green marketing; Event planning industry; Green concept; Green purchase intention; Eco friendly products and services

Innovation and Triple Bottom Line: The Role of Environmental Dynamism

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Small Medium Enterprises (SMEs) are considered as driving engines of a country's economy. In Jaffna District, there has been no significant improvement in the development of SMEs due to inadequate financial resources, lack of governmental support, work condition, inadequate innovation and environmental pollution. Hence, SMEs organizations are using some innovative practice to achieve their sustainability with regards to Triple Bottom Line (TBL) goals are arisen to measure SMEs performance. However, this study aims to consider Environmental Dynamism as a moderating variable, to build a conceptual framework for innovation and triple bottom line goals. Thus, this study evaluated the relationship between innovations and Triple bottom line and while the relationship between innovation and Triple Bottom Line with Environmental Dynamism. Questionnaires were distributed by using random sampling technique to collect primary data from 120 managerial level employees who are working in 120 SMEs manufacturing organizations that are registered under Industrial Development Board (IDB) in Jaffna District. Moreover, descriptive statistics as mean, standard deviation and percentage were analyzed through SPSS software. The measurement model was tested through content validity, convergent validity and discriminant validity and structural model as Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis and Assessment of moderation analysis were performed to analyze the research objectives using Smart PLS 3. Software to analyze those data. The results of the study indicated that there is a positive relationship between innovation and Triple bottom line goals. Further identified, environmental dynamism is negatively moderated relationship between innovation and Triple Bottom Line goals. Based on research findings, the study recommended that when SMEs produces new products or services to their market, they must concern about their people, profit and environment. Detailed findings say that innovation leads to achieving TBL in the SMEs strongly influence on environmental dynamism. Finally, this study would be done a greater job to increase the performance of SMEs in Jaffna District.

Keywords: Environmental Dynamism; Innovations; Small Medium Enterprises (SMEs); Triple Bottom Line

Impact of Green Marketing Mix on Consumers' Purchase Intention with the Mediating Effect of Corporate Image (With Reference to Food and Beverage Market)

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With the degradation of earth increases organizations identified an opportunity to turn their businesses in to green. The organizations realized that their long term existence depend on coordination between environment and benefits of consumer and society. As a social responsibility most manufacturers concern on green marketing mix including green product, price, place and promotion. Therefore it leads to create a positive corporate image and thereby it directs consumers to make purchase decisions. The lack of research attention has been given on the impact of green marketing mix on purchase intention with the mediating effect of corporate image. Hence, the current research addresses the knowledge and empirical gap. The main objective of the study is to investigate the mediating effect of corporate image in the relationship between green marketing mix and purchase intention. The data were collected from a sample of 384 millenials in Sri Lanka based on stratified and convenience sampling techniques. The collected data was analyzed using descriptive statistics, correlation analysis, regression analysis. Further to test the mediating impact, the researcher used the Baron and Kenny model and Sobel test. According to the findings of the regression analysis, the researcher drew a conclusion that there is a significant impact of green marketing mix on purchase intention. Meantime the results of the Barron and Kenny analysis and sobel test led to reveal that the relationship between green marketing mix and purchase intention is mediated by corporate image. Finally the researcher could be able to meet the expected objectives of the study and further the researcher recommends marketers to promote the green concept and improve the consumer awareness through marketing campaigns and other awareness programs.

Keywords: Green marketing mix; Green product; Green price; Green place; Green promotion; Corporate image; Purchase intention

Study of Intension to Adapt Green Banking Practices for Environmental Performance (With Special Reference to Listed Commercial Banks in Western Province)

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In most of emerging economies, an important role is occupied by the banking system for the development and create the core of money market. Going green concept become an enormous trend in global as well as it is common to the banking industry. This generated a huge transformation from traditional banking to green banking. In Sri Lanka, banking industry can recognize as monopolistic competitive market and both sectors advocate variety of non-monetary competitive strategies to become market leader. Hence, most of banks are in the process of moving to green banking. With this greater trend towards green banking, many researchers had studied on the green concept from various appearance in world banking system. The results of some of the studies are contradict on each other. While same senarios continues in greening research, there are few different appearances with controcted findings in Sri Lankan context as well. Seemingly, there are lack of studies undertaken in Sri Lanka regarding green banking practices together with environmental performance is highlighted. This study is conducted to study of intension to adapt green banking practices for environmental performance to address the knowledge and empirical gaps. Research objectives is to examine the impact between intension to adapt green banking practices for environmental performance, to understand the green banking practices adapted by listed commercial banks in Sri Lanka and to discover the problem faced by banks while adapting green banking practices. The data were collected from four banks based on past researchers and sample of 108 employees who worked in selected banks in Western Province using multistage simple random sampling method. The mixed research design is used and data was analysed by using descriptive statistics, regression, content and thematic analysis. The finding of the study revealed that, intension to adapt green banking practices, management commitment and support, competitor pressure and customer pressure have positive significant impact on environmental performance. Further, it revealed green banking practices and problems faced by banks while adapting green banking practices. The current study will be important in understanding the empirical knowledge regarding the intension to adapt green banking practices for environmental performance.

Keywords: Green banking; Green banking practices; Intension to adapt green banking practices; Environmental performance

Social Capital and Operational Performance of Domestic Licenced Commercial Banks in Sri Lanka

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Social capital, a valuable resource for strengthening an organization, yet a less studied concept in Sri Lankan context. This study endeavoured to explore the impact of social capital on operational performance of domestic licenced commercial banks in Sri Lanka with the hypothesis that there is a positive relationship between social capital and operational performance of licenced commercial banks in Sri Lanka. Three dimensions of social capital, relational, structural and cognitive social capital were used as the proxy for the independent variable while the operational performance of the organizations were measured using cost, quality, flexibility and delivery. The study relied on a survey design and a cross-sectional data was collected using a likert scale type questionnaire. Data were collected across 100 branch managers from top five domestic licensed commercial banks, which has their national ratings as "AA" by Fitch Ratings (Lanka) Ltd. using multistage sampling technique. Descriptive Statistics, Pearson Correlation Coefficient, Simple Linear Regression Analysis and Multiple Linear Regression Analysis techniques were used as statistical analysis. The study revealed that all three dimensions of social capital showed a strong positive relationship with operational performance while the cognitive social capital showed the highest positive relationship. Further this study revealed that the social capital significantly and positively impacts on operational performance of domestic licenced commercial banks in Sri Lanka. The outcome of this study recommends managers and the policymakers to have a mechanism to improve the social capital of top management as it leads to enhance the operational performance. Further this study contributes largely to the Sri Lankan literature in the context of social capital.

Keywords: Cognitive social capital; Operational performance; Relational social capital; Structural social capital; Sri Lanka

Factors Influencing Consumers' Purchase Intention of Ecofriendly Apparel (With Special Reference to Colombo District Millenials)

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The ecofriendly apparel is an emerging concept in Sri Lanka. The purpose of the study was to examine consumers' purchase intention towards eco-friendly apparel by investigating the effects of their expectations, perception, subjective norms, perceived behavioral control, and attitudes. The study was selected six eco-friendly outlets and collected data from 150 millennials who live in Colombo the questionnaire was used as the data collecting technique. Millennials were selected by using a simple random sampling method. Descriptive statistics, correlation analysis, and regression analysis were used to analyze data with the support of the SPSS 22.0 version. The purpose of the study was to examine consumers' purchase intention towards eco-friendly apparel by investigating the effects of their expectations, perception, subjective norms, perceived behavioral control, and attitudes. Based on the result all the independent variables have positive relationship with dependent variables. All the independent variables (expectation, perception, subjective norms, perceived behavioral control, and attitudes) positively impact on purchase intention. As well as subjective norms are the most impacting predictor of purchase intention. This study provides recommendations and suggestions to sales and marketing managers should implement marketing strategies to enhance purchase intention concerning the factors of eco-friendly apparel. Hence marketing managers, fashion designers, and relevant policymaker need to identify what are the factors influencing purchase intention towards eco-friendly apparel with special reference to Colombo districts millennials.

Keywords: Attitude and Purchase intention; Ecofriendly apparel; Expectation, Millennials; Perception; Subjective norms; Perceived Behavioral Control

Impact of Crowdsourcing on Generating Innovations

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Crowdsourcing is an innovation technique implement through a combination of crowd and outsourcing. It is a kind of internet-based people outsourcing to accomplish organizational tasks. Traditional innovational aspects are a burden for companies because innovative ideas are only generated through internal organizational methods. In that case, crowdsourcing has become popular within the business sector in the last few years. Since people outsourcing through internet platforms is a common factor within IT sector, the IT industry is known as one of the most innovative business sectors. The Sri Lankan IT sector plays a major role in the country's economy as the fourth largest export income generator. The influence of crowdsourcing on generating innovations in Sri Lanka has not been explored in the existing literature. Therefore, this research has been carried out to find the impact, association, and the existing usage of crowdsourcing and innovations in Sri Lanka. The data were collected by distributing a self-developed questionnaire across 50 IT firms that are registered in SLASSCOM in the Colombo district. Data analysis was performed through descriptive analysis, correlation coefficient, and simple linear regression analysis. The results of the study denote that there is a strong positive relationship between crowdsourcing and innovations in Sri Lanka and also the existing usage of the concepts on developing innovations at a satisfactory level in the country. Outcomes of the research will lead policy makers to make decisions to increase the activities related to the crowdsourcing. The overall research findings provide managerial and theoretical implications for further enhancement of the crowdsourcing on generating innovations in Sri Lanka.

Keywords: Crowdsourcing; Innovations; Internet; IT Industry

Social Capital and Customer's Satisfaction on the Bank-Customer Relationship in Sri Lanka

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Social capital, is a set of social organization characteristics, like trusts, norms, and networks which may leads to improve the behavioral and social efficiency through coordinated actions. There are less studies on the concept of social capital in the Sri Lankan context, particularly the nexus between social capital and customer's satisfaction on the relationship with the bank though it is an essential phenomenan specially to the service sector organizations. Thus, the purpose of this paper is to investigate the influence of social capital on customer's satisfaction regarding the Bank-Customer relationship in Sri Lanka. Structural social capital, relational social capital, and cognitive social capital were considered as the diamentions of social capital while the re-patronage intention and negative word of mouth were used to measure the customer's relationship satisfaction. The sample of this study was 150 unsatisfied customers, selected 30 from each of the top five licensed commercial banks according to the Fitch Ratings (Pvt.) Ltd, 2020 using convenient sampling techniques. The data were collected using a structured questionnaire and the descriptive statistics were measured using SPSS version 26 software. The major analysis technique used in this study was the structural equation model in Smart PLS software. The results revealed that all three diamentions of social capital have a significant positive impact on customer's relationship satisfaction. This study recommends the service sector organizations to create meachnism to improve the social capital and there by improve the relationships with customers. Further this study contributes to the Sri Lankan literature in the context of social capital.

Keywords: Social capital; Customer's satisfaction; Customer relationship; Banking sector; Sri Lanka

The Impact of Debt Capacity on Firm’s Growth: A study of Listed Manufacturing Companies in Colombo Stock Exchange

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Capital structure and company’s growth is important for any firm because company success depends on its growth and that off course required capital. In competitive market growth shows strength and stability of firm and profitability continuation in long run. In Sri Lanka few empirical studies have been done to establish the relationship between debt capacity and firm’s growth. Therefore the study attempts to fill the empirical and knowledge gap by establishing how debt capacity and firm’s growth are linking and how company can change its debt portion while maintaining its growth level. Hence a quantitative study has been undertaken to establish a conclusion that the debt capacity of an entity has an impact on firm’s growth in listed manufacturing companies in Colombo stock exchange. From the twenty sectors of the Colombo stock exchange, manufacturing sectors was selected for the present study. The sample of this study composed of 31 listed manufacturing companies in the Colombo Stock Exchange and period of five years from 2014/15 to 2018/19 from secondary data sources. To perform the analysis of the study, STATA analyzing technique has been used. The study discovered a significant relationship between interest coverage and market capitalization. Further identified that the interest coverage has a significant negative impact on market capitalization but debt to assets ratio has an insignificant positive impact on market capitalization. There is no prior literature in Sri Lanka comprising Debt Capacity and Firms’ Growth. So, this study contributes to the extant literature and fills the existence gap in the literature by providing empirical evidence regarding the impact of Debt Capacity and Firms’ Growth in the Sri Lankan context.

Keywords: Debt to assets; Interest coverage; Market capitalization; Price earnings

Impact of Internal Recruitment on Job Performance (Special Reference to Operational Employees in Apparel Industry in Western Province - Sri Lanka)

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Internal Recruitment is a method that an organization encourage potential employees to apply for existing or future job openings within the current workforce, hence, it has the ability to motivate employees and enhance their outcomes. Apparel industry is one of the major industries in Sri Lanka in terms of revenue for the country and the operational level employees are the key workforce within the apparel industry and their performance is very important for organizational performance. With the empirical gap which identified by reviewing literatures, it is necessary to identify whether the internal recruitment impacts on operational employees' job performance. The primary objective of the research is identified whether Internal Recruitment impacts on the Job Performance of operational level employees. The secondary objectives are to identify the current internal recruitment methods mostly used by the apparel industry, identifying the relationship between internal recruitment methods and job performance and identifying the issues and barriers faced by the apparel industry when recruiting internally. This study used mixed approach and a structured questionnaire was used to collect data over a convenient sample of 108 respondents who were operational employees in the apparel industry. Further, structured interview was conducted in order to gather qualitative data with human resources professionals to achieve third research objective. Descriptive statistics, correlation coefficient and regression analysis were used to analyze the quantitative data and thematic analysis was used to analyze qualitative data. According to the findings, internal recruitment significantly and positively impacts on operational employees' job performance and job promotion and supervisor/employee referral has positive and significant relationship with operational employees' job performance and job transfer has negative and insignificant relationship. Further, job promotion is the currently most used internal recruitment method in apparel industry and the influence of interviewers' perspectives, lack of performance management and legal issues are the main barriers which are the industry face when using internal recruitment policies. Therefore, the practitioners are encouraged to follow effective internal recruitment methods like job promotion and supervisor/employee referral to increase operational employees' job performance.

Keywords: Apparel Industry; Internal Recruitment; Job Performance; Operational Level Employees

Customer Satisfaction on Service Encounters in the Special Reference to State Banks of the Western Province in Sri Lanka

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Banks as a service provider, offer similar kinds of products, and those are differed by the quality of their service. Banks involved in the provision of a range of services including traditional banking services and beyond that it involves the provision of self-banking services. When banks providing a service, banks should have the ability to satisfy customers in the purchasing movement it is known as service encounter. The concept of service encounter reveals that, direct interaction between customer and service provider. This study focused on traditional and self-service bank encounter quality and how it affects customer satisfaction. Recovery, spontaneity, and adaptability are the common encounter themes that are available in the literature. However, traditional service encounter quality measures are not efficient to measure the self-service encounter quality. The researcher had to consider technology-based service quality measures to evaluate the self-service encounter quality such as easy to use, convenience, security, and efficiency. A quantitative approach was used to conduct the research and data were collected from 171 youth state bank account holders in the western province through a Stratified random sampling technique therefore, Bank of Ceylon, People's Bank, National Savings Bank, Regional Development Bank selected for the study due to their huge branch network compared to other public banks. The online survey method used to collect the data and SPSS 25 software was used to analysing the data. The hypotheses were tested by using Correlations analysis and simple linear regression, and multiple linear regression was used to analyse the research objectives. Findings reveal that, the strong positive impact of encounter service quality towards customer satisfaction (0.811). In addition that, traditional and self-service encounter quality has a positive and significant impact on bank customer encounter satisfaction. Spontaneity is the highest contributor for the traditional service encounter quality while recovery shows minimum contribution. When considering the Self-service encounter respectively convenience, ease to use, security, and efficiency significantly impact the encounter satisfaction. Furthermore, Self-service is the most promising banking method in the youth. However, banks have to set a precedent benchmark in both banking methods to offer greater convenience to customers.

Keywords: Service encounter quality; Service encounter satisfaction; State bank

A Study on Impact of Consumer Ethnocentrism on Willing to Purchase with Mediating Role of Perceived Value (Special Reference to Dairy Industry in Sri Lanka)

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Consumer Ethnocentrism directly influence to the appearances and characteristics of the consumer. Consumer ethnocentrism emphasizing competitive business trends in dairy product sector in Sri Lankan market. With a current scenario the improvement of global economy consumers of around the world increase exposed foreign products and increasing purchase choices. However global economy intensified foreign competition for domestic manufacturers in motivating and protection domestic buyers. Recent studies exposed that consumer's interest towards foreign dairy brands was decreasing. One clarification for such changes may be nationalistic or ethnocentric behaviors of consumers. Hence future dairy companies face effect of the perceived value problems of the parent brand. However, lack of research attention has been given on the impact of consumer ethnocentrism on willing to purchase the dairy products where perceived value playing the mediatory role. Thus it identified knowledge gap and empirical gap and however this research study covered this gap by providing evidence to encourage get purchasing decisions of consumer's. In accordance by the above considerations this study develops a model to identify the impact of consumer ethnocentrism on willing to purchase products mediated by perceived value in dairy product sector in Sri Lanka. Data were collected from 200 dairy product consumers from Southern Province using multistage sampling and convenient sampling techniques. Further, data was analyzed using descriptive statistics, coefficient correlation analysis, regression analysis, and mediator analysis based on the research objectives and hypothesis developed. According to the findings there is positive impact of consumer ethnocentrism on willing to purchase and partially mediation exists with the PV. These results provide both knowledge and managerial implications, and as well suggestions some further research areas for future research.

Keywords: Consumer Ethnocentrism; Willing to purchase; Perceived Value

The Impact of Social Media Marketing on The Purchase Intention of Environmentally Sustainable Cosmetic Products: The Role of Brand Trust as the Mediator (With Special Reference to Badulla District)

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The Social media platforms emerged as a result of new technology and ‘social media marketing’ is attracting the attention of business world as a prominent method of reaching a wider customer base. Social media marketing impacts on the purchasing intention of the customers and the role of brand trust is playing a vital role in the online business environment. However, in an environment where the customers tend to reflect a paradigm shift towards purchasing the environmentally sustainable products, the investigation of the impact of social media marketing on the purchase intention of environmentally sustainable cosmetic products or the role of brand trust in there, seems an area that is not discussed widely. Therefore, this study intended to investigate the impact of social media marketing on the purchase intention of environmentally sustainable cosmetic products with the mediation effect of brand trust. For this study both primary and secondary data were used and the primary data were collected online from 200 respondents by using a structured questionnaire. The collected data were analyzed by using IBM SPSS statistics 25.0 and Smart PLS software. The findings of the study revealed that the social media marketing has a significant impact on the purchase intention of environmentally sustainable cosmetic products and is partially mediated by the brand trust. This study recommends, the managers and the marketers to focus more on offering some additional support to the consumers through their social media page designs and producing environmentally sustainable cosmetic products by utilizing more organic ingredients within the production process. Further, the future researchers are encouraged to investigate the respective area of study considering larger sample sizes with different other social media marketing dimensions in order to have more reliable output.

Keywords: Social Media Marketing; Brand Trust; Purchase Intention; Environmentally Sustainable Cosmetic Products

The Impact of Advertising Media Effectiveness on Brand Equity (With Special Reference to Toothpaste Industry in Sri Lanka)

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This study was carried out to determine the impact of perceived advertising media effectiveness on the brand equity of toothpaste market in Sri Lanka. Advertising blends and several variables cause major variations in the success of a brand and this study is particularly focus on the toothpaste industry that can be noticed as one of the most competitive industries in Sri Lanka. Sample of this study consisted of 100 respondents from Matale district who consume toothpaste regularly. Responses for the study collected through five-point Likert scale questionnaire. Descriptive statistics and regression analysis was employed to answer the research questions by achieving the research objectives. This study's findings revealed that selected respondents from Matale district show moderate response to the Perceived advertising effectiveness from toothpaste companies. However, they almost agree with the existing brand equity for toothpaste brands in Matale district. Demographic factors revealed that the majority of the respondents use toothpaste twice a day. The regression analysis results show that the perceived advertising media effectiveness has a positive impact on the brand equity of toothpaste brands that validated the findings of the previous studies. This study provides recommendations and suggestions for the practical implementation of effective advertising campaigns and it suggests that Audience engagement with content, Audience attentiveness and responsiveness is playing a vital role in perceived advertising media effectiveness and Friends & family environment has a significant impact on building brand equity.

Keywords: Audience Engagement with Content; Audience Attentiveness and Responsiveness; Brand Equity; Friends and Family Environment; Media Effectiveness; Perceived Advertising.

Impact of Influencer Marketing on Purchase Intention of Cosmetic Products: Evidence from the Instagram Users in Sri Lanka

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Influencer marketing is a trending social media marketing technique that focuses to drive a brand's message to a larger market using influencers. Since the human beings are rapidly entering to the cyber universe in this digital technological era, such social media marketing can easily be continued with many organizational operations, including the arrival in the target market, the launch of products, handling customers' orders and sales etc. Despite the growing trend of influencer marketing technique around the globe, the impact of influencer marketing on purchase intention of Sri Lankan customers is an under researched area. The aim of this study was to investigate the impacts of influencer marketing on purchasing intention of cosmetics products of Instagram users in Sri Lanka. Based on the source credibility and source attractiveness model factors of influencers that can affect for the Instagram users' purchase intention are trustworthiness, expertise, likeability, similarity, and familiarity of influencers were considered as independent variable of this study. 200 Instagram users aged between 20 to 34 years who follows social media influencers in purchasing goods were selected using snowball sampling technique as the sample of this study and the response rate was 66%. The data were collected using a structured questionnaire. Descriptive Statistics, Correlation Coefficient Analysis and Simple Linear Regression Analysis techniques were used for statistical analysis using SPSS version 25 software. The study revealed that influencer marketing impacts on purchasing intention of cosmetic products in Sri Lanka. Further, it revealed that the trustworthiness of the social media influencer is the mostly affecting factor towards purchase intention of cosmetics products. Hence, this study recommends the marketers who use influencer marketing technique to pay attention on all the source credibility factors lending special consideration on the trustworthiness of the social media influencers. The findings of this study will contribute to the marketing literature in particularly to the social media marketing.

Keywords: Followers; Influencer marketing; Instagram; Purchase Intention; social media influencers

COVID-19 Impact on E-commerce Usage: An Empirical Evidence from Sri Lankan SME Sector (With special reference to Northern Province)

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The adoption of e-commerce in the small and medium sector has become one of the main business improvement areas in the Small and Medium Enterprises that seems unavoidable in competing and even surviving in a highly competitive industry before and during COVID-19. This study focus on the impact of e-commerce usage in small and medium enterprises under the COVID-19 outbreak. It is found that many firms are having a difficult situation with business operation and attempted to use e-commerce to upgrade their operation and competitive capabilities for survival in the industry. To review this problem in the Sri Lankan Small and Medium Enterprise sector, Technological, Organizational and Environmental model was modified and used as a conceptual framework to review the problem in the Sri Lankan small and medium enterprises. This study focused on the Northern Province of Sri Lanka, consisting of five districts: Jaffna, Killinochchi, Vavuniya, Mannar and Mullaitivu. This research was conducted based on quantitative survey method. The structured questionnaire was distributed among 120 samples of small and medium enterprises, which was selected using a simple random technique. The data collected through this survey was analyzed using SPSS and PLS-SEM (SmartPLS) version 3 to examine the relationship between variables and test the hypothesis. The findings of the study reveal that perceived benefits, e-commerce knowledge, external pressure and supply chain integration have a significant positive impact. In the other hand, IT infrastructure has an insignificant effect on e-commerce usage. In addition, the benefits obtained from this study can be used to empower e-commerce usage in the small and medium enterprise, including manufacturing industry, service industry and trade industry. Also, it will enhance the quality of providing goods and services. The origin of this research is combining effect of Technological, Organizational and Environmental and Diffusion of Innovation theory on e-commerce usage for the Small and Medium Enterprises to contribute to the literature.

Keywords: COVID-19; E-commerce; Small and Medium enterprises; Organizational; Technological; Environmental

Impact of Covid – 19 on Performance of SMEs in Uva Province

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COVID – 19 as a globally spread virus, has led to inactive almost all the economies in the world and it has been created a negative impact on all businesses especially including SMEs worldwide. This study provides a detailed analysis of how the COVID - 19 has affected the performance of SMEs in the Uva Province of Sri Lanka. Moreover this study has been focused to identify SME holders ability to conduct the business siring the pandemic situation. This study has adopted the quantitative approach as research design. In addition the questionnaire was the major instrument of data collection administered to the one hundred and twenty (120) respondents from two (02) districts in Uva Province namely, Monaragala (56) and Badulla (64). The data obtained under three constructs consisting of 38 dimensions were analyzed employing both descriptive analysis and t - test analysis by using IBM SPSS software. The findings of the study have revealed that COVID – 19 has affected the performance of SMEs in Uva Province in both positive and negative manner. It further revealed that there is a significant difference in the financial performances and marketing performances of SMEs in Uva Province during the COVID – 19 and before the COVID - 19. However, innovative performances of SMEs have increased during COVID – 19 compared to the Pre COVID – 19 Period. Moreover, the study provides details about SME holders’ ability to conduct the business even under a pandemic situation. The studt revealed that the majority of SME holders (give the percentage if available) have the ability to continue their businessess only about 3 to 6 months under this pandemic situation.

Keywords: COVID – 19; Small and Medium Enterprises; Performance of SMEs; Financial Performance; Innovative Performance; Operational performance

The Impact of Extended Marketing Mix on Customer Purchase Intention (With Special Reference to Hela Bojun Outlet in Galle District)

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The fast food industry in Sri Lanka is experiencing market related changes from the globalized food patterns to the indigenous nutrient food products which are promoted by the public sector agencies through the concepts such as establishing Hela Bojun Outlets Island wide. In order to gain and secure the existing state of competitive advantages for Hela Bojun outlets, they need to identify and understand the importance of the Elements of the extended marketing mix which defined as Product, Price, Place, Promotion, People, Process and Physical Evidence. Hence the respective area of study is not widely discussed in the academia, through this study it is expected to investigate the impact of Extended Marketing Mix elements on the Customer purchase Intention of Hela Bojun Outlet with special reference to Galle District. In order to conduct the research survey, a sample of 200 respondents, who have the capacity to make purchasing decisions were selected from Hela Bojun outlet in Galle district. A self-administered questionnaire was used to collect the primary data both physically and online from the respondents and SPSS Statistics version 22 was used as the data analysis tool. Data analysis was performed through the descriptive statistics and multiple linear regression analysis. As the finding of the study revealed except place, people and process elements, all the other variables of product, price, promotion and physical evidence significantly and positively impact on the purchase intention of the customers. Further 'product' element has the highest impact on customer purchase intention. Accordingly, this study recommends the Administration of the Hela Bojun to expand their service into various market segments based on the impact of the marketing mix elements and new business strategies should be formulated to enhance the performance of those marketing mix elements.

Keywords: Extended Marketing Mix; Customer Purchase Intention; Fast food Consumption; Indigenous Fast Food Industry; Hela Bojun Outlets

Impact of Social Innovation in Rural Development (With Special Reference to Mullaitivu District)

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Entrepreneur success research suffers from a lack of consistency in defining the scope of Social Innovation plays a prominent role in rural development of many developing countries. Sri Lanka is a developing country with unique attributes and resources, Day-by-day social innovation becomes a crucial indicator for improving the quality of life of the people in rural areas. This study aims to assess the roles and functions of social innovations that have been undertaken in rural areas of Mullaitivu District. Main focus of this research is to analyze the impact of social innovation in rural development. A sample of 45 households who were engaged with social innovation practices was drawn using convenience sampling for a qualitative study. Primary data were collected by conducting semi-structured interviews. The researcher has used thematic analysis method to analyze the data, using Microsoft Excel 2013 software. It was found that rural people with poor economic condition in Mullaitivu District are encouraged to participate in social innovation practices and the findings revealed that more favorable perceptions of the economic, social and environmental impacts lead to greater support in their livelihood and the economic condition. Social innovation impacts in individual empowerment by fostering human development and social protection. Also social innovation positively impacts on community development by enhancing the quality of life economically and non-economically. It is a clear statement that the roles and impacts of social innovation is crucial to support rural development and to support village economy. Participants are willing to engage in social innovation, thus it is necessary to take proper actions to promote social innovations for further development of rural areas.

Keywords: Social problems; Innovation; Social Innovation; Living condition; Rural development



Analysis of Household Determinants of Demand for Food Away-from-Home (FAFH) in the Urban Sector of Sri Lanka

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Food consumption in Asia has undergone significant changes over the past two decades. This change in consumption patterns can be attributed to the rapid economic and income growth, urbanization, modernization of marketing infrastructures, the emergence of processed food companies, the spreading of multinational fast food service providers, increased female labour force participation. One of the biggest changes in food consumption patterns in Sri Lanka is the increased consumption of food away from home (FAFH). Nutritionists, economists, public health officials, and policymakers are concerned that consumption of more FAFH, relative to food at home (FAH) likely to contribute to food-related chronic diseases in humans. This study aims to investigate the demand characteristics of FAFH consumption in Sri Lanka with special reference to the urban sector. Data were collected from the Household Income and Expenditure Survey (HIES) 2016, conducted by the Department of Census and Statistics (DCS) in Sri Lanka. The theoretical model of this study is derived from Becker's Household Production Theory. Factors influencing households' decisions to consume food away from home and how much to spend on these food items were analyzed using Cragg's double hurdle model. According to the results, income, household size, all adult members engaging in a job, being single have positive and significant effects on the household's expenditure on FAFH. However, household head's age, and education level have significant negative effects on away from home food consumption expenditure. Further, estimations of the first hurdle model reveal that the household head's age, family size, and household head's education level negatively and significantly affect the FAFH consumption decisions. Accordingly, younger households, less educated households, and all working households have a greater preference for convenience than other households as illustrated in their expenditure patterns on food away from home. Getting richer will also lead to a higher level of FAFH expenditure. Educating consumers about healthful FAFH choices could have a significant payoff, especially if self-control is impaired when eating away from home.

Keywords: Urbanization; Income growth; Health; Consumption; Food away from home; Double Hurdle Model

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Recommender System Based on Food and Exercise Ontologies to Find the Suitable Fitness Exercise Plan with the aid of Python

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In the modern world, professionals of diverse industrial sectors have severely become victims of overweight and obese conditions which can be minimized by having proper dietary plans, physical activities, and minimizing alcohol-based relaxation. However, most of the exercise plans provided by fitness applications currently available for usage are not personalized and general exercises are given for every individual. In this research context, individuals are guided by recommending suitable exercises with exercise frequency, exercise environment, and unique time period to perform according to body parameters. According to domain experts, fitness plans highly depend on individual characteristics. Therefore height, weight, age, sex, diet details, medical history and user preferences for exercises taken from the front end which is a Tkinter Graphical User Interface. In this system, food ontology uses these details to calculate the daily calorie intake and extra calorie intake of the particular individual. Disease extraction using natural language processing techniques, computed with Python and integrated with the output of Food Ontology which is to be mapped with the exercise ontological knowledge base along with the predefined rules to match respective exercises suitable for the particular individual that is compatible with his preferences. Two ontologies for foods and exercises developed using Protégé 4.3 and data retrieved by running Simple Protocol and Resource Description Framework Query Language (SPARQL) queries inside the Python code using the RDFLib module and output is taken and directed to the front end. The entire system developed with Python 3, where two ontological files of Foods and Exercises are loaded and tested for consistency using the HermiT reasoner with the aid of Owlready2. The task-based ontology evaluation approach is performed by addressing the competency questions through the execution of SPARQL queries. In conclusion, this study provides an approach to integrate two ontologies and a disease extraction model using Python programming language. Correctness and qualitative evaluations of the system are verified by the domain experts, and recommendations from the ontological system are beneficial for physical trainers to improve and validate their manual exercise recommendations.

Keywords: Exercises; Ontology; Food; Tkinter; Python

A Nutrient Based Diet Plan Recommendation System using Machine Learning

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At present obesity is a key health issue as everyone is busy with their day-to-day lives. Existing diet recommendation systems suggest a common diet plan instead of considering the person's lifestyle and diseases and hence it leads to health issues. This research develops a system to recommend an appropriate diet plan for each person based on their personal profiles. The proposed system collects the personal information from users such as age, height, weight, gender, chronic diseases, and physical activities, and then it recommends the diet plans for the breakfast, lunch, tea time and dinner with appropriate calorie levels (carbohydrate, protein, lipid, calcium, phosphorous, fiber and iron) that helps to maintain the healthy weight of the body. The data was collected from the hospitals using a questionnaire. A Linear Regression models and a Neural Network model are trained to predict the required amount of calories per day based on the users' profile. Based on the error rate comparison of both model, the Neural Network model is the best fit for calorie prediction. The diet plan is defined by a rule-based system based on the predicted calorie level. The predicted diet plan for a given user is compared with the diet plan recommended by a nutritionist to measure the accuracy of the proposed system. Accordingly, the prediction accuracy of the system is 95%, which is decent enough when compared to the existing models in the literature. A limited number of parameters of users are considered to predict the calorie level and the diet food combinations. However, considering more parameters would further enhance the diet plan suggestions.

Keywords: Machine Learning; Obesity; Linear Regression; Neural Network; Diet Plan

Analysis of Traffic Sign Detection and Recognition Techniques

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Automated Traffic Sign Detection and Recognition (ATSDR) is a trending research field in this current decade. It is a very important part of the intelligent transportation system as traffic signs assist the drivers to drive more carefully. This paper provides a review of three major steps in the ATSDR system; video segmentation, detection, and recognition. There are many techniques used for the detection and recognition process. However, those techniques are affected by different internal and external conditions like camera quality(fps), lighting conditions, time periods, etc. The main objectives are; to identify the different traffic sign detection and recognition techniques, develop the ATSDR system by using those selected technologies and analyze the performance of those techniques in different lighting conditions and time periods in Sri Lanka. Real time video sequences of traffic signs were collected and partitioned into single frames using video segmentation. The traffic signs were detected using shape-based and color-based features along with learning-based methods (Convolutional Neural Networks (CNN)). Subsequently, the signs were recognized using selected techniques such as Random forest method, CNN, and Support Vector Machine (SVM). Selected techniques were applied to the 10 varieties of traffic signs in Sri Lanka in different conditions, each having 1000 samples. Experimental results show that the approach obtained the desired results effectively. CNN method obtained 74.16% overall accuracy, SVM method obtained 63.5% overall accuracy and Random forest method obtained 58.6% overall accuracy. In the future, accuracy can be improved by testing the technologies in different internal factors like different camera quality (fps) and different computing power, as well as high-resolution images and a large number of training images should be used for the analysis. The experimental results showed that CNN is the most suitable technology to detect and recognize traffic signs based on the Sri Lankan traffic signs database

Keywords: Traffic sign detection and recognition; Convolutional Neural Network; Support Vector Machine; Shape based methods; Color based methods; Random forest

Comparative Evaluation of Unsupervised Machine Learning Algorithms for Anomaly Detection in Time Series Data

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Anomaly detection is a mechanism of identifying data, occurrences and observations deviating from the normal pattern. Anomaly detection in time series data is used to identify critical and fraudulent events, technical glitches and potential opportunities in the systems. Hence it is important to build robust models that can properly identify anomalies in time series data. In the literature, Anomaly detection is done using supervised, unsupervised and hybrid machine learning algorithms. However, most researches have focused on unsupervised algorithms to build anomaly detection models due to unavailability of labelled data. These unsupervised algorithms are based on probability, distance, density or a boundary function. This study provides a comparative evaluation of multiple unsupervised algorithms for anomaly detection in time series data, namely Elliptic Envelope, Gaussian Mixture Model, Isolation Forest, Local Outlier Factor, One Class Support Vector Machine and K-Means Clustering algorithm. Based on previous literature, these algorithms were selected as a famously used subset of algorithms for multi-domain anomaly detection. The algorithms were evaluated using Yahoo! Webscope S5 labeled dataset. This dataset contains real and synthetic time series data in 4 classes with overall 572,966 data instances and 367 metrics. Feature extraction was done using time series decomposition and statistical techniques. These extracted features were integrated with specific features given in the data classes to improve the performance of these algorithms. The feature normalization was done using min-max scale. Elliptic Envelope and Gaussian Mixture Model were the best performing algorithms with 26.3% - 81.7% F1 score, 26.4% - 82.7% true positive rate and below 2% false alarm rate for the 4 data classes in the dataset. The reason for this is the ability of probabilistic models to adapt and identify the complex patterns in time series data that helps to identify deviations in a more robust way. One Class Support Vector Machine is the worst performing algorithm with 1.2% - 6.5% F1 score and around 50% false alarm rate for the data classes in the dataset as its decision function was unable to properly adapt to the complex patterns in time series data. However, it had 96.2% - 99.5% true positive rate. Other algorithms performed moderately where Isolation Forest performed best in the high contamination data class

Keywords: Anomaly detection; Time series data; Unsupervised machine learning algorithms; Comparative evaluation

Secondary and Super Secondary Structure of Prefusion Conformation of Spike Protein of SARS-CoV-2: A Computational Structure Profiling

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The spread of the COVID-19 infectious disease that is caused by the SARS-CoV-2 virus (severe acute respiratory syndrome coronavirus 2) has been a huge threat to the people of Sri Lanka and worldwide. It has stirred a global health crisis since 2019 which has led to the declaration of a public health emergency of international concern by the World Health Organisation. Owing to its novelty, there is a lack of effective therapeutic options to combat the viral infection. To better appreciate key secondary level interactions leading to the structural complexity, a computational structural analysis of secondary and super secondary structures (motifs) of the SARS-CoV-2 S protein (RCSB PDB ID: 5X5B) was carried out. The three-dimensional prefusion structure of the S protein was first structurally characterized using the ProFunc server tool, followed by analysis of molecular graphics of secondary and super secondary structures as well as torsion angles of helical sequences using RasMol program and STRIDE visual assignment tool, respectively. Three distinguished protein chains namely A, B and C were identified from the prefusion three-dimensional structure of the SARS-CoV-2 spike glycoprotein. The protein chain A is represented with the identical chains of B and C with 1033 protein residues. Among the 14 β sheets of the chain A, 9 are observed to be formed from more than two strands. The present work identifies a special region of irregular β sheet in the S protein of the prefusion conformation which is experimentally verified in previous optical spectra studies of SARS-CoV-2 proteins. Helical turns show a large deviation from an ideal helix by 9.8 Å. Interhelical interactions are observed to experience the highest negative interaction angle of magnitude 162.80°. The most occurring non-flexible β turns may or may not be stabilized by hydrogen bonds. This study emphasizes the need for further investigation of fused conformation of SARS-CoV-2 virus in the light of current urgency of establishing optimal treatment strategies for COVID-19.

Keywords: SARS-CoV-2; Computational analysis; Prefusion conformation; Spike protein

Sentiment Analysis in Sinhala Texts using Convolution Neural Networks

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Because of the rapid development of the information communication technology, an enormous amount of data is produced, shared across the internet and other media. Opinion mining, also known as Sentiment Analysis, is a technique, which can be used to detect the opinion of a given sentence or to make a judgement based the given sentence, can play a major role in automatically analysing this data. In addition, the development of Natural Language Processing in Sri Lanka leads the Sri Lankan native user to browse web in their native language and to express their opinions in their mother tongue. But in most of the cases Sinhala language was named as the morphological rich, less resourced language. An automatic solution for the text categorisation and opinion mining could be very useful for analysing sentences from Sinhala language. This work explores a Convolution Neural Network (CNN) based sentiment analysis technique, where, each word of a sentence is converted into a numerical representation using a pretrained FastText word embedding model. These numerical representations obtained for each word of the sentences are then used to train the CNN, in order to predict the opinion of the given sentences at test time. This CNN model is trained and tested on a Sinhala news comments dataset which consists of 5010 comments. There were 2520 negative comments and 2490 positive comments. Dataset used in this project is collected by crawling Sinhala online news sites, mainly www.lankadeepa.lk. This data was initially preprocessed by removing non-Sinhala characters, punctuation marks and stop-words. Our model was trained and tested on 70% and 30% of the data respectively. Experiments report a testing accuracy of 85%.

Keywords: Convolution Neural Network; Natural Language Processing; Sentiment Analysis; Text analysis for Sinhala Language

Spatial Behaviour of the Undergraduates’ Satisfaction and Issues of Participation on E-Learning during COVID-19

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All the higher education institutions in Sri Lanka have shifted to e-learning from face to face learning with the COVID-19 by making e-learning essential for every university student. However, the studies on e-learning during COVID-19 focused more on the overall satisfaction and issues, rather than aerial unevenness behind them. Therefore, as a preliminary attempt, this research was examined the spatial variation of undergraduates’ satisfaction and issues of participation in e-learning according to the residence. At the moment, 151 undergraduates have taken as the sample by covering 105 Divisional Secretariat Divisions in 20 Districts; representing 32% - 45% out of the total number of Divisional Secretariat Divisions in each district (hope to be completed all 25 Districts in further studies) and the findings & conclusions were made based on the sample. Geostatistical analysis: Inverse Distance Weighted Interpolation used as the main analysis technique to generate findings with the support of ArcGIS. The findings indicated that a minimum of 25% to a maximum of 86% of the undergraduates in different districts was believed that e-learning was successful. A higher percentage of undergraduates in Kandy, Colombo, and Galle were satisfied with the new learning method when respondents in Anuradhapura, Gampaha, Kegalle, Jaffna & Matale were moderately satisfied. But, a significant number of students in Monaragala, & Trincomalee were dissatisfied with the system and believed that it was unsuccessful. This reveals the students who live in major provincial capitals, and recently developed regions believed that e-learning was successful than the students in under-developed regions. Furthermore, respondents of 18 districts suffered from stuck/freezing rather than other difficulties in issues of participation. Except for the students in Colombo, Kalutara, & Galle, more than 70% of all other districts faced problems related to weak network strength due to uneven coverage network & geographical obstacles. Subsequently, the issue of data cost wounded respondents in 18 districts; mostly Monaragala, & Badulla, except for Colombo & Puttalam. Therefore, by indicating these spatial variations, the study suggests that the implementation of solutions and decisions on e-learning have to be flexible with both national and regional scales to provide a better virtual learning experience to the undergraduates.

Keywords: E-learning; COVID-19; Undergraduates; Spatial Behaviour

Support Vector Machine based Named Entity Recognition for Sinhala

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Named Entity Recognition (NER) can be defined as identifying Named Entities (NE) in human language and classifying them. A NER system is a major fundamental subtask that facilitates more complex tasks like automatic text summarization, question answering, etc. Today automated language tools are a more solved problem for resource-rich languages like English. But for Sinhala, which is a low resourced South Asian language, only a few prior works can be observed. Unfortunately, systems developed for the English language cannot be directly used for Indo-Aryan languages. Considering the attempts on Sinhala NER systems, it can be observed that only Conditional Random Fields (CRF) and Maximum Entropy (ME) were used. But for other low resourced Indo-Aryan languages, several other algorithms have been used and among them Support Vector Machines (SVM) have given more prominent results. In this paper, we present a novel NER system using SVM for the Sinhala language. Here we have only considered PER (person), LOC (location) and ORG (organization) tags. Since this is a data driven approach preprocessing of the training data is a crucial task. The most suitable format for the training data is word-per-line format (CONLL-2002). For a more extended classification task Beginning-Inside-Outside tagging scheme was followed increasing the total number of tags into 7. The dataset consisted of 100,000 tokens and the first we have observed that with size of the training data, performance is increasing. As the prior works have shown the effect of language features next we have observed the behavior of different feature combinations and figure out that gazetteers, clue words, word-length and Part-of-Speech features as the most effective for PER, LOC. Excluding the word-length from above mentioned features remaining are the best for ORG. Ultimately both sets of tags were able to prove the effect of gazetteers with SVM. Next we have set up the experiments to observe the impact of the word-length of 4,5,6,7. Lengths of 4 and 5 were best matched for the purpose of this work. As future work we have planned to experiment the influence of varying the kernels, context and degree while expanding the training data.

Keywords: SVM; NER; NLP; BIO

Quality Assurance Policy Realization Framework for Higher Education: With Special Reference to Teaching and Learning Process in Sri Lankan State Universities

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The higher education sector has focused on assuring and improving the quality of education and research. In this context, quality assurance is a proactive and continuous process encompassing a diverse set of policies and procedures. The quality assurance monitoring process assures the quality through examining the compliance while indicating instances where changes in policies and procedures are required. Nevertheless, universities still apply traditional methods in quality assurance that rely heavily on bulky documentary evidence, mainly based on manual techniques. Thereby, quality assurance has become an additional burden for the employees. Although universities employ a variety of information systems, their focus on quality assurance is limited. These systems heavily focus on running routine and day-to-day operations instead of acting like an integrated management information system. Therefore, this paper proposes a new information system module that can act as a quality assurance policy realization module while providing a mechanism to operationalize policies and procedures in electronic form. The study followed the design science research methodology. Experts' interviews, physical observations of the quality assurance activities, and references of quality assurance related documentation were used as the main data sources. The system consists of three sub-modules: process monitoring and recording, quality assurance rules management and execution, and performance evaluation. Given the complexity, this study demonstrates only how quality can be assured in the teaching and learning process. In the first sub-module, the teaching and learning process was explored and respective sub-processes and activities were identified. Then, quality compliance reports were introduced to monitor the activities and record compliance with existing and recommended policies and procedures. The second sub-module specifies the quality assurance rules on activities and guides the activities in the execution stage. The third sub-module is a quality assurance knowledge repository that can deliver information for decision making. The proposed system facilitates the dynamic nature of quality assurance policies and procedures through online monitoring and establishing an evolving rule-base.

Keywords: Quality assurance; Higher education; Information system

A Chatbot for Online Investing and Earning Services for School and College Students

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In many countries education is not free, students need to pay in order to pursue their studies. Therefore, financial hardship can play negative impact on student's academic progress. However, they have numerous opportunities to avoid their financial stress through online investments and earnings, but normally students are not aware about them. Hence, this paper aims to present a chatbot that provides online earning and investment platforms by scanning student's profiles. Although students can browse google in order to know regarding internet based earning and investment tendencies, nevertheless, it's not only time consuming but searching in google in order to find out useful information that suitable to that specific user's need is a kind of art, hence, everyone is not an artist. Thus, to overcome such obstacles, we proposed a chatbot that have a strong natural language ability to interact with users, initially the chatbot asks set of questions in order know the specific student's profile in according to that the chatbot will recommend them online earning and investment platforms that is fitted to that particular student. In addition to that, the chatbot not only suggests online earning and investment platforms but it also educates students that how to use them in an effective manner. The main purpose of this research paper is to encourage students to defeat their financial issues and to motivate them to become future entrepreneurs. Moreover, to inspire students to invest in Sri lankan stock markets. On the other hand, there are few limitations, for example the stock prediction module only work for Sri Lankan context, the proposed chatbot has only bitcoin price prediction module and the chatbot has the ability to help students not in all online earning and investing opportunities but in many such as e-commerce, stock buying and selling, forex trading, freelancing, social media earning module, cryptocurrency, affiliate marketing, website flipping, dropshipping, dropservice, saas business module and blogging. In conclusion, this proposed system can help students to avoid time-consuming method of browsing google or youtube by using of this free of cost chatbot

Keywords: Chatbot; Machine Learning; Online earning; Amazon Lex; Finance

Classification of Monkeys for the Automatic Monkey Repellent using Transfer Learning

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Monkeys take over the cultivations looking for foods, and it makes the fields wasted and it has become one of the major problems that farmers have to face in many areas. Furthermore, monkeys attack the normal households, and cities have become a common problem in the present society. The typical method to warding off monkeys is through human involvement such as shouting and lighting torches, air riffles, and fire crackers to repel the monkeys that come to their crops. Moreover, these methods are not easy, and some of them are harmful to monkeys as well as human. Additionally, these methods are familiar to the monkeys. Therefore, even if they leave at those times, they are used to coming back again. This is a lot of time wasting for the farmers, and it is difficult to protect the cultivations whole day. In some scenarios, monkeys attack farmers when they attempt to repel them from cultivations. Due to the damages that made by monkeys to the cultivations in Sri Lanka, there is a huge lose to economy. Therefore, accurate, efficient automatic method for chase different classes of monkeys is very useful tool. This paper describes classification of three classes of monkeys using transfer learning and electronic monkey repellenter to prevent this issue. This can help to protect the cultivation for the farmers whole the day without any labor cost. This can fill the gap of experts with cheap labors and computers or mobiles. The developed application consists of four main steps namely image pre-processing, data augmentation, train the model and visualize the results. Furthermore, this model can identify the three classes of monkeys and repel them from the cultivations by emitting a frequency wave. The accuracy of the system was calculated after visualized the results with the help of the prediction of the labels of the test images, and found as 98%. In the conclusion, the developed method can help farmers to recognize three classes of monkeys and warding off them early and cheaply using the Automatic Repellent.

Keywords: Monkey; Transfer learning; Data augmentation; Cultivations

Short Text Topic Modelling using Non-negative Matrix Factorization with Neighbourhood-based Assistance

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A massive number of short texts are generated every day in the forms of tweets, news headlines, questions, and answers. Analyzing short texts is an effective method to acquire valuable insights from these online archives that show diverse applications in community detection, trend analysis, classification, and summarization. Topic modeling is a widely used technique for this purpose as it is capable of latent topic discovery, and finding relationships among terms, topics, and text documents. In discovering thematic structure in collections of texts, a higher number of terms appear in the document \times term matrix representation and associated sparseness creates issues for distance-based and density-based document similarities calculations. This phenomenon is known as distance concentration where the distance differences between points become negligible due to sparseness in high dimensions. Additionally, the short text shows a shorter length compared to conventional documents. This leads short texts to create extremely sparse, high-dimensional text and challenge finding documents that share the same topic structure within them. Non-negative Matrix Factorization (NMF) which is aligned with the natural non-negativity of text data is proposed as an effective technique that handles high dimensional representation with lower-dimensional projection. However, this higher-to-lower dimensional projection results in an information loss. This paper proposes Neighbourhood-based assistance to compensate for this loss. Neighborhood information within documents is captured using Jaccard similarity considering term sets included in the documents. We coupled a symmetric document \times document matrix that carries this neighborhood information with the document \times term matrix using NMF to identify the lower order topic \times document matrix. This unsupervised method learns a dense lower-order topic presentation by minimizing the encoding error of factor matrices. We empirically evaluate the effectiveness of the method against the state-of-the-art short text topic modeling methods belongs to probabilistic and matrix factorization categories. Experimental results using three Twitter datasets show that the proposed approach is able to deal with information loss attached with higher dimensional matrix factorization of short-text and attain high accuracy compared to relevant benchmarking methods.

Keywords: Topic Modelling; Short Text; Non-negative Matrix Factorization; Neighbourhood-based Assistance

Evaluating the Usability of Sri Lankan University Websites

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With the internet as the backbone and websites for sharing information over the internet, information and communication technology has revolutionized the way businesses and individuals carry out tasks. To achieve its goals, a university, as an organization that develops knowledge for the world, need a functional website. According to a preliminary study conducted in January 2020, the majority of Sri Lankan university website users are not satisfied with the usability of their university websites, and these poorly designed websites don't provide necessary support for universities to compete with world-ranked universities. However, researchers were not focused in studying the usability of Sri Lankan university websites from the perspective of both website developers and website users. The purpose of this study was to evaluate the usability of Sri Lankan university websites from the perspective of website designers in order to identify issues with website development principles and standards by testing websites by automated website testing tools. In addition, the study aims to assess university web sites based on user feedback using a questionnaire-based evaluation method to evaluate the quality of the user experience on websites. As stated in the results, the overall usability score for the Sri Lankan university websites provided by the Web Page Analyzer tool is 43 and by the SEO toolbox is 58% respectively, according to the Pingdom tool the grade for the performance of Sri Lankan university websites is 69, the WAVE tool discussed existing web site errors, and it is critical to increase mobile-friendliness as Mobile User-friendly Testing tool. Confirming to the results of the questionnaire survey, the usability of Sri Lankan university websites is at an average level. Finally, the study recommends best practices for increasing the attractiveness, controllability, efficiency, helpfulness, and learnability of university websites in order to deliver a better user experience.

Keywords: Website Usability; Sri Lankan University Websites; Website Development Principles; Website Development Standards; User experience on Websites

Detect Appropriate Period to Apply Fertilizer for the Tea Plantation Using Image Processing

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Tea cultivation is one of the main income sources of the export field in Sri Lanka and the main sources of employment in the country, employing more than one million workers. Tea inflation is a national challenge. Tea revenue drops several times a year due to the low yield of tea and it is the main threat to the tea industry. The yields can be reduced due to the poor nutrition of the plant. Fertilizer should be applied to the plant on time to maintain the nutrition of the plant and can get a proper harvest. When the plants do not have fertilizer, the fibers in the leaves change, and gradually the color of the leaf change to yellow. Experts' eye observation is the ordinary method to recognize the time to fertilize. Especially, it is hard to recognize the exact period of the fertilizer application to tea plants by eye observation with the help of color changes on leaves for novel tea planters. Hence, they may require to grab the assistance of expertise, which is more expensive. Early recognition of the period of the fertilizer application is the key to avert losses in the quality and quantity of tea products. Therefore, an accurate, efficient automatic method for recognizing fertilizing period is a very useful tool for novel planters among tea cultivators. This research describes the automatic recognition of the period of fertilizer application for the 'TRI 4049' type of Tea plants using image processing technique. This can fill the gap of experts with cheap labor and computers. It is beneficial to get a nutritional harvest for a large estate. The developed application consists of four main steps namely image acquisition, image pre-processing, segmentation, and feature extraction and Classification. The green pixels percentage was calculated to find out the suitable period for the fertilizer application of the Tea plants. The accuracy of the system was found as above 73% after the train and validate the model. In the conclusion, the developed method can help novice planters to recognize the most suitable period of the fertilizer application for tea plants early and cheaply.

Keywords: Image Processing; Feature Extraction; Classification; Fertilizer Applications

An Image Processing Application for Diagnosing Acute Lymphoblastic Leukaemia (ALL)

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Acute Lymphoblastic Leukaemia is a fatal disease that affects white blood cells and bone marrow in the human body. Every year, considerably a large number of adolescents and children become victims of this type of leukaemia. The early detection of this disease directly affects the recovery rate of the patients. In the manual process, pathologists can identify Acute Lymphoblastic Leukaemia and the accuracy of the prediction may rely upon their experience. Hence this research has proposed an image processing approach for early detection of Acute Lymphoblastic Leukaemia cells to prevent the spreading of cancer, enabling the medical experts to initiate the treatment without any delay and increase the recovery rate of such patients. For that, microscopic blood sample images were analyzed considering the features such as color, shape, presence of nucleoli, and nucleon to a cytoplasmic ratio of the cells separately using three Conventional Neural Networks (CNNs). Based on that, the Acute Lymphoblastic Leukaemia cells were identified and classified as either Acute Lymphoblastic Leukaemia or healthy. Compared to the laboratory testing methods, this approach obviously leads to early detection of Acute Lymphoblastic Leukaemia with an accuracy of 94.57% that has been confirmed by the domain experts. The proposed approach is an effective and less expensive method that would assist doctors to get fast and accurate results. Hence the originality of this research was to identify the presence of Acute Lymphoblastic Leukaemia cells in the microscopic blood sample images and classify them as either Acute Lymphoblastic Leukaemia or healthy by identifying the features of the Acute Lymphoblastic Leukaemia cells separately. Moreover, this research has found that Conventional Neural Networks (CNN) is the most suitable Neural Network to identify Acute Lymphoblastic Leukaemia using image processing technique.

Keywords: Acute Lymphoblastic Leukaemia; white blood cells; conventional neural networks; Image Processing; Machine Learning

Automated Traffic Violation Detection

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One of the most serious health risks has been and will continue to be road accidents. The number of deaths and injuries caused by traffic accidents has been proven statistically. Road accident is a most unwanted thing to happen, especially on the pedestrian crossings to a road user, though they happen quite often. Some reasons for the accidents and crashes are due to human errors such as drunk driving, high speed, red light jumping and overtaking on the pedestrian crossing, etc. Among these reasons, especially an overtaking on the pedestrian crossing is one of the most common traffic rules violations in Sri Lanka, and the accidents associate with this violation cause a huge loss to life and property. Although automated techniques for detecting some traffic offenses exist, such as detection of the speed limit and drunk drivers, currently there is no automatic mechanism for the detection of the vehicles which are overtaking on pedestrian crossings. Manual identification of overtaking vehicles on the pedestrian crossing is more critical than anything else because detection of moving vehicles, then tracking and classifying them in real-time in a complicated environment, is extremely tough. Therefore, an accurate and efficient automatic method for detecting traffic violations is a very useful tool for road safety. This paper describes an automatic detection of traffic violation offender on pedestrian crossings. This paper proposed an improved dynamic background-updating approach and a feature-based tracking method to detect overtaking vehicles on the pedestrian crossing. This can fill the gap of manual detection with automatic detection and no labour costs. Thus, it is beneficial in various ways such as the confirmation of road safety. The application is proposed as a mobile application. A complete traffic violation detection system is realized in C++ with Open CV libraries. The accuracy of the system was found as above 73% after the train and validate the model. In conclusion, the developed method can help to detect vehicles that have violated the traffic rules on the pedestrian crossing accurately.

Keywords: Traffic Violation; Road Safety; Mobile Application; Manual Detection;

Word Embedding as Word Representations for Clustering Sinhala News Documents

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News articles are increasing by the day and the manual clustering or classification has become an impossible task. So there has been a need for new methods for clustering these articles. There is a huge number of text documents created and added to many sources including the internet daily. Manually clustering or classifying these documents into related fields has become an impossible task. Therefore, finding similarities in these documents has turned out to be a very inclusive topic. It helps save time by specifically searching articles. We evaluated the applicability of word embedding mechanisms like fastText to find its applicability to increase the accuracies in the classification process. We explored the feasibility of word embedding models like fastText, doc2vec as a word representation methodology compared to frequent methods like Term Frequency–Inverse Document Frequency in these documents and evaluate its accuracies. The research is based on evaluating the performance of different word representations for clustering and classification of Sinhala news documents. Initially about 10,000 Sinhala news documents were collected by a scraping algorithm from different news websites. They were cleaned, preprocessed to remove irrelevant characters and words. The models were checked for accuracy with changing the number of documents with each model. This model is used for representing words in the model and checked for higher accuracies with various representation mechanisms for both clustering and classification where models like kmeans used for clustering and k nearest neighbours and support vector machines for classification. We have tested the accuracies of various word representations like Term Frequency–Inverse Document Frequency, doc2vec and fastText and upon research and experimenting we have found that fastText models as word representations give best results for both clustering and classification. Therefore, using fastText word embedding models to represent documents for classification and clustering purposes will increase the accuracy.

Keywords: Clustering; Classification; Word embedding; FastText; Sinhala documents

Prediction of Share Prices in Sri Lanka, using Data Mining Techniques and Machine Learning, With Special Reference to Material Sector Companies Listed on Colombo Stock Exchange

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Stock market plays a prominent role in every economy and it is understood as a very important section of the monetary segment of an economy. It is also recognized as playing an energetic part in the deployment of capital in numerous of the developing economies. Stock market is the greatest context for an investor to invest in the shares of listed companies, and have attractive revenue of investment which will offer a hedge against possible loss from inflation. In the stock market there is no any clear-cut mechanism to predict the share prices in advance. The main objective of this research study is to identify behaviour of share prices in Sri Lanka and developing a model to identify the stock price using the share price patterns within the target period for Colombo Stock Exchange. Most of the researchers are focused on the statistical process. Statistical approach accuracy is pretty much inefficient when comparing with the advanced machine learning mechanisms. So, in order to minimize this gap data mining base approach were implemented. In the Colombo Stock Exchange, material sector companies are used to this research. By analyzing the 39 number of variables, appropriate variables are selected to research purpose. However, using the machine learning based regression algorithm, the prediction results are generated with high accuracy. OLS Var model used to generate the prediction results. As the final conclusion and the model summary OLS model was selected to forecast the share price in Colombo stock market. RMSE value for that model was 46.50 since R squared value was 0.95. An R-squared of 100% means that all actions are totally clarified by movements in the index. Here it is almost close to 95%. A great R-squared, between 85% and 100%, indicates the share price moves comparatively in line with the index. Stock market prediction is the most difficult activity due to non-linear variations of the factors affecting the stock market. Here the main problem is the stock price does not only depend on the particular company's past stock value but also the external factors such as economic changes, political changes etc. Stock market predicting covers discovery of market trends, preparation asset strategies, classifying the finest period to acquire the stocks and which stocks to buy

Keywords: CSE; Data mining; Share price; Regression; Prediction; Material sector

Utilization of Text-based Emotions in social media for Depression Analysis.

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As estimated, millions of people around the world suffer from depression every year. It is a common and serious medical illness that negatively affects the way a person feels, thinks, and acts. Emotions can be used to identify depressed people through changes in their moods, expressions of thoughts, ideas, and opinions. With the expansion of online social media networks, many people share their thoughts and opinions as text-based posts and these are rich sources of human emotions. The current study has used text posts and comments which were published on public groups on Facebook related to depression as the labeled dataset for text analysis. Although previous studies have detected depression using different techniques, such as facial expressions analysis, behavioral analysis, and investigation of linguistic characteristics of written text, the results were not adequate for life-saving applications. Therefore, intending to solve with higher accuracy, this study investigated a novel emotional intensity-based approach to detect depressed people. During this study, depression is identified by analyzing emotional intensities in-text sources using a supervised learning approach. The existing NRC lexicon model which contains 8 basic emotions; anticipation, trust, joy, fear, sadness, surprise, anger, and disgust was used to get similar word lists with real-valued scores of weights for each word in eight basic emotions. After pre-processing the text, the techniques, such as developing a Bag of Words to collect all the words related to emotions, performing vectorization to extract words from posts that are similar to the Bag of Words, and finding intensities for each emotion using cosine similarity were conducted. Finally, the intensities of all 8 emotions of each post were fed into a Feed-Forward Neural Network to learn and predict the pattern of intensities to classify depression or non-depression according to the text posts. As the main output of the study, people with depression were identified, with 90% accuracy according to the patterns of emotional words in their posts on social media.

Keywords: Bag of Words; Cosine Similarity; Emotional Intensities; Feed Forward Neural Network; NRC Lexicon; Vectorization

Predict Human Personality based on Handwritten Signature

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Personality is a unique thing that everyone has and it shows how a person acts both in daily life and at work. Therefore, tracking a person's personality has become more important, especially for an employer. Within this context, the purpose of this research is to identify a person's personality through big five-factor personality traits based on his/her handwritten signature. The majority of earlier researchers have focused on analyzing handwritten signatures to describe personality with the help of graphology. The current research was designed a way to apply graphology on the signature image and improve the performance using neural networks. In this study, the personality of a person was evaluated based on four selected features of a signature -namely, the size, curved start, pen pressure, and underline. Further, an online questionnaire, which was conducted with the participation of 500 selected individuals, has been utilized to measure and gather the personality of each person. The complete system evaluates signature samples based on the above features and divided into four modules. Then these four modules were fed into the feature extraction model, which analyzed the input image with the Convolutional Neural Network (CNN) model and all four features were extracted from the signature data set. After that, the extracted features were combined with the online questionnaire test result to help with supervised learning. As the final output, this model predicts the correct big five-factor personality values with 85% accuracy, when a person wrote his/her signature on a paper. This solution is unique as this predicts the big-five factor personality traits based on the signature for the first time and this is a more efficient approach compared to other existing work

Keywords: Convolutional Neural Network; Personality Traits; Signature Analysis; Supervised Learning

Early Identification of Major Pest attacks Caused to Crop Loss in Paddy Fields: A Case Study

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Unrecognized or late recognized pest attacks are one of the major problems which lead to crop loss in paddy cultivation. According to the most recent season harvest Data of Rice research institute, it was recorded 40% of crop loss in the paddy cultivation in the *Hambanthota* district. Under a preliminary survey, it was identified Aphids, Brown-planthoppers, and Thrips were the major pests that caused the crop loss in paddy in the selected area. Due to the lack of proper knowledge in identification and lack of timely and accurate information, farmers are struggling to identify and control these pest attacks in their paddy fields. Due to crop loss, most of them are losing their money, interest, time, and confidence in paddy cultivation. During the study, domain experts revealed that early identification and early-stage of controlling these pests can save the majority of the crop loss and save lots of money which were spent on pesticides in paddy cultivation. This Case study was conducted to address the issues identified above, in the selected paddy fields in *the Gonnoruwa* area in the *Hambanthota* district. The proposed model use image processing techniques in combination with Convolutional Neural Networks to detect the pest's attacks in paddy cultivation by analyzing the symptoms. A set of self-captured images which were labeled with the help of domain experts were used to build and train the proposed model. The model has achieved 95% of accuracy while testing. The proposed model will be further improved to identify more pests and disease attacks in the future while delivering it as a handheld portable device where farmers can use it in real-time in their paddy fields which will lead to saving their time and money while increasing the paddy yield.

Keywords: Crop loss; Paddy; Pest and diseases; Pest identification model

A Supervised Learning Approach to Detect Black Pepper Adulteration

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Black pepper is one of the widely planted spices in the world and its cost is very high when compared to other spices. Many People earn huge income from black pepper by exporting and selling. Therefore, they mix unwanted adulterants, such as stones, weeds and other low-cost items in order to increase the quantity and the profit. Out of these adulterants, papaya seeds are very common, as their appearance is very similar to black pepper seeds. Those malpractices will reduce the quality of pepper samples and it is difficult to control as these two types of seeds cannot be easily classified even by an expert eye due to the smaller size in bulk samples. Hence, more advanced solutions are required to determine the adulteration of pepper samples. Currently, there are some existing studies and methods; one is a manual method to separate papaya and pepper seeds using water by considering their weights. Further, there are chemical methods, such as the Thin-Layer Chromatography (TLC) approach to detect the adulterated papaya seeds by using mixed samples of black paper powder and ground papaya seed. In this study, a classification method was proposed to differentiate black pepper from papaya seeds using the Convolutional Neural Network (CNN) technique. The images of the samples were captured using a high-resolution digital camera and the features, such as size and shape were extracted to classify the seeds. Next, these features were fed as the input to the CNN model for the classification task. The experimented model was able to successfully label the papaya and black pepper seeds with an accuracy rate of 85.94%. As the main output of the model, the percentages of papaya and pepper seeds in the given sample were presented. To improve the accuracy of the model, high-quality images and more features such as texture and color will be used in future work.

Keywords: Black Pepper Adulteration; Feature Extraction; Image Processing; Supervised Learning

Text-to-Face Generation with StyleGAN2

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Synthesizing images from a text description has become an active research area with the advent of Generative Adversarial Networks. It is a flexible way of generating images in a conditioned environment and has made significant progress in the recent years. The main goals of these models are to generate photo-realistic images that are well aligned with the input descriptions. Text-to-Face generation is a sub-domain of Text-to-Image generation that has been less explored because of its challenging nature. This is difficult because facial attributes are less specifically mentioned in descriptions and also because they are complex and has a wide variety. Although few works have been done in this domain, it has a variety of applications like in the fields of criminal investigation. But still there is the need to improve the image quality and how well the generated images match the input description. In this paper, we propose a novel framework for text-to-face generation using the state-of-the-art high-resolution image generator, StyleGAN2. For this task it is required to learn the mapping from the text space to the latent space of StyleGAN2. We chose BERT embeddings to encode the input descriptions. The text embedding mapped to the latent space, in turn was input to the StyleGAN2 model to generate facial images. We train and evaluate our model on the Text2Face dataset containing descriptions with at most 40 attributes for the images in the CelebA dataset. Our novel framework generates photo-realistic images by adopting StyleGAN2 and also improves the semantic alignment with the use of BERT embeddings that better capture the content of the description and the perceptual loss calculated using a pretrained VGG16 model. In the initial training we obtained a FID score of 370.57, Face Semantic Distance of 25.57 and a Face Semantic Similarity score of -0.002. With further training we believe the images could be made more realistic and semantically matching the input description.

Keywords: Text-to-Image Synthesis; Text-to-Face Synthesis; StyleGAN2; High-resolution; Semantic Alignment

Identification of Diseases of Rose Flowers using Image Processing Techniques

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Exporting rose flowers are one of the major business for farmers in upcountry. When exporting roses, there are several quality factors to be considered like size and color. Due to the high sensitivity to its growing environment roses are vulnerable to several diseases. Due to the diseases, the quality factors are heavily affected and sometimes entire fields of cultivations are getting wasted before plucking a single flower. The lack of knowledge in symptom identification by farmers and the limited no of domain expertise in the area are the major problems in identifying and controlling the diseases which are affected the rose flowers. Through a field survey and by consulting domain experts, it has been identified that gray mold, black spots, and anthracnose are the major diseases that are heavily affected to bud, flower, and lifetime of flower and the rose plant. Further, the survey revealed that early identification of these diseases can save flowers, plants, money, and the confidence of the farmers while improving the export quality and volume of flowers. To address the findings of the survey, this study was conducted in selected rose fields in *Bandarawela, Badulla* district. A set of self-captured images which were labeled with the help of domain experts were used to build and train the proposed model. The proposed model will identify the diseases by identifying and categorizing the symptoms. The model was built in combination with the image processing techniques and Convolutional Neural Networks and used the guided data processing technique for training the data set. The developed model achieved over 94% of accuracy with the test set. The model will further be improved to identify the severity and the stage of the diseases and it will assist farmers in their rose cultivation by providing context-specific, updated information to identify, control and prevent the spreading of the identified diseases by improving the quality of the export rose flowers.

Keywords: Anthracnose; Black spots; Gray mold; Disease identification model; Rose

Analyzing Infant Crying Patterns: Classification of Hunger and Discomfort

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Infant crying is the crying of infants as a response to an internal or external stimulus. Infants cry as a form of basic instinctive communication. An infant's cry contains a lot of information about the baby such as hunger, pain, discomfort, sleepiness, burp, anger, etc. Parents' or guardian's inability to recognize and timely address the reason for the infant's cry prompts dissatisfaction for the infant and a feeling of helplessness for the parents. Therefore, an accurate, efficient automatic method for analyzing infant cry patterns and notifying the cause of cry is a very useful tool for parents. This study aims at the detection of baby cry patterns and identification of uniqueness of the hunger and discomfort crying patterns of the infants. This is achieved through analyzing the different patterns of the sound waves of the infants crying by converting the crying signal to an equivalent frequency waveform. This novel model can fill the gaps in the current models by achieving higher accuracy. Thus, this research is beneficial in various ways such as reducing parental dissatisfaction and helplessness when infant crying, minimizing child abuse and helping parents to better understand their child's needs and psychosis by analyzing crying patterns. The proposed model detects sound frequency, draws the waveform of the signal, and uses a Convolutional Neural Networks methodology to identify and distinguish the crying patterns of the infants. The dataset was collected, and the crying patterns were labeled by getting assistance from the domain experts. The model was trained and tested against the labeled data and it gained an accuracy of 91%. The proposed model will be further enhanced to identify more feelings of the infants and will be further developed to assist to recognize selected medical conditions by analyzing the crying patterns of the infants.

Keywords: Cry signal; Discomfort; Hunger; Infant crying patterns

Machine Learning Approach for Intelligent Product Recommendation System based on Product Reviews Given in Sinhala Language

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In this era of technology businesses all around the world including Sri Lanka are moving to the web. The increased amount of businesses and their products online made the process of selecting the most appropriate, suitable and trustworthy product online highly exhaustive. To mine this vastly available data and make a better choice takes lots of effort, cost and time for a person to perform. Therefore data mining techniques can be used to intelligently mine data and provide the best suggestions to the customers. When it comes to Sri Lankan online businesses most users use Sinhala Language to provide their reviews. Here in this research some machine learning techniques are used to train a model to understand user reviews that are in Sinhala and Singlish and suggest products with best overall reviews. To develop this model Python programming techniques are used. For the model dataset of 2100 separate phrases were manually scraped from some online business pages in a way that it contains negative and positive sentiment. Annotation for sentiments was given by 5 annotators for increased reliability. A specific data cleaning was done by removing garbage tests like html tags, special characters, pronouns and numeric data as the whole result relies on the words included in the dataset. Especially after the cleaning the cleaned text is converted to “unicode” mode to make it viable to use this knowledge for future usage. Feature extraction functions like ‘Count Vectorization’ and ‘Tf-Idf vectorization’ used and features stored using “LexiconBuilder”. Supervised and Unsupervised learning techniques are used. Ensemble, RNN (with GRU), RNN (with LSTM), Word2Vec (with CNN), Word2Vec, Decision Tree and AdaBoost algorithms are compared for their accuracy. Word2Vec (with CNN) gave 100% Precision and F1-Score which led model overfitting and unacceptable. As the solution the model with high precision, high F1-Score and least overfitting/under-fitting was chosen. Therefore, Ensemble Classifier which had 69% F1-score and 70% of precision was selected as the most suitable model finally.

Keywords: Intelligent Product Recommendation Systems; Machine Learning; Natural Language Processing; Sentiment Analysis; Sinhala Product Reviews

Music Emotion Recognition using Deep Neural Networks

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Emotion is an integral part of music and a complex aspect of music that is not easily understood by machines. The emotional aspect of music is further complicated by the fact that it is a subjective experience that cannot be easily conveyed to machine. Although it is a complex problem, some progress has been made in this area suggesting that it might be feasible to develop computation models that can be used in real-world applications. Real-world applications of music emotion recognition systems range from entertainment to healthcare. In this paper we introduce a deep learning model that recognizes emotion in music from the audio signal. 1d and 2d convolution layers with different kernel sizes have been tested. Adaptive pooling layers have also been used to extract a fixed feature representation for the dense layers. We have also used trainable spectrogram extractors to learn different representations of the audio. To address the lack of data for the task of music emotion recognition we have also used the latest trends in audio data augmentation and converted it for music data. Till now we have been able to achieve an accuracy of about 0.92 for the PMemo dataset and about 0.6 F-1 score from using the raw audio signal and 1D convolution layers to extract features. Preliminary experiments show that using 1d convolutions with the combination of learnable spectrograms performs satisfactorily. Further experiments are to be conducted using different combinations of raw audio and calculated features. Different model architectures using recurrent networks are also to be tested considering that audio has temporal relationship between each unit of time. Finally, the work done in this study is mainly to explore the high dimensional feature space of raw audio to extract features which can contribute to the recognition of emotion in music using automated methods such as convolution and recurrent layers.

Keywords: Music Emotion Recognition; Deep Neural Networks; Music Data Augmentation; Arousal and Valence Prediction

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Automated Farming Robot

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Robotics is a fascinating field of engineering that provides many opportunities for research. In addition, the evolution of technology in recent years has led to intelligent mobile robots. As farms grow in size, together with the size of the equipment used on them, there is a need for ways to automate processes, previously performed by the farmer himself, such as handling the equipments himself to perform the task. The control of these robots, however, is a difficult task that involves knowledge in different areas such as robotics, automation, programming, electronics, etc. The objective of this research is to technically develop the new agricultural technologies to savings in terms of both cost and time, to optimize production efficiency, declining availability of manpower, minimize production-associated risks. Hence automation is the ideal solution to overcome all the shortcomings by creating machines that perform the operations and automating it to increase yield on a large scale. In this the robots are developed to concentrate in an efficient manner and also it is expected to perform the operations autonomously such as Drilling (for plantations of seeds), seed dispensing and watering. For manual control the robot uses the Bluetooth pairing app as control device and helps in the navigation of the robot outside the field

Keywords: Farming Robot; Bluetooth module; Arduino;Agriculture; Water pump

A New Stochastic Restricted Two Parameter Estimator in Multiple Linear Regression Model

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Instead of using the Ordinary Least Square Estimator (OLSE) to estimate the regression coefficients, the biased estimators are proposed in the multiple linear regression to overcome the multicollinearity among the predictor variables. An alternative technique to solve the multicollinearity problem is to consider parameter estimation with some restrictions on the unknown parameters, which may be exact or stochastic restrictions. In this research, we propose a biased estimator, namely new stochastic restricted two parameter estimator (NSRTPE) in a multiple linear regression model to tackle the multicollinearity problem when the stochastic restrictions are available. The proposed estimator over the ordinary least square estimator (OLSE), ridge estimator (RE), Liu estimator (LE), almost unbiased Liu estimator (AULE), modified new two parameter estimator (MNTPE), mixed estimator (ME), stochastic restricted Liu estimator (SRLE) are compared in the scalar mean square error (SMSE) sense through a simulation study by considering different levels of multicollinearity and different values of shrinkage parameters (k and d) selected within the interval 0 to 1. From the simulation study, it can be noticed that the proposed estimator performs well than existing estimators when the value of d is large. Furthermore, it can be observed that the proposed estimator is always superior to MNTPE. Finally, it could be concluded that the proposed estimator is meaningful in practice.

Keywords: Multiple linear regression; Multicollinearity; Stochastic restriction; New stochastic restricted two parameter estimator; Scalar Mean square error

Development of Tracking over Speed System Using IoT Technology for Vehicles

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Now, IoT technology is used for many applications. But they are certainly used for agriculture purpose in Sri Lanka. In the modern era, many accidents occur due to over speed. But accidents are controlled with the help of the police force and speed bumps in the past. IoT technology was used in this project to monitor the high speed. First, the velocity of the motorcycle was measured with the help of a Tachometer. When approaching the predefined maximum speed, the warning message was sent to the driver. When crossing the predefined maximum speed, all details including the reading of the Tachometer and location were sent to the mobile number of the motorcyclist and to the web application that was created for the police force at the same time using GPS/GPRS/GSM module. Finally, the output of the complete project shows 90% accuracy and the system showed the expected output with the available components.

Keywords: IoT technology; over speed; Tachometer; Gps module; GPRS module; GSM module

Development a Self-Driving Golf Cart Using Kinect Sensor and Robot Operating System (ROS)

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An automated guided vehicle (AGV), in general, follows markings or wires on the floor or uses vision or laser sensors for its navigation. AGVs have been applied for flexible manufacturing systems, storage systems, delivery systems and in many similar situations in the industry mainly to move materials around a manufacturing facility or a warehouse. They are programmable mobile vehicles. AGVs are advantageous over conventional material transportation methods because of their repeatability and economic savings because of the absence of labor. The aim of this paper is to develop an automated golf cart for human transportation. To date, in Sri Lanka, there is no self-driving system for human transportation. Hence, by introducing an electrical self-driving solution for the Sri Lankan transportation system, environmental impacts and exhaust emissions can be reduced which are generated by fossil fuel consumption. The price of petrol is increasing due to shortage in supplying crude oil. If there is an electric self-driving system, the shortage of fuel can be overcome. This AGV system can be used in large factories, hotels, gardens and parks for human transportation. This self-driving technology may create new industries and job opportunities for thousands of employees in Sri Lanka. Paper presents an autonomous navigation AGV system based on a Robot Operating System (ROS) for indoor and outdoor navigation tasks. This system uses a Kinect sensor for map building of its environment. First, the system was developed and simulated using the ROS platform. Then, this self-navigation system was applied to a real golf cart by updating its control and drive system to match with the new self-navigation system. In this update, the Ackerman steering system and the braking system of the golf cart was automated to work in parallel with the new controller. This innovative system can carry up to four persons at a time. Experimental trials showed the ability of the AGV to move loads and people to their target locations.

Keywords: AGV; ROS; Kinect Sensor; Ackerman Steering System; Automated Navigation

Semi-Automated Weeds Identification and Watering System Using Machine Learning: Based on Cabbage Crops

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Fast-growing novel technologies influencing the world's different industries with innovative solutions for the issues arising to simplify the human workload and to avoid time consumption. In the Sri Lankan context usage of novel technology in the agricultural industry is not at a satisfactory level and weeds can be identified as a major problem agricultural field. Manual weed identification and removal methods are still using and it needs a lot of human workload and time. This Semi-Automated system was developed for plant and weeds identification and watering the crops using machine vision and machine learning technologies. Raspberry pi model B+ was used as the controller with camera and python with OpenCV is used for programming. This system was developed based on the cabbage crops and Bayesian classification and Mahalanobis distance for non-diagonal classification was used for recognition of plants. The plant watering mechanism works on the identification of plants this is an autonomous mechanism. This robotic system can be controlled through Bluetooth and it is able to ride through different field conditions. 85% of accuracy in the identification of plants and weeds is achieved in conducted trial runs using this system. Implementation of the system will enhance crop cultivation and cost, time reduction of the farmers in Sri Lanka. The system is successful in the trial runs and it will develop with the robotic arm for weeds removal in the future with this identification. Results manifest that farmer can use this system for their crop cultivation as an effective method in Sri Lanka.

Key words: Artificial Intelligence; Machine learning technologies; Watering; Plantation; Weeds Management

Development of an Automated Defect Identification System based on the Apparel count in Apparel Cartons

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In apparel industry garment cartons are considered to be having defect if there is a mismatch between the actual and the default garment count. Therefore, this kind of defect identification is an essential part for the quality assurance system in apparel industry for maintaining high product quality to ensure customer satisfaction. In many local apparel industries this defect identification process is carried out manually and due to this manual process subsequent human errors may happen degrading the product quality. In order to minimize the human intervention and to improve the accuracy in defect identification novel automated low-cost defect identification system is introduced using RFID technology. First, the system will identify the apparel carton when it is placed at the docking of the system. Then the carton will be gripped using a specially designed robotic gripper and will be transferred to the inspection area. In the inspection area, RFID tags attached to the garments will be scanned to get count of the garment in the cartons and the count will be compared with the default count. If there is a mismatch between the actual and default count, the carton will be rejected by the system. The developed defect identification system improves Accuracy, Efficiency, and repeatability. Therefore, defect identification manual process can be replaced by the developed low-cost method successfully.

Keywords: Automated Defect identifications, RFID, Apparel Industry, Quality Assurance

Exploring the Richness of Content of GREENSL Rating in Sri Lanka with Respect to Green Rating Systems in Japan, Singapore and Malaysia

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Green building construction is a concept under sustainable development, which has been introduced in many countries. GREENSL is the green rating tool which was introduced to Sri Lanka by the Green Building Council Sri Lanka and its contribution to the expansion of Sri Lankan green construction, has been very slow over the past decade according to the certified no of buildings. The main objective of this study was to assess the essence of Sri Lankan green evaluation content with internationally recognized CASBEE, BCA-GM and GBI ratings in the Asian region. Desk study including qualitative analysis was done to achieve the main objective of the study. Residential new construction manuals of CASBEE 2014 edition (Japan), BCA Green 2016 revision (Singapore), GBI 2013 version 3.0 (Malaysia) and GREENSL 2018 version 2.0 (Sri Lanka) were studied to gather data. Comparative analysis was done using check lists prepared with issues under each criterion. Categories under the content i.e. sustainable site, energy, material, water and indoor environment which are common to all tools were studied. According to the results, it was revealed that, GREENSL has paid its highest attention to all the selected criteria and some specific issues also have been addressed than other rating tools such as water efficiency in air conditioning, innovative wastewater technologies and constructed wetland. Specifically, GREENSL has considered construction waste management, hazardous waste management and operation solid waste management while other tools have considered about only one or two from them. When comparing to other green rating tools selected, GREENSL shows paramount importance since it can be used for all categories of buildings unlike in other rating tools which have separate guidelines such as for residential, non-residential, new and existing buildings. Therefore, it can be concluded that the GREENSL rating tool can be used as an international rating tool such as CASBEE, BCA GM and GBI and its content is far ahead of the other tools. It was suggested to address building security directly through the tool and to mention the cost-effective construction methods to motivate towards more green buildings in Sri Lanka.

Keywords: BCA GM; CASBEE; GBI; Green rating tool; GREENSL

Optimal Helix Angle and Channel Depth of Single-Screw Extruder for PLA Extrusion Using Finite Element Analysis

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Extrusion is a process that the cross-section area of a billet is reduced by forcing it to flow through a die with a certain shape with high pressure. Different types of extruders are used with several materials in extrusion processes. Obtaining the product without defects, energy efficiency is some major considerations of the extrusion process and process optimizations are conducting for better extrusions. Among all the extruder types, single screw extruders play a major role due to low cost, easiness of manufacture and maintenance, and parts resistance to abuse. Screw speed, taper angle, channel depth, helix angle, pitch are some of the parameters related to screw and which can affect the extrusion process. Scholars have studied the effect of the metallurgical properties of the material, friction factors, and flow indexes of materials, screw speeds, and taper angles. The effect of the channel depth and helix angle should be considered in material extrusion process optimization. This study carried out the relationship between channel depth and helix angle within extrusion, optimal helix angle, channel depth for the PLA polymer extrusion process and variation of pressure gradient of extruder with channel depth and helix angle was studied using the finite element analysis methods. PLA polymers with different MFI values used for analysis in Abaqus. This study suggests the optimal helix angle and channel depth for PLA extrusion to obtain maximum flow with a high-pressure gradient.

Keywords: Single-Screw extruder; Helix angle; Channel Depth; Extrusion Optimization

Design of Dust Extractor to Prevent Chemical Dust Coming out of Water Treatment Process

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In water purification, every water purification unit makes sure to apply the appropriate chemicals to the specific need and locations. In this case, various chemicals have to be applied to separate the mud or any substance that has been mixed with the water and destroy the micro-organisms such as harmful bacteria in the water and purify the water. From time to time a coagulant like alum has to be applied to the water purification process. Here the chemical substance has to be used as a powder for those processes. This paper comes up with a solution to prevent the dust from mixing with the person with the substance as well as the environment. The dust may be released into the environment and into the body of the person performing that task. As a solution for that, there is a requirement called for a dust extractor for the water treatment plants. The main objectives of this case are contributing to the increase of local production at a lower cost and helping to retain local currency here and enlarge the technical knowledge and their production, which encourage the people by avoiding harmful processes for the global. A dust extractor is a device that collects suspended dust. They have filters that effectively separate large particles from microscopic particles. The importance of the dust extractor is, frequently utilized as an air contamination control gadget to keep up or improve air quality. But its special feature is that although there is a dust extractor machine as a solution, they are expensive and inefficient and cannot be used for a long time. This paper mention something about designing a dust extractor for this at no extra cost. This is most suitable for water treatment plants. This is an attempt to manufacture this machine at a very low cost and suits the economic level of Sri Lanka. As well as using a simple mechanism.

Keywords: Dust Extractor; Environmental effect; Healthy; Cost-effective; Water treatment

Challenges In Implementing LED Lighting in Commercial/Non-Residential Buildings in Sri Lanka

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Conserving energy and being sustainable is very important for any commercial building in the current context. Since lighting systems consume a considerable amount of energy in a commercial building, it is essential to implement energy efficient lighting systems. LED lighting is the most energy efficient lighting technology that is commonly available today. LED lighting has been used in commercial buildings in Sri Lanka for over ten years now. However, LED is still an evolving technology and relatively new technology for Sri Lanka as well. Hence, there can be challenges faced by the building sector professionals in using LED lighting. This study aims to identify the perception of different stakeholders of commercial buildings, the challenges they have faced in implementing LED lighting. Further it was necessary to identify possible measures that can be taken to overcome the prevailing issues were analyzed. A survey questionnaire was conducted among the different stakeholders involved in commercial building projects during different phases of the building life cycle. Further a desk study was conducted regarding the standards, regulations prevailing in Sri Lanka and the initiatives taken by other countries to identify the possible strategies that can be used to overcome the identified issues. It was found that stakeholders were enthusiastic in implementing LED lighting but they had several concerns. The main challenge identified was the lack of standards and relevant regulations in Sri Lanka with regards to LED lighting used for commercial buildings. Further it was found that there are educational gaps among the professional regarding LED lighting. In addition, it was found that the regulations in the building sector are not sufficient to make energy efficient lighting mandatory. It was concluded that introducing comprehensive quality standards for commercial LED lighting is essential and regulatory measures should be taken to enforce energy efficient lighting in commercial buildings. These measures are required to solve these issues and utilize the LED lighting in an optimum manner to reach the sustainability goals of the country.

Keywords: LED lighting; commercial buildings; Sri Lanka; challenges

Influence of Commonly Used Pipe Material in Housing Construction in Sri Lanka

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This study focuses on the frequently used pipe material and their standard sizes available in the market including the generally used sizes for the plumbing work of housing construction taking place in Sri Lanka. Both qualitative and quantitative approaches were used for the effective fulfilment of desired objectives. Three preliminary interviews and fifteen semi-structured interviews were conducted with professionals who are passionate about research areas of this nature. The collected data for common pipe sizes being used were analyzed through the relative importance index (RII) analysis. The collected data for regular material used in house construction were analyzed through the content analysis and summarized through relative percentage. No house would be complete without a proper plumbing system. Choosing the suitable pipe material for residential purpose is often determined by the client's needs and the project's nature. Several different materials are used in house construction in Sri Lanka, namely: polyvinyl chloride (PVC), polyethylene (PE), polypropylene (PP), and polybutylene (PB). However, it was highlighted that PVC is the most commonly used commodity in Sri Lankan housing construction for water supply, drainage and electrical insulations in domestic applications. The length of the standard sized pipes is being cut into pieces according to the requirement of each project. SLS 147 and SLS 659 are the Sri Lanka standards applied for PVC products such as pipework, joints, and fittings. The standard sizes of four and six meter long PVC pipe are available from the range of 20mm to 355mm diameters whereas, the pipe sizes being used are up to 110mm diameter in housing construction. As opposed to alternative materials viz PE, PP, and PB, the PVC is preferred due to it being relatively low cost, flexible, light in weight, moderate in toughness, strong, easily joinable, and chemically inert to water. However, the alternative materials also have their own significant characteristics. Therefore, the pipe manufacturers shall consider increasing the demand for such alternative pipe materials based on their unique characteristics.

Keywords: PVC; Alternatives; Standard sizes; Common sizes

An Analysis of Medium Voltage Feeder Tripping in Ceylon Electricity Board Distribution Network – A Case Study of Western Province South 1 Network

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Providing a reliable power supply with minimum breakdowns is one of the main objectives of any electricity supply company. Frequent breakdowns in the power system occur due to various faults. To improve network reliability, it is more essential to have a proper analysis of these faults and incorporate them into the network development plans. The main objective of this research is to do an analysis of the feeder tripping details in a selected area of the Ceylon Electricity Board Medium Voltage distribution network. The area of Ratmalana, Kalutara, Mathugama, and Dehiwala which operates under Western Province South 1, Ceylon Electricity Board were considered for the present study and feeder tripping data were collected from relevant grid substations for the year 2019. First, an analysis was done to identify the feeder lines with frequent failures. The Auto type feeder tripping details of the selected feeders were then further analysed and it was observed 75.02%, 14.48% and 6.15% of faults were due to Earth Faults, Over-Current and simultaneous occurrence of Earth Faults and Over-Current respectively. The rest were due to the Under Frequency relay operations and 132 kV incoming failures. Auto type feeder tripping occurs repetitively in the network and minimizing them leads to building up a healthy network. These repetitive failures can be minimized by addressing solutions for individual feeder lines, where frequent failures occur. Hence a comprehensive analysis to identify the reasons for auto type feeder trippings is extremely important. Utilities can incorporate these research findings in their network development plans. They will consequently be able to eliminate many repetitive breakdowns on the Medium Voltage Network, and thereby improve the network quality while maintaining reliability indices at an optimal level and increase their financial revenue.

Keywords: Auto type Feeder tripping; Ceylon Electricity Board; Earth Faults; Medium voltage distribution network; Over-Current Faults

Smart Sun Tracking System for Solar Energy Generation

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The use of renewable energy is becoming more prevalent with the global energy crisis. Solar energy is nature's most abundant renewable energy available around the world. The main challenge with solar energy harvesting is the reduction of solar energy absorbed by the use of photovoltaic (PV) systems. Excellent performance of PV systems can be achieved when the panel is oriented perpendicular to the radiation direction of the sun. Solar tracker systems are capable of optimum positioning of the PV panels to capture maximum solar radiation. Single axis solar trackers are widely used around the globe at the present day. The single axis tracking systems produce lower energy output during sunny times and it can track the daily change of Sun's position but not seasonally. This study proposes an automated dual axis solar tracking system considering the limitations of fixed panels and single axis trackers. This project involves the designing and developing of an automated dual axis solar tracking system for domestic energy purposes. Moreover, demonstrates a prototype of the proposed dual-axis solar tracking system. The proposed dual-axis solar tracker increased energy generation by tracking Sun rays from switching solar panels. Sun rays are detected in different directions by the LDR system with a smart solar sensor mechanism. Advanced LDR arrangement and Algorithm development enabled way to smart sun tracking. The development of an Algorithm for this sensing mechanism improves the effectiveness and accuracy of the system. It is more accurate than a fixed solar panel and single axis system. Moreover, this design can be applied to the large-scale solar energy system in practice. This project is also expected to investigate the performances of the dual axis tracking system compared to the system with a fixed mounting method.

Keywords: Solar energy; Photovoltaic; Sun tracking system; Automation; Micro-controller

Development of Groundnut Threshing Machine for Sri Lankan Varieties

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Groundnut threshing is a fundamental process in post-harvest management. The threshing process is done using manpower and machinery. The majority of groundnut growers separate the groundnuts by their hands. But the manual threshing process is inefficient and it is a very time-consuming process. At present, imported threshing machines with various capacities are used by Sri Lankan farmers for threshing the groundnut of Sri Lankan varieties with the limitations of those imported machines. The main reason is for the low productivity of imported threshing machines is that the machines are designed based on the specifications of the groundnut types available in those countries. The objectives of this project are (i) to design and develop a machine for threshing the groundnut pods from the groundnut bushes after harvesting and (ii) to develop a low-cost and efficient groundnut threshing machine for local varieties. Several field visits were made to find short coming of the available machines. Based on the field visit information, a three-dimensional design of the threshing machine was designed to avoid those short comings. The designed threshing machine is powered mechanically and size of the machine is smaller (L=1750mm) than the others. New improvements in the current design are being made by analyzing farmer's data and their ideas. In this process, two to three days after the groundnut harvesting, the bushes are threshing, which reduces the force required to separate the pods from the bushes that should be minimized damage to the pods internally and externally. This developed threshing machine can adjust the scale of air blower input area, that air input requirement scale depending on the type of groundnut. The main difference between groundnut varieties is the mass of pods. This threshing machine gives positive feedback to groundnut farmers to grow several types of groundnut in large quantities and contributes to the growth of the local economy.

Keywords: Groundnut threshing machine; Field efficiency; Groundnut varieties

Design an Extruder Machine to Make Artificial Rice

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More than half of the world's population consume rice as a staple meal. Sri Lankans consume 2.34 million metric tons of rice per year on average. But rice shortage occurs due to natural disasters in Sri Lanka. Sri Lanka produced 1.471 million tons of paddy during the Yala cultivation season in 2019. Rice peases are procuded as a by-product during the milling process and therefore the value of the rice is dropped down. As a solution of this low value products, more nutrition, taste rice varieties with good appearance can be prepared for different purposes. In order to facilitate these reqerements, artificial rice production has attracted the attention of other countries in the world. It is our defeating goal to establish this in our country too. extrusion technology is used to achieve this goal. The purpose of this study is to develop a new type of rice using extrusion technology using raw rice and other protein ingredients as raw material. Extraction is the process by which a mixed ingredient passes through a narrow opening called a die to form and get the desired shape of food. Processing flowcharts of some extruded food products ingredient storage 1. Ingredient Feeding 2. Mixing, Extrusion 3. Drying 4. Cutting 5. Packaging. this machine is designed with three main units feeding unit, compressing unit, and cutting and rolling unit. stainless steel SUS 304 is used for every part of contact with food. shape of the rice produced using this machine is basmati rice. Construction is based on Single screw extrusion. This machine can be used to produce artificial rice and content of the rice material can be modified in order to have good taste, appearace and nutritions. Indeed, it is a value addition to the grain grown in Sri Lanka and make a new quality product for the local market as well as export to the global market.

Keywords: Artificial rice; Extrusion Technology; Synthetic rice; Extruder machine

Design of an Automated Damage Inspection System for Aircraft Wheel Hubs

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The wheel assembly is one of the most critical parts of an aircraft. Landing, take off and taxi operations generate repetitive stresses on the wheel hubs, resulting in small imperfections or damage that can potentially grow into cracks. These cracks may cause catastrophic failures that harm the passengers' lives. At present, the Sri Lankan aviation industry uses handheld eddy current inspection equipment for aircraft wheel hub inspection. The handheld inspection method reduces the accuracy of the testing. This study proposes a design of a pre-coordinated eddy current inspection mechanism using Arduino programming. Component Maintenance Manual (CMM) provides by the aircraft manufacture describes the standard inspection methodology of the wheel hub. According to the CMM, the beading area of a wheel hub should be thoroughly inspected as the beading area has repetitive stress concentration. The inspection is done by the rotating wheel hub on a rotary table, and placing a scanning probe on the surface at the top of the beading area gradually moves down the probe in 2 mm steps. When the machine operates, there is relative motion between the wheel hub and the moving arm. In order to reduce the moment of inertia, the tray rotates at 50 RPM. On the assembling step, a collision check was done on mates. The time for each wheel hubs with change concerning the size of the wheel hub. If someone chooses the wrong size, the probe might be damaged so, safety switches have been installed on the moving arm as a safety feature. The proposed design was aimed to inspect four types of wheel hubs (wheel sizes: A330 (main and nose wheel), A320 (main and nose wheel). These sizes have been coded on the Arduino code. The proposed design will facilitate high accuracy, time-efficient, and low-budget NDT inspection operation.

Keywords: Non-destructive testing; Eddy current; Crack damage; automated inspection system, Aircraft maintenance

Development of a Low-cost pH Meter using Arduino Programming

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A pH meter is an electronic device that measures the acidity or alkalinity of solutions by combining a pH sensor with a temperature sensor for a complete pH meter. The study was undertaken to create a low-cost pH meter with high accuracy. It is essential to measure accurate H⁺ ions in water-based solutions for various purposes such as aquaculture, water quality testing. The pH meter is an essential device for laboratories such as medicine, food, and agriculture. In today's world pH meters are very expensive and need to pay more to buy a pH meter and that is a major issue for laboratories when importing pH meters. Different varieties of pH meters are commercially available in the market. The specialty of this research is the preparation of low cost of production nearly 6 times, compared to the commercially available similar pH meters. The designed pH meter is Arduino-based and the power supply via USB. Analog voltage signals are used to take the readings. A pH glass electrode sensor of a range of 0-14 and a DS18B20 temperature sensor was used. The voltages were measured by adding the pH sensor in pH 4.01, 7.01, and 10.01 standard buffer solutions. Then a graph of the pH vs. voltage was plotted and a mathematical model to calibrate the pH sensor was created using the piece-wise linear interpolation. The temperature sensor was calibrated at 0 and 100°C. The pH and temperature readings taken by the laboratory pH meters and thermometers were compared with the designed pH meter readings. The finalized device contains a menu especially for the calibrations and the adjustments by having major 4 sections as sensor calibrations, display settings, output mode, and the about device. The accuracy is up to 2 decimal points of pH and the stabilization values are given less than 30 seconds. It is identical to a pH meter found in a standard laboratory and the outcome of the study is a low-cost pH meter. Because of its user-friendly interface, simple calibration process, and high level of accuracy at a reasonable price, the pH meter can be used instead of existing pH meters.

Keywords: pH meter; Low-cost pH meter; pH sensor calibration; Temperature sensor calibration; Piece-wise linear interpolation

Design of a Traversing Arduino Pitot Tube for the Low-speed Wind Tunnel of KDU

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The educational wind tunnel presently available at Kotelawala Defence University renders readings of pressure via a 24-tube multi-tube manometer. However, readings thus obtained are subject to observer and instrumental error. The present work addresses these issues with the aim of obtaining finer readings to yield far accurate flow measurements. Since the design of the test section permits mounting of a pitot static tube at midpoint with very little flexibility of movement in the direction of the flow, a special apparatus was designed to incorporate a traversing pitot tube with an Arduino-based pressure indicating system, thereby replacing the conventional manometer. The aerodynamic performance of the designed apparatus was examined through Computational Fluid Dynamics simulations. It was found that the presence of the additional apparatus imposed minimum increase turbulence in the streamwise direction. The Arduino-based pressure sensing system was developed to obtain numerical readings of pressure and velocity without additional manual calculations. The designed system was used to measure the dynamic pressure variation inside the test section, which shows acceptable variations in the order of 0.4%. Further the readings obtained with the device vary from that of the clean test section with rigid pitot tube in the order of 5-7%, which is acceptable. The data generated will enable future users to make necessary corrections to results obtained during experiments.

Keywords: Arduino-based pressure sensor; Computational Fluid Dynamics; manometer; Pitot-tube; turbulence; wind tunnel

Batteries to Manage Voltage Rise Caused by Solar PV in LV Distribution Networks

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Solar power from solar photovoltaics (PV) is one of the fastest growing renewable energy sources in the world. Recent government policy initiatives in Sri Lanka have significantly increased the number of rooftop solar PV systems connected to the low voltage (LV) distribution network. As a result, increased solar PV penetration to LV distribution network can nominally disrupt network operating conditions and leading to power quality issues. Voltage rise has been reported as the most prominent power quality issue with high solar PV penetration levels. This will significantly exceed the load requirement. In order to reduce the voltage rise, excess power from the solar PV units must be reduced. Therefore, battery energy storage systems (BESS) are recommended to store the excess energy. This project presents real feeder and real data of the Rajagiriya area in Sri Lanka to prove voltage violation issues and find optimal solution through research. All simulations are made using the DIGSILENT powerfactory platform, mainly to detect the location of the voltage violation at the selected feeder. Based on that, it has been identified which customers' solar PV system is causing the voltage violation for the particular time in the feeder. Subsequently time required to store energy which is supplied from the particular solar PV system has been calculated for a day. Based on that, the battery capacity was calculated and it is recommended to the particular solar PV customer. For this study lithium-ion batteries were selected according to the Depth of discharge (DOD), efficiency, and calendar life cycle. The amount of power that can be delivered to the grid for night peak demand is calculated by the DOD rating of the lithium-ion battery. And it is decided that the hybrid inverter was optimal for this system. Total cost is calculated considering the capital cost of solar PV, batteries, and inverter. The income and the capital cost were compared and the payback period was observed. Finally, it is verified that the cost of capital can be recovered by the customer within the specified year.

Keywords: Solar Photovoltaic; Voltage Violation; Low Voltage Distribution Network; Battery Energy Storage System

Technical and Economic Feasibility of Recycling Aluminum Scrap to Aluminum Re-Draw Rod

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Maintaining the bear low voltage line is a major difficulty that Ceylon Electricity Board faces today since it is very sensitive to the natural and other impacts such as wayleaves, animal collisions and electricity thefts. At present, Aerial Bundled Conductors are used for replacing existing low voltage bear lines under maintenance/rehabilitation work and for newly constructed schemes or new extensions. Aerial Bundle Conductors provide multiple benefits to the electricity distribution network by increasing the network effectiveness, reducing the distribution network failures/faults and losses, minimizing clearing of vegetation which protects environment especially in urban areas, protecting the distribution network from theft and illegal tapping. When the low voltage power lines of bear Aluminum conductors are converted to Aerial Bundle Conductors, the Aluminum conductors are removed as scrap material and nearly 1000 MTon Aluminum scraps are being sold per year at a predetermined price without using it for value-addition purposes. This project involved the study and investigation of the technical and economic feasibility of recycling Aluminum scrap into Aluminum Re-Draw rod to manufacture low voltage Aerial Bundle Conductors from the recycled Aluminum scrap. Testing and detailed analysis were done on chemical composition, electrical properties, mechanical properties and dimensional tolerance to the find technical feasibility of the scrap Aluminum recycling process. Accordingly, with respect to all testing and analysis, fabricating Aluminum Re-Draw Rod from scrap Aluminum is technically feasible. Further, a pricing formula was generated and the total price was calculated for the Aluminum Re-Draw rod fabricated from recycled Aluminum scrap by studying, witnessing, measuring and analyzing every sub-process of the Aluminum recycling process namely Aluminum cleaning, Aluminum bailing, scrap ingot making and Re-Draw Rod making. From this recycling process of Ceylon Electricity Board, the country can save about US \$ 2.3 million (Rs 412 million) foreign exchange per year by converting 1000 MT of scrap Aluminum to Re-Draw Rods every year. According to the results, the economic benefit of the process of recycling will be more than 50%. Hence this process of recycling Scrap Aluminum to Aluminum Re-Draw rod is technically and economically feasible.

Keywords: Ceylon Electricity Board; Aerial Bundled Conductors; Aluminum; Recycling; Feasibility

Automated Powder Dispensing System for Manufacturing Industry

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In many manufacturing industries, powders should be weighed and dispensed as a part of the routine production process. In these scenarios, workers must prepare power batches based on the material requirement manually. This manual process reduces the efficiency of overall production. Existing powder dispensing systems have issues including material and time wastage, human errors in the measurements. Since some powders are toxic to humans, works should avoid direct contact with the material. This study proposes a system to address these issues which are equipped with a screw conveyor and electronic weighing measurement. Also, the proposed system has features including automatic quantitative, Speed control. Further, Screw conveyors have an agitator to give vibration motion to the screw conveyor to ensure the Powder quickly comes to the screw conveyor. A valve is installed at the point where the powder exists, and the valve opens. Then the Powder comes out to the screw conveyor the Powder starts to dispense into the container. The load cell system collects data and measures the amount of powder that falls through the conveyer. PID unit is used to control the speed of the conveyor. The powder measuring machine is suitable for food additives, flavors and fragrances, flour, milk powder, protein powder, solid drink, sugar, monosodium glutamate, pesticides, veterinary drugs, detergents, enzymes, chemicals, and other powder (powder, super fine powder). The dispensing system is having 85% efficient 90% accurate than the conventional methods used in local manufacturing facilities.

Keywords: Powder; Screw conveyor; Dispenser; Weight measurement; Loadcell

Casting Defects and Crack Propagation of Cast Aluminum under Applied Stress

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Die casted pure Aluminum samples which were having rectangular cross-sectional areas were studied experimentally. A steel die was prepared in the machine shop. Aluminum was melted at 800 °C in a graphite crucible and poured in to the die at room temperature under the gravity. The eight samples were casted and subjected to a normalizing or annealing process before the measurement. The mechanical properties of each sample were studied using the tensile tests and hardness tests. It was observed a significant reduction of the Modulus of Elasticity and Hardness due to the high density of defects. The calculated Modulus of Elasticity was in the range of 4.5-7.2GPa and the Tensile Strength was in the range of 115-170 GPa. The samples with high density of defects were used to study the crack propagation and failure under the applied stress. All the samples showed a brittle fracture. The surface morphology of the cracked surfaces was studied visually. It was observed that cracks were always originated from defected sites near the surface of each sample. The critical defects of each sample were identified with the visual observations and the x-ray radiographic imaging. The lowest Tensile Strength (115.5 MPa) was observed in the sample (sample C) which was not annealed or normalized. The critical defect was a void of diameter 7mm. Shrinkage defects and piping were also observed as dominating critical defects. The distribution of defects was widely varied in samples. Thus, the mechanical properties were mainly dependent on the distribution of defects. It is suggested that minimizing the surface defects would lead to improve the mechanical properties. It is also required to follow a more improved process of casting to control the defects and hence to study the effect of the type of defects on crack propagation and mechanical failure of cast Aluminum.

Keywords: Die-casting; Aluminum samples; Radiographic testing; Tensile test; Hardness test; Casting defects

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An Investigation on Awareness and Good Practices Regarding Respiratory Health Related Problems Among Traffic Police Officers in Colombo District, Sri Lanka

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With increasing urbanization, a number of vehicles contribute to the severe pollution related health hazards. Traffic pollution is a major public health threat and traffic officers who are continuously exposed are at an increased risk. The aim of this study was to evaluate the awareness of police officers in Colombo district regarding respiratory problems that may arise in them. A descriptive cross-sectional study was conducted and the participants were traffic police officers with more than 5 years of experience. Convenient sampling technique was used to collect data using a self-administered questionnaire. Analysis of collected data was performed through Microsoft excel for descriptive statistics. Throughout the study of 50 traffic police officers, 76% of the respondents was between 20 to 30 of age and 24% was between 31 to 40 of age who had an experience more than 5 years. The results of the investigation of knowledge regarding “what is traffic air pollution” was relatively not satisfiable, since 22% of participants had false assumptions. Furthermore, it was remarked that 43.7% out of the total respondents were unfamiliar with the safety measures needed to reduce the risk of respiratory related health problems. According to previous studies, traffic police officers are prone to respiratory problems and 74% of the respondents in this investigation had knowledge regarding the risks of pollution on their health but very few were practicing the preventive measures. According to this investigation, the level of knowledge among participants is sufficient; however, the level of practice for preventing the risk of respiratory problems is not satisfactory. Furthermore, it is recommended to conduct awareness sessions regarding the importance of maintaining a safe respiratory health while providing them with sufficient safety gears to ensure the same.

Keywords: Awareness; Traffic police; Respiratory problems; Air pollution

Rainfall and Flood Events in the Deduruoya Basin in Sri Lanka

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Disaster risk reduction of vulnerable communities is a requirement for the well-being of society. Among many natural disasters, the flood can be identified as the most frequent and threatening disaster in Sri Lanka. A proper study of the relationship between rainfall and flood within the Deduruoya basin has not yet been conducted, therefore it is essential in flood risk management. This study aimed to find the trend of rainfall and the relationship between rainfall and flood in the Deduruoya basin. A time series analysis was employed to find the trend of rainfall using the R software. The Mann-Kendall test and Sen's Slope estimate were used for trend detection. A correlation analysis was performed to find the relationship between flood and rainfall. The study was conducted from 1960 to 2019. A significant decreasing trend of monthly mean rainfall was observed in the basin as a whole during the study period. The average monthly rainfall was 140 mm in 1960 and it was decreased to 120 mm by 1985 and further decreased to 108 mm in 2019. The overall reduction of the monthly mean rainfall was 32 mm over the 60 years. This was confirmed by the Mann Kendall test with the $P = 0.01$ confirming a significant trend. As per the tau value of the MK test, it was reported as -0.06 confirming the overall decreasing trend. The Sen's Slope estimate has also confirmed the result (-0.03). 23 flood events were identified in the Deduruoya basin from 1978 to 2020. Eleven flood events (48%) have been occurred in the Second Inter Monsoon (SIM), 07 (30%) events have been occurred in the North East Monsoon (NEM) and 05 flood events (22%) were occurred in South West Monsoon (SWM). No floods have been reported in First Inter Monsoon (FIM) season from March to April. The study revealed that the SIM and NEM seasons' rainfall has a strong relationship with floods (78% floods). The findings will be important for flood risk reduction in the Deduruoya basin.

Keywords: Rainfall trend; Flood pattern; Flood risk; Relationship between rainfall and floods; Deduruoya basin

Removal of Phosphorous and Nitrogen from Wastewater of Uva Wellassa University by utilizing Bittern Solution

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Fluidized bed reactors (FBRs) are one of the best methods used for phosphorous recovery as Struvite crystallization from municipal wastewater streams. This study aims to remove and recover of phosphorous (P) and nitrogen (N) from wastewater generated at Uva Wellassa University through struvite precipitation in air agitated fluidized bed reactor by utilizing bittern solution. Bittern solution is a by-product of salt manufacturing process used as a low-cost source for Mg source in this study. Operating conditions i.e., pH range, aeration rate, constant bittern solution inflow rate and hydraulic retention time (HRT) were tested for obtaining optimal conditions for both batch mode and continuous flow mode air agitated FBR setup. According to the batch mode experimental results, the maximum recovery efficiency of P ($\text{PO}_4^{3-}\text{-P}$) and N ($\text{NH}_4^+\text{-N}$) were achieved 98.29% and 19.82% respectively through 3.0 L/min aeration at 180 minute HRT. Considering the operational parameters of the batch mode air agitated FBR setup, aeration rate increment (from 1.0 L/min to 3.0 L/min) did not show any significant effect on P ($\text{PO}_4^{3-}\text{-P}$) removal efficiency. On the other hand, for continuous flow mode experiment, the P and N maximum removal efficiency were reached 80.62% and 5.19% respectively through 65.0 mL/min wastewater inflow rate at 60 minute HRT. While optimizing the HRT for continuous flow mode air agitated FBR setup, the HRT is proportional to the wastewater inflow rate. Hence, the optimal operational parameters of experiments were obtained as 9.0 - 9.5 pH range, 1:1 molar ratio of $\text{PO}_4^{3-}:\text{Mg}^{2+}$, 120 to 180 minute HRT and 1.0 to 3.0 L/min aeration for batch mode air agitated FBR setup. According to the experimental results batch mode is more suitable than continuous flow mode for removing P from municipal wastewater for achieving higher efficiency. Therefore, the findings of this research would be applicable in designing and operating pilot scale air agitated FBR for struvite crystallization from wastewater.

Keywords: Air agitated Fluidized bed reactor; Phosphorous removal; Struvite precipitation; Aeration; Hydraulic retention time; Batch mode

Pseudomonas fluorescens* BG-E, a Potential Biological Control Agent for Bloom-forming Cyanobacterial genus, *Pseudanabaena

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Outbreaks of toxin-producing cyanobacterial blooms in freshwater reservoirs in Sri Lanka have increased over the past few decades and are likely to be responsible for fish death reported in many reservoirs. Various physical and chemical methods are in practice to eliminate cyanobacterial blooms. However, due to some limitations adhered with those practices, currently researchers have focused on the applicability of algicidal bacteria as an environmental friendly sustainable control strategy. The present study aimed to investigate cyanolytic and microcystin-LR (MC-LR), degrading potential of heterotrophic bacteria isolated from freshwaters. Sub-surface water samples were collected from Bandagiriyia reservoir in Hambantota district. Bacteria were isolated from a composite water sample collected from 22 sampling sites representing the entire reservoir in 50% nutrient agar. Axenic cultures of colonial (*Microcystis* sp., *Synechococcus* sp.) and filamentous (*Pseudanabaena* sp., *Pseudanabaena lonchoids*, *Leptolyngbya*, and *Geitlerinema* sp.) cyanobacterial genera were used as tested cyanobacteria. Seven morphologically distinct bacterial isolates were screened for the lytic activity against cyanobacteria in BG11 broth. Briefly, cyanobacterial cultures at $\sim 2 \times 10^6$ cells/mL were inoculated with 10% v/v each bacterial isoates at $\sim 1 \times 10^8$ cells/mL. Following 10 days of incubation, distinct discoloration of blue-green into yellowish-brown color in the cell mass of two species of *Pseudanabaena* was observed in cultures inoculated with BG-E bacterial isolate. Microscopic images provided evidence for complete disintegration of filamentous structures. Disappearance of blue-green color might be due to the oxidation of released photosynthetic pigments during cell wall disintegration. The % lytic activity of BG-E against *Pseudanabaena* sp. and *Pseudanabaena lonchoids* based on the chlorophyll-a analysis were 82% and 73% respectively. Bacterial isolate BG-E was identified as *Pseudomonas fluorescens* by sequencing of its 16S rRNA gene. Since *Pseudanabaena* is a MC-LR producing and frequently found filamentous form in freshwater reservoirs of Sri Lanka, MC-LR biodegradation potential of BG-E was investigated. Results showed that BG-E is not capable of degrading MC-LR at tested concentrations. Further, none of the genes in the microcystin-degrading gene cluster, mlrABCD were amplified in polymerase chain reaction and might be the reason for the incapability in degrading MC-LR. However, strong cyanolytic activity highlights potential application of *P. fluorescens* BG-E in future biological control strategies in Sri Lanka.

Keywords: Cell lysis; Cyanobacteria; Cyanotoxin; *Pseudanabaena*; *Pseudomonas fluorescens*

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Bird Call Recognition using a Convolutional Neural Network

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Birds are an important indicator of biodiversity in an eco-system as well as identified as a crucial indicator of health of an environment. They are susceptible to environmental changes therefore; it is significant to investigate and monitor bird species. Birds have different sounds (which are called 'birds calls') that are melodious to the human ear. Therefore, bird call identification and classification remains as very interesting and important area because it requires expert naturalists to manually identify bird type according to the bird call. Furthermore, birds have different types of voices. Such as calling, singing and mimicking representing different acoustic characteristics and this research suggests a novel pre-trained neural network model using verbosity, number of epochs, frequency and batch size of bird calls in identification of bird type and analysis how these factors will affect to the accuracy of bird call prediction. This research introduces a novel and a scientific method which can be used in bird explorations and helps ecologist to be aware of environmental changes. But there are some challenges when doing bird call classification such as background noises, different types of bird voices, inter-species variance and multi-label classification problem. This study use as pre-trained Neural Network (CNN) Model with bird recordings acquired by the Xeno-canto bird sharing database. Spectrograms are generated for every bird call and background noises were filtered. The key fact of bird species identification is the extraction of features of bird vocalizations. And neural network model has a strong self-learning and signal extraction ability, and it can automatically acquire and combine characteristic information from the bird recordings. Mel-Frequency cepstrum(MFC), Finite Impulse Response (FIR) filter and Fast Fourier Transform(FFT) techniques were performed on each and every spectrogram and after creation of Mel-spectrogram data were split into train process and train the dataset using Keras and Librosa libraries. The proposed methodology predicts the birds' name analyzing the bird call with 90% of accuracy. This is of great significance to the identification of birds with small sample size.

Keywords: Convolutional Neural Network; Mel-Frequency Cepstrum; Fast Fourier Transform; Finite Impulse Response

Defluoridation of Groundwater by Electrocoagulation: Performance Evaluation of Electrodes

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Fluoride dissolves in groundwater due to water-rock interaction and human activities. Drinking water with a low or high level of fluoride can cause adverse health effects to humans. Sri Lankan drinking water standard for fluoride is 1.0 ppm but, most of the groundwater from dry zone areas of the country exceeds this level while some even exceed 5.0 ppm. Electrocoagulation is one of the best methods that can be used to remove excess fluoride from drinking water. During this study, the performance of different metal electrode pairs, the dependence of initial pH, the retention time of process, the effect of pH variation, applied voltage and conductivity were studied concerning the removal of fluoride. Al-Al, Fe-Fe and Al-Fe were chosen for performance evaluation of electrodes. At the same time, initial pH was varied from 6.5 to 8.0 by 0.5 uniform intervals, and samples were taken in each 30 minutes intervals up to 4 hours in all experiments to determine the removal efficiency. The fluoride concentration of samples, were determined by UV Spectroscopy. DI water with 10 ppm fluoride was used for all experiments and during this process voltage, conductivity, current density, electrode separation distance and effective area of electrodes were maintained at constant. Al-Al electrodes showed better performance at 7.0 pH in a low retention time of 90 minutes and Fe-Fe electrodes were effective at 8.0 pH in a high retention time of 120 minutes. Natural groundwater with a higher concentration of fluoride (5.36 ppm and pH 7.98) was tested using Al-Al electrodes. After 2 hours of process, fluoride concentration was reduced to less than 1.0 ppm level, for Fe-Fe electrodes more time was required than Al-Al electrodes. During the procedure, pH was stable for Fe-Fe electrodes, but for Al-Al electrodes, pH value was increased more than 8. Al-Al electrodes can be effectively used for defluoridation of groundwater in Sri Lankan arid zones.

Keywords: Defluoridation; Groundwater; Electrocoagulation

Study of Removal Efficiency of Rhodamine B Dye from Industrial Waste Water with Different Energy Sources Using TiO₂ Photocatalyst

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Various hazardous chemicals discharged to the environment without proper treatments are responsible for whispered pollution. Economical treatment of these hazardous industrial wastes is in high demand in waste treatment sector. Fabric dyes are one of such visible pollutants that are very difficult to treat. In this study, photodegradation processes of Rhodamine B dye in real effluent that was discharged from a fabric dye plant are investigated using various light sources and TiO₂ photocatalyst. The UV visible spectrum of the effluent that contains Rhodamine B dye was used to monitor the degradation process. The effect of four different light sources such as sunlight, UV C light, LED blue and LED cool white light were investigated. Physical conditions such as amount of photocatalyst, exposure time, and mass transfer effect were investigated for the kinetics of removal of Rhodamine B. LED blue and LED cool white light show very small effect for this removal process even at high intensities. Sunlight and UV-C light were found to be very effective for the degradation of Rhodamine B dye in fabric plant effluent. The degradation rate of Rhodamine B under sunlight in the presence of TiO₂ photocatalyst found to be significantly higher than that for UV C light. However, both light sources are found to be practically usable. Under the sun light, not only Rhodamine B dye but also most of the other chemicals in the effluent were almost entirely eliminated. When sunlight was employed, the degradation rate was highly fluctuated with the change of intensity of sun light. The mass transfer effect is identified as crucial factor for the removal kinetics. Under the agitation, UV-C light also shows removal rate comparable with that of sunlight. Therefore, though less effective than sunlight, UV-C light has higher potential using in industrial applications with proper wavelength, agitation rate and intensity tune up. The pilot plant is under construction in a fabric dye plant based on the outcome of this study.

Keywords: Photocatalyst; Degradation; UV light; Rhodamine B; Dyes

Adult-Recruit Spatial Association of Shorea Species Determined by Topographic Variation in a Mixed-Dipterocarp Tropical Rainforest, Sri Lanka

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The spatial distribution of recruits around conspecific adults of woody species conveys detailed insights on the mechanisms governing species co-existence in tropical rainforests. Hence, we studied adult-recruit association of eight *Shorea* species (*Shorea affinis*, *S. congestiflora*, *S. cordifolia*, *S. disticha*, *S. megistophylla*, *S. trapezifolia*, *S. stipularis*, *S. worthingtonii*) in the Sinahraja Forest Dynamic Plot, using spatial point pattern analysis. The adult-recruit spatial patterns were extracted from four censuses in 1996, 2001, 2006 and 2011 conducted at the plot. We used slope, elevation, aspect, curvature, topographic wetness index and seventeen soil nutrients as habitat variables. To assess the adult-recruit spatial relationship, we used two null models created by the pattern reconstruction method. The null model of independence distributed recruits independently on conspecific adults without considering habitat association, but maintained their observed aggregation. In contrast, the Heterogeneous Poisson Process considered additionally the effect of topographic variations. Departures from the null models were assessed by simulation envelopes and goodness-of-fit tests using the bivariate distribution function of nearest neighbor distances and the bivariate pair correlation function. *S. trapezifolia* and *S. stipularis* indicated independent placement of recruits around adults for all distance intervals of 1-120m while other species showed significant positive association, for all distance intervals of 1-50m. Thus, the majority of recruits of *Shorea* species showed positive associations with conspecifics adults at medium spatial scale which implies high interference of individuals of *Shore* species with conspecifics. Based on the fitted intensity functions of recruits, slope, elevation and soil nutrients were identified as the main environmental factors influencing the bivariate adult-recruit spatial distributions of *Shorea* species. Further, for *S. stipularis*, the fitted Heterogeneous Poisson Process described the observed pattern well (goodness-of-fit test's p-value = 0.15), which suggests that the adult-recruit pattern was mainly driven by habitat heterogeneity. However, departures from the null hypothesis of habitat heterogeneity were shown for all other *Shorea* species (goodness-of-fit tests' p-values < 0.05). We conclude that the heterogeneous environment alone is insufficient to explain the observed patterns of recruits around conspecific adults of *Shorea* species. Consequently, the impact of other mechanisms on conspecific adult-recruit association should also be studied.

Keywords: Adult-recruit association; Intraspecific; Habitat heterogeneity; Heterogeneous Poisson Process; Tropical rainforest

Electrocoagulation for the Abatement of Cr(VI) from Simulated Water Using Al Electrodes

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Potentially toxic metal/metalloid contamination of water is inevitable mainly due to anthropogenic activities and pose highly adverse health effects on humans. Therefore, development of cost effective promising green technology is of immediate priority concern worldwide. Electrocoagulation holds great promise for the remediation of water and wastewater contaminated by toxic metal ions and organic pollutants. This study evaluates the electrocoagulation performance for the removal of 5 ppm Cr(VI) in simulated water composed of $0.003 \text{ mol dm}^{-3} \text{ Na}_2\text{SO}_4$ which imparts a conductivity of $600 \mu\text{s cm}^{-1}$. The electrocoagulation process, in terms of pH, conductivity, dissolution rate of both anode and cathode, current density was monitored at fixed direct current potentials in a range 1V to 5V at initial pH of 6.5 in a batch mode reactor. In the first 10 min, pH was found to increase from 6.5 to 9.0 and remained constant until the end of the electrocoagulation process after 60 min. Higher rate of dissolution of both anode and cathode was noticed due to electro oxidation and chemical dissolution of the anode and cathode respectively. The removal of Cr(VI) was monitored by UV-Visible spectroscopy at 370 nm and Inductively-Coupled Mass Spectroscopy (ICP-MS). The maximum removal of 97% achieved after two hours of electrocoagulation. The X-ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) studies performed on dried electrochemically generated sludge in the electrocoagulation reactor revealed the presence of Al and Cr.

Keywords: Electrocoagulation; Batch-mode reactor; Pollution abatement; Cr(VI); Al electrodes

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Cellulase Activity of Fungal and Bacterial Isolates and their Fungal-bacterial Biofilms

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Enzymes are crucial in speeding up many biological reactions, but the lack of suitable sources to extract them with high productivity in low cost is a constraint. Present study designed in order to evaluate the cellulase production by some fungal and bacterial isolates and their fungal-bacterial biofilms (FBBs). Five fungal (F1-F5) and 27 bacterial (B1-B27) strains were isolated from soil samples collected from a municipal garbage dump near Vincent Dias Stadium, Badulla, Sri Lanka. All bacterial isolates were screened for cellulase activity using Congo Red Agar medium. Two strains (B6 and B15) with significant ($p \leq 0.05$) cellulase activity were selected along with all fungal strains for biofilm formation. Accordingly, ten fungal-bacterial combinations (F1B6, F1B15, F2B6, F2B15, F3B6, F3B15, F4B6, F4B15, F5B6, F5B15) were used for the formation of biofilms under in vitro conditions. The biofilm formation was monitored regularly through microscopic means. On day four, three successful biofilms (B6F1, B15F1 and B15F4) were resulted with bacterial cell attachment to mycelia. These three mixed-culture biofilms and their monoculture counterparts were re-cultured in Czapek-Dox broth with the culture medium alone as a control. On day four, a portion of the broth was centrifuged and the supernatant was used as the crude cellulase extract. The extracts were then tested for their efficacy through a well diffusion assay using Carboxymethyl Cellulose agar medium in a Complete Randomized Design with three replicates. The diameters of the clear zones around the wells were measured and the data were analyzed by one-way ANOVA and t-test. The B15F1 showed a significantly higher cellulase activity over F1, the second highest cellulose producer ($p = 0.02$). F3 and F4 also showed considerably high levels of cellulase activity. The least cellulase activities were shown by B6 and B15. Thus, the fungal-bacterial biofilm B15F1 can be introduced as a potential source for bulk extraction of cellulases. However, further studies are needed to find out the optimal maturation stage with the highest cellulase activity of the biofilm, B15F1.

Keywords: Cellulase; Bacteria; Fungi; Fungal-bacterial biofilms

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A Novel Polyaniline Modified Fluorine Doped Tin Oxide Anode for Microbial Fuel Cells

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Microbial fuel cells are increasingly interest in the scientific community as a potential solution towards worldwide energy related problems and waste water purification. Microbial fuel cells harness the metabolism of microorganisms and utilize the organic matter to generate electric energy. The research method used in the study is cheap, easily manufactured and environmentally friendly compared to the other microbial fuel cells. A dual chamber microbial fuel cell, divided by a ceramic septum was used to separate anodic and cathodic compartments in the cell. Synthetic waste water was used as a fuel with *Saccharomyces cerevisiae* as a biocatalyst and methylene blue as a mediator in anaerobic anodic chamber. Distilled water was used for aerobic cathodic chamber with platinum electrode as a cathode. Five different electrodes (i) Expanded graphite coated titanium plate (ii) Activated charcoal coated titanium plate (iii) Bare fluorine doped tin oxide glass (iv) Polyaniline deposited fluorine doped tin oxide glass (v) Polyaniline – activated charcoal composite coated fluorine doped tin oxide glass were used as the anode material at constant operating conditions. FT-IR spectrum was used to characterize the polyaniline-activated charcoal composite. Open circuit voltage, short circuit current and voltage through series of external resistances were measured. Electrical performance of microbial fuel cells were characterized using open circuit voltage-time curves, polarization curves, power curves, current-time curves and maximum power densities of each microbial fuel cell. The highest maximum open circuit voltage of 967 mV was shown by Polyaniline-activated charcoal composite coated fluorine doped tin oxide glass electrode. The highest maximum power densities were recorded in both expanded graphite coated titanium plate and polyaniline – activated charcoal composite coated fluorine doped tin oxide glass electrode which were $2.68 \times 10^{-3} \text{ mWm}^{-3}$ and $2.66 \times 10^{-3} \text{ mWm}^{-3}$ respectively. It is suggested that, polyaniline-activated charcoal composite coated fluorine doped tin oxide glass is a promising anode material for microbial fuel cells.

Keywords: Microbial Fuel Cell; polyaniline; *Saccharomyces cerevisiae*; Fluorine doped tin oxide glass

X-ray Photoelectron Spectroscopic Probing of Nano-zero Valent Iron Assisted Nitrate Degradation

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Excess nitrate adversely contributes to groundwater pollution. However, nitrate remediation is not an easy task. Upon boiling it concentrates, and does not sorb, in significant amounts, onto soils or other surfaces. Metallic iron (Fe) is an attractive alternative for nitrate reduction compared to conventional treatment processes. In this research nano zero valent iron-reduced graphene oxide composite (nZVI-rGO) was synthesized using modified Hummers method. Polyphenols derived from natural tea leaves were used to reduce Fe²⁺/Fe³⁺ into Fe. All X-ray photoelectron spectroscopic (XPS) measurements were carried out by an XPS (5000 VersaProbe II ULVAC-PHI Inc., Japan) system equipped with an X-ray source (monochromatic Al K_α 1486.7 eV X rays). These measurements were used to elucidate the surface sites and the oxidation states of nitrogen adhered to the surface of nZVI-rGO. At 5.6 pH, composite material reduce 70% of 0.8064 mM nitrates within an hour at 25°C. However, the mechanistic steps of nitrate reduction are inconclusive to date. The Fe-XPS signal was assigned to oxidized Fe signaling surface oxidation, and Fe(0) within the core-shell structure of nZVI-rGO. The N 1s transition indicates the aromatic N presence in polyphenols. After nitrate reduction, ammonia accounts for 95% of the nitrogen mass balance with N₂, NO and NO₂⁻ traces. The peak at 706.7 eV contributes to Fe(0) was disappeared and the intensity of the Fe(II) and Fe(III) peaks decreased. During the reduction, oxidized Fe²⁺(aq) was converted into Fe₃O₄ via spontaneous electron transfer between the Fe²⁺ and the pre-existing surface Fe³⁺ oxides and enhanced the nitrate removal efficiencies. nZVI reduces nitrate into NO, which has a high electron density. This NO can easily trap free electrons and form negatively charged NO⁻. The adsorbed NO⁻ to the cationic iron oxides sites of nZVI-rGO surface identified by N 1s transition peak at 401.7 eV. Further research is required for the identification of nitrogen-containing groups of natural green tea leaves polyphenols to confirm the surface sites of nitrogen.

Keywords: Nano-zero valent iron; Nitrate reduction; Polyphenols; Reduced graphene oxide; X-ray photoelectron spectroscopy

Fungi in Sri Lankan Ecosystems: A Review of Current Knowledge, and Future Directions

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Fungi are an incredible source that can be used for the economic development of developing countries like Sri Lanka to achieve the United Nation's Sustainable Development Goals. The utilization of fungal resources towards economic development is considerably less because fungi are one of the groups that have been poorly investigated in Sri Lanka. This study aimed to critically evaluate the knowledge gap of fungal studies in Sri Lanka by considering the status of the South Asian region, the Asian region and the World. Therefore, local, regional and world literature related to fungal studies were collected. Data collection was done by using online available sources, visiting resource places as well as contacting resource persons. Then, the collected 1142 different types of literature documents were referred and classified mainly under basic fungal biological studies and applied fungal studies by considering the areas of studies available. After that, necessary information from the literature of each category was extracted and analyzed the gap concerning the world status through the literature to identify new research opportunities of mycology in Sri Lanka. At present global mycology is in the status of identifying and introducing new fungal divisions, classes, orders and new families by using molecular techniques such as quantitative PCR techniques, DNA barcoding, probe development and effective amplification techniques. The global estimate is about 2.2 to 3.8 million fungal species and out of those 144,000 species have been already named and classified. Thus, over 93% of species are currently not explored and are unknown to science. Currently, the Asian region is the pioneer for fungal discovery. In 2017, 35% of new fungal species were discovered in the Asian region which is the highest fungal discovery percentage among all the regions in the World. Findings of this study showed that Sri Lanka is far behind in the World and the Asian region as approximately 3000 fungal species have been identified out of estimated 25,000 native fungal species. The highest knowledge gap is exhibited in the area of fungal taxonomic research in Sri Lanka. There is a great possibility of implementing fungal research in Sri Lanka. However, collaborative efforts of scientists of different fields are needed with financial support to reveal the fungal resources to be utilized in the economic development of the Island.

Keywords: Mycological studies; Fungal diversity; Sri Lanka; Knowledge gap

Investigating the Effectiveness of Mycofiltration in Treating Greywater Generated at Uva Wellassa University for Recycling Purposes

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Greywater is the waste-water from domestic activities. It is used water of kitchen, bathroom and laundry activities which represents least polluted contaminants as it consists of organic and inorganic contaminants, nitrogen and phosphorus derivatives, oil, food particles and fats. Mycofiltration is one of the bioremediation techniques in which fungus is used for treatment of greywater. Daily 720 000 L of greywater is generated at Uva Wellassa University (UWU). However, this wastewater is discharged into drainage without any proper treatment. This study was therefore taken to treat greywater generated at UWU using myco filters and to investigate their effectiveness for recycling purposes. Greywater samples were collected in sterilized plastic containers and initial physico-chemical parameters such as pH, BOD, COD, nitrogen, total suspended solids (TSS), alkalinity, turbidity, conductivity, total dissolved solids (TDS) and colour were analyzed using the standard methods. Mycofiltration was performed using two different fungi namely *Aspergillus niger* and *Pleurotus ostreatus* in two different permeated substrates namely rice and saw dust. Greywater samples was allowed to pass through four different types of myco filters. Physico-chemical parameters of filtered water were analyzed again. pH, BOD, COD, nitrogen, TSS, and alkalinity parameter values have been reduced from the initial value and turbidity, conductivity, TDS and colour parameter value have been increased from the initial value. Removal efficiency from *Aspergillus niger* for both permeated substrates rice and sawdust were 43.76% & 35.92%. Removal efficiency from *Pleurotus ostreatus* for both permeated substrates rice and sawdust was 34.52% & 26.80%. Therefore, *Aspergillus niger* in rice media was chosen as the effective fungi in reducing contaminants present in greywater. Furthermore, the quality of *Aspergillus niger* in rice media filtrated water sample was compared with the standard permissible level for outdoor gardening given by Central Environmental Authority standards. Major parameters of *Aspergillus niger* in rice media filtrated water were below the permissible level. Hence, it was concluded that the greywater filtered through *Aspergillus niger* in rice media can be reused for outdoor gardening. However, this removal efficiency could be further increased by the use of bio coagulants along with myco filters in future.

Keywords: Greywater; Mycofiltration; *Aspergillus niger*; *Pleurotus ostreatus*; Reuse

Potential of Reservoir Capacity Enhancement Adopting Piano-Key Weir Type Spillways – A Case Study of Wemedilla Reservoir in Dambulla, Sri Lanka

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Development of storage facilities has been identified as one of the adaptation options for Climate Change in Sri Lanka. The objective of the present study was to carry out a case study for Wemedilla Reservoir in Dambulla, Sri Lanka to demonstrate the potential of using Piano Key Weir (PKW) spillways to increase the reservoir capacity. The Ministry of Irrigation in Sri Lanka has identified Wemedilla Reservoir as a key location in Diverting Mahaweli Water to North Western Province. Increased storage capacity in Wemedilla Reservoir will provide benefits to many areas. So, Wemedilla Reservoir was chosen for the current Case Study. According to the Department of Irrigation, Sri Lanka, Wemedilla Reservoir's Full Supply Level (FSL) is 221.34 m above mean sea level (AMSL) and its High Flood Level (HFL) is 222.56m AMSL and therefore, the difference between HFL and FSL is 1.22m. The proposed PKW crest elevation was taken as 222m AMSL, and an amount of 0.56m was hence, kept for accommodating the afflux. Four (04) PKW configurations were selected for the Case Study. Flood routing was performed for floods with 1,000 and 10,000 year return periods and the results were compared with that of the existing spillway. The PKW configuration with an Upstream-downstream length of 7.2m and 11 PKW units could be identified as the best out of the four proposed configurations. With the proposed PKW configuration, the capacity of Wemedilla Reservoir can be increased by 11% while afflux reductions of 41% and 40% were observed for 1,000 year and 10,000 year return periods respectively. The present work demonstrated the capacity enhancement potential of Wemedilla Reservoir with the incorporation of PKW, without raising the reservoir bund level or acquiring upstream land. Physical model testing, cost-benefit analysis and a comprehensive study on environmental and social impacts are further required before implementing this proposal.

Keywords: Piano Key Wier, Reservoir Capacity; Spillway Discharge, Climate Change Adaptations

Microbiota Diversity associated with Mosquito Breeding Habitats in Kegalle District, Sri Lanka

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The distribution, abundance, and individual fitness of mosquitoes are known to be dependent on associated microbiota composition with developing larvae. Identification of such naturally occurring microbiota and their interactions on mosquito larvae, in terms of parasitic, pathogenic, competitive or predatory organisms against larvae is beneficial. Such agents can be used for potential larval controlling approaches, in an environmental- friendly manner. Thus, the present study aimed to investigate the diversity of microbiota associated with mosquito larval habitats. Sampling was performed from a variety of breeding habitats in Kegalle district, Sri Lanka. Microbiota in water samples were preserved using Rose Bengal solution and Lugol's iodine, and were identified observing under the microscope, using standard identification keys. A variety of mosquito breeding habitats indicated the presence of 37 microbiota species under 9 phyla, belong to; Amoebozoa, Arthropoda, Ciliophora, Charophyta, Chlorophyta, Cyanobacteria/ Cyanophyta, Euglenozoa, Ochrophyta/ Heterocanthophyta and Rotifera. Except in coconut shells, every breeding habitat type investigated had the prevalence of rotifers, at least with one species. Thus the phylum Rotifera displayed the highest percentage of abundance (30.83%) of total microbiota. Species under phylum Charophyta had the lowest abundance among recorded (2.19% of total microbiota). *Philodina citrina* and *Euglena pisciformis* were found as species showing all three categories of abundance types; constant, common and accidental/or rare. Although the highest number of microbiota species were recorded from paddy field breeding habitats, all the species were existed as accidental or rare species in the habitat type according to their abundance. Only ponds and tree holes were recorded with beta diversities over 50% (high heterogeneity) in microbiota composition among the systems. Paddy fields, marshy lands, blocked drainages, metal containers, and leaf axils had beta diversities between 20 and 50%, indicating intermediate heterogeneity. The rest of the other habitats had beta diversities below 20%, indicating low heterogeneity. Paddy fields exhibited the highest gamma diversity (16) and Shannon-Weiner diversity (52.17) values. From the microbiota species recorded, *Zoothamnium* sp. was identified as an epibiont in *Culex gelidus* and *Culex tritaeniorhynchus* mosquito larvae. Updated information from the present investigation would be facilitated for implementing appropriate vector control interventions.

Keywords: Abundance; Constant; Heterogeneity; Rotifers

Impact of Landscape Elements on the Psychological Safety of Pedestrians in Urban Streets of Sri Lanka

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Irrespective of having confronted a crime or not, many users feel insecure in public spaces. This feeling of insecurity is directly related to the mental conditions of an individual and sometimes to many other environmental cues or different physical elements. This insecurity is perceived frequently in urban streets as it is a widely used urban component by most of the urbanites. Out of the many physical elements present in streets, trees play a vital role in aesthetic quality, thermal comfort and enhancing physical and mental health of the users. Up until now, only a limited amount of research has been carried out in search of the contribution of trees on the assurance psychological safety of the pedestrians. This study aims to identify the impact from different characteristics of trees in urban streets on the psychological safety of the pedestrians. This is achieved through an exploratory survey study in identifying the characteristics of trees and, an evaluation of the appropriateness of the explored characteristics in ensuring psychological safety in urban context of Sri Lanka. The exploratory study has identified a total of 11 characteristics of trees as important in assuring psychological safety. The evaluation was conducted with the aid of a questionnaire using 7 point rating scale, and a total of 60 responses from both experts (with more than 5 year experience in designing, planning and similar disciplines) and non-experts (general public) were obtained for the analysis through snowball sampling technique. The results from the questionnaire indicated that the relative size of the tree (with respect to human scale) make the highest impact on the psychological safety of the users whereas the texture of the tree bark makes the least impact. Mann Whitney U test results claim that only the response for spread of the canopy has shown differences across two samples where experts claim a high importance when compared with the non-experts. Extension of these results for a comprehensive outcome can be accommodated in the planning and designing of urban streets in a tropical country like Sri Lanka.

Keywords: Psychological safety; Trees; Urban streets; Pedestrians

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Determination of Pectinase Activity of Selected Bacterial and Fungal Strains

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Enzymes have been utilized to speed up the biological reactions in industrial productions. Enzymatic methods are environmentally friendly, low cost in production and disposal but the limitation of sources to extract different enzymes is an issue. Therefore, the current research aimed in order to determine the pectinase activity of selected bacterial and fungal strains isolated from a municipal garbage dump. Thirty-four bacterial (B1–B34) and five fungal (F1-F5) strains taken from the culture collection were activated in Nutrient Agar (NA) and Potato Dextrose Agar (PDA) respectively. For the enzymatic assay, the bacterial and fungal strains were re-cultured in NutrientBroth (NB) and Potato Dextrose Broth (PDB) respectively. The culture medium collected on day four was centrifuged and cell free supernatants were then tested for pectinase activity by well diffusion assay conducted in Pectinase Screening Agar medium (PSA) by following the Complete Randomized Design with three replicates. The NB alone was the control. Diameters of halo zones formed around the wells were measured at day four as the data. Data were analyzed by one way ANOVA. The bacterial culture, B16 showed the highest pectinase activity among bacterial strains. F3 showed significant ($p \leq 0.05$) pectinase activity among fungal strains. The study was further elaborated to find out the optimal maturity stage of B16 and F3 with the highest pectinase activity. For that, B16 were re-cultured in NB and F3 was re-cultured in PDB. The crude enzyme was extracted from the subsamples collected from each medium within 6 hr time intervals and used to digest pectine and the amounts of sugar formation after the pectine digestion was evaluated by DNSA method. The B16 showed highest pectinase activity (2.95 AU) at 72 and 78 hours of inoculation whereas F3 showed the highest pectinase activity (1.43 AU) between 54 and 78 hours of inoculation. Thus, the pectinase activity of B16 is higher than that of F3. Therefore, B16 of present study can be introduced as an efficient culture to extract pectinase enzyme in bulk for industrial applications.

Keywords: Bacteria; Fungi; Pectinase

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Shoreline Change Analysis along the East Coast of Sri Lanka: A Remote sensing-Based Approach

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The changes along the eastern coastlines of Sri Lanka have been investigated for short- and long-term natural and anthropogenic processes. Such coastal changes can be classified as either negative (coastal erosion, seawater intrusion) or positive (coastal accretion) impacts. The understanding of such impacts can directly be applied to coastal conservation/management and the designing of coastal engineering structures. In this study, the authors examined Landsat 5, 7, and 8 sun-synchronized earth resources satellite data for understanding coastal changes since 2000. These Landsat series have advanced sensors (e.g., thematic mapper (TM), enhanced thematic mapper plus (ETM+), operational land imager (OLI)) for data acquisition. Data selection, pre-processing, and processing were carried out using a geographic information system (GIS). Besides, the authors developed a new model known as “*Jargon’s script*” for data preprocessing and processing. Modified Normalized Difference Water Index (MNDWI) is the important algorithm of *Jargon’s script* models that helps to extract water and land features. The threshold value for the MNDWI to get maximum contrast of objects was identified as 0.13. Furthermore, the current study covered nearly 1043 km coastline along major coastal zones such as Jaffna, Mullaitivu-Trincomalee, Batticaloa-Hambantota, Matara, etc. Long-term and short-term coastal changes were then determined using Digital Shoreline Analysis System (DSAS) software linked to ArcMap 10.6. Results identified five major parameters such as net shoreline movement (NSM), shoreline change envelope (SCE), endpoint rate (EPR), linear regression rate (LRR), and weighted linear regression rate (WLR). In this study, coastal geomorphological changes were classified into eight classes based on the annual variation of EPR values, such as extreme erosion (>-10 m/year), high erosion (-10 to -5 m/year), moderate erosion (-5 m/y to -2.5 m/year), low erosion (-2.5 to 0 m/year), low accretion (0 to +2.5 m/year), moderate accretion (+2.5 to +5.0 m/year), high accretion (+5.0 m/y to +10 m/y), and extreme accretion (> +10 m/year). Those parameters can be used to visualize spatial and temporal variations of geomorphological changes along this coastline, and such variations can be used to correlate natural (monsoon, sea-level rising) and anthropogenic activities. According to the EPR results of Karainagar east, Kalido beach has the highest coastal erosion compared to other coastal areas.

Keywords: Shoreline change rate; Satellite images; Coastal geomorphology; Sediment dynamics; East coast of Sri Lanka

Soil Organic Carbon and Interdependencies among Soil Physio-Chemical Parameters of Mangrove Dominated Ecosystem at Palakaimunai in Mannar Region, Sri Lanka

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Palakaimunai, positioned at North Western coast of Sri Lanka, has been shaped and influenced by oceanic, terrestrial and anthropogenic activities to varying extent. The natural vegetation in this deltatic system is dominated with mangroves with intermittently spreading saltmarsh patches at the foreground and littoral woodland species at the back. The extent which the mangroves in such seasonally dry tropical climates would provide sediment-grounds for soil carbon and other nutrients is yet to be revealed. Therefore, spatial variation of soil carbon and carbon fractions, and the associations of these to available nutrients in Palakaimunai mangals were examined in this study. Stratified random sampling adhering to 10 m × 10 m grids based on ArcGIS were laid and soil sampling (n=30) was done from the layer of 0-15 cm from surface. Samples were analyzed for available nitrate, phosphate and ammonium, microbial biomass carbon (MBC), permanganate oxidizable carbon (POC), water soluble carbon (WSC) and soil organic carbon (SOC), soil macro and micro nutrient cations. Principal component (PC) analysis and agglomerative hierarchical clustering based on geometric positioning under PCs revealed five clusters indendogram, despite there was a high spatial heterogeneity examined soil parameters over the area. Interdependencies were unreciprocated among pH (+) to SOC (-) and WSC (-) and ammonium (-) and zinc (-) to MBC (+). The samples in the clusters with the highest mean SOC content of 11.3%- 14.0% and was associated with low MBC ($0.005\% \pm 0.007$), high POC (712.23 ± 6.97 mg/kg), high WSC (0.15% - 0.16%) and high ammonium (14.2 ± 8.5 mg/kg) contents. Nevertheless, the samples in the cluster with the lowest SOC content of 1.99 ± 1.54 was found to be associated with the highest availability of nitrate (2.90 ± 0.78) and lowest of phosphate (14.98 ± 6.02 mg/kg) contents. These highest SOC contents were recorded at proximate substratum with *Avicenia* and *Rhizophora* species and within frequently saturated substratum. Simultaneously, low MBC content was related with the above prevailing anoxic condition. Thereby, generalization over in-site SOC may not verify the carbon sink potentiality thus varied by geomorphological traits.

Keywords: Blue carbon ecosystems; MBC; WSC; Cluster analysis; SOC

Prediction of Crop Yield for Rice, Tea and Sugarcane in Sri Lanka using Sunspot Number

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In this research, the relation of crop yields to sunspot number for tea, rice and sugarcane was studied in Sri Lanka located between latitudes 5° 55' N and 9° 51' N and longitude 79° 41' E and 81° 53' E. Parametric analysis was carried out to obtain historical coefficients for solar activity index and crop yield data, using observed yields with time, sunspot number, and cultivated area as input variables. Data on the total cultivated area (ha) with yield (hg ha⁻¹) of rice, tea and sugarcane from 1961 to 2016 were statistically analyzed. Data were obtained from Food and Agricultural Organization, Statistics Division (FAOSTAT) and online data on yearly mean total sunspot number was retrieved from World Data Center – Sunspots Index and Long term Solar Observations (WDC - SILSO). To predict crop yield, a multiple linear regression model was used which best described the relationship between sunspot number and crop yield variables using Minitab Software. The coefficient of variation depicts the relative deviation in yields of the various crops, with sugarcane yields being the highest (29.4%) and rice yields being the lowest (23.7%). During periods of maximum solar activity in the years 1968, 1989, and 2000, yields for tea and sugarcane decreased significantly while yields for rice indicated an increment. Besides, yields for tea and sugarcane increased significantly and yields for rice decreased during periods of minimum solar activity in the years 1976, 1996, and 2008. The model explained 91.93% of yield variance for rice and 82.16% of yield variance for tea also 51.51% of yield variance for sugarcane. This overall study indicates that there is a considerable contribution to yield from SSN and the pattern of yield that varies with SSN can also be identified.

Keywords: Crop yield prediction; Multiple linear regression; Solar activity; Sunspot number

Diversity and Relative Abundance of Industrially Important Enzyme Producing Microbial Genera in Hot Springs in Sri Lanka

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Thermal tolerant enzyme producing bacteria can be successfully used in industrial settings to minimize environmental impacts caused by excess use of chemical catalysts in production chains. Hot springs are a major habitat for extremophiles which produce extremozymes. Characterization and identification of microbial community in hot springs provide an initial platform for identification of extremophilic microorganisms for industrial applications. In the present study, the diversity and relative abundance of industrially important enzyme producing microbial genera in hot springs in Sri Lanka was studied. Water samples were collected from surface and bottom of the hot springs. Temperature, conductivity, pH and Dissolved Oxygen (DO) were measured at the site using portable meters. To analyse microbial community (bacteria and archaea) of hot springs, extracted DNA was sequenced through 16s rDNA amplicon sequencing on Illumina MiSeq platform. Sequencing data were analyzed using Mother V. 1.42 software. METAGENassist web server tool was used to predict the metabolic functional diversity of the bacterial and archaeal communities. The temperature of the hot springs were ranged from 33.7 °C to 55.4 °C where conductivity, pH and DO levels were ranged from 801 to 1507 µS/cm, 7.20 to 8.27 and 1.05 – 3.5 mg/L respectively. The microbial communities of the hot springs were mostly comprised of Bacteria and Archaea. Bacteria was the dominant component respectively 99% and only <1% Archaea. *Chloflexus*, *Rubellimicrobium*, *Acinetobacter*, *Pseudomonas*, *Methylobacterium*, *Tepidimonas*, *Rheinheimera*, *Flavobacterium*, and *Vogesella* were the major bacteria genera recorded in all hot springs. The metabolic inference analysis of the microbial community of hot springs comprised of dinitrogen-fixing bacteria, lignin degraders, nitrogen and sulfate reducers, nitrogen fixation bacteria, sulfur reducers, denitrifying bacteria, cellulose degraders and sugar fermentors. Thus the results of the present study implied that the hot springs could be a useful source of bacteria for future industrial perspectives. Further studies are in progress along with a metagenomic analysis.

Keywords: Hot springs; Community analysis; Extremophiles; NGS analysis; Biotechnological Prospects

Identify the Best model to Forecast the Monthly Rainfall in Jaffna District, Sri Lanka by Using Time Series Analysis

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Rainfall is an important component of the water cycle and is the main of giving fresh water to the earth. Also, rainfall is one of the most significant climatic elements that has a direct impact on agriculture. The Jaffna district is in the Dry Zone of Sri Lanka and the major source of water for agricultural production in the district is rainfall which receives mainly during October to December. However, in real-world practice, rainfall data have a seasonal pattern with short-term and long-term fluctuations; and therefore, forecasting monthly rainfall is important for making decisions in daily human activities and agriculture. The main purpose of this study was to find a suitable Seasonal Auto Regression Integrated Moving Average (SARIMA) model to the monthly rainfall data of the Jaffna district. In this study, the monthly rainfall of the Jaffna district is modelled by Box-Jenkins' time series approach. The 228 monthly rainfall data were gathered from the Department of Meteorology, Sri Lanka during the period of January 2002 to December 2020. Further, three statistical criteria; Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and Mean Squared Error (MSE) were used in order to select the best model. According to minimum AIC, BIC, and MSE, it was found that Seasonal Auto Regressive Integrated Moving Average: $SARIMA(0,1,1)(0,1,3)_{12}$ is the best fitting model for the Jaffna district. Finally, the Ljung-box test was used to determine whether this fitted best model is adequate. Hence, the identified model can be used to assist scientists and policymakers in developing strategies for effective monitoring and mitigation of flood, urban planning, irrigation water management and other environmental management purposes.

Keywords: Box-Jenkins' Approach; Ljung- Box Chi-squared statistics; Monthly rainfall; SARIMA model

Nephrotoxic Effect of Environmental Water Sample on Wistar Rats with Special Reference to Synergistic Effect of Fluoride and Hardness

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Chronic Kidney Disease of unknown aetiology (CKDu) is a serious health problem in Sri Lanka and it has spread in epidemic proportions among the rural farming communities in the North Central Dry Zone of the country. There are several hypotheses on this phenomenon and the present study was focused on the nephrotoxic effect of environmental water samples on Wistar rats. Special attention was taken to evaluate the synergistic effect of water hardness and fluoride on nephrotoxicity. Experimental protocols were approved by the ethics committee of the Institute of Biology, Sri Lanka (ERCIOBSL 194062019). Fourteen Wistar rats were randomly assigned into two groups (n=7). One group of rats was treated with water sample collected from Padaviya while the other group was given de-ionized (DI) water as the control group. Body weight and daily water consumption of each rat were measured and blood and urine samples were collected at 0, 7, 14, 28, 42, 60, 90, 120 and 150 days' intervals. Serum creatinine, urine creatinine and urinary biomarker KIM-01 were analysed. The concentrations of fluoride and hardness of Padaviya water sample were 1.91 and 280 mg/L respectively. There was no significant difference in body weights and daily water consumption between treated and control groups ($p>0.05$) were recorded. Average serum creatinine levels of the rats treated with Padaviya water and DI water were ranged from 0.73 to 1.02 mg/dL and 0.56 to 0.71 mg/dL respectively. Average urine creatinine levels of the rats treated with Padaviya water and DI water were ranged from 0.61 to 0.76 mg/dL and 0.65 to 0.7 mg/dL respectively. KIM-1 level was not detected in the control group treated with DI water where rats received Padaviya water, the KIM-1 level was 5.9 ng/mL at the end of the study. The results indicate that there was a nephrotoxic effect from Padaviya water sample which recorded high fluoride and water hardness. Thus, further studies are needed to evaluate the synergistic effect of water hardness and fluoride to determine the threshold levels.

Keywords: Synergistic effect; Fluoride; Water hardness; Creatinine levels; Nephrotoxic effects

Monitoring the Urban Sprawl in Colombo Metropolitan Area (CMA) Using Remotely Sensed Data

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The urbanization of Sri Lanka is mainly concentrated in the western part where the Colombo metropolitan area (CMA) is located. The CMA urban cluster is very dynamic and rapid due to its being the country's only metropolitan area. In such context, present study intends to measure the urban sprawl in the CMA over 20 years (from 1997 to 2017) using Landsat 5 and 8 images. Specifically, three land use/cover (LULC) classes, namely built, non-built, and water were classified for three time points (1997, 2007, and 2017) using pixel-based supervised classification technique. The study area was delineated employing the 40km buffer from the city center of Colombo where the zero-milestone located mainly covering CMA. The clustered random samples points were used to assess the accuracy of LULC. The accuracy assessment results revealed that overall accuracy of LULC classification is 98% in 1997, 98.9% in 2007, and 98.7% in 2017. The present study mainly focused on buildup change as a proxy to measure urban sprawl. The LULC change matrix of 1997-2007 shows buildup area gained around 5717 km² from non-built area with an annual average gain rate of 571.7 km² per year. According to the LULC change matrix of 2007-2017, the buildup gain was 7987 km² with an annual average gain rate of 798.7 km² per year. The results revealed that urban sprawl was more intense or faster during the period of 2007-2017 compared to the period of 1997-2007, coinciding with the trend of rapid population increase and economic growth which took place after the end of the 30-year civil war in 2009. These analysis results of the study are important in the context of urban planning and understanding the urban sprawl related issues in the CMA.

Keywords: Urban sprawl; Colombo metropolitan area; Land use/cover; Urban planning

Status of Knowledge on Mangrove in Sri Lanka: A Comprehensive Analysis on Twitter™ Social Media Platform and Scopus® Database

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Mangroves are one of the important ecosystems found in many tropical and subtropical areas. The importance of mangrove ecosystems in Sri Lanka has highlighted in numerous scientific studies and the findings of these studies are disseminated through various publications indexed in popular scholar databases. Moreover, with the advancement of new technologies, knowledge of mangrove is also disseminated on popular social media platforms. Quantification of this information is important in determining the status of knowledge on mangrove and related science communication. In this backdrop, the present study focused on determining the status of knowledge on mangroves using the popular social media platform; Twitter™ and scholarly database; SCOPUS®. In social media analysis, 475 twitter messages/tweets related to the keyword ‘Mangrove’ was extracted from the Twitter™ database. R programming language and various other packages (*TwitterR*, *tm*, *word cloud* etc.) were used in analyzing the textual data. Topic modelling was employed to identify the latent topics in mangrove related tweets. Scientometric analysis of mangrove related studies in Sri Lanka was carried out using the Scopus® database. Results of the Twitter™ analysis showed the existence of various subthemes in mangrove research (e.g. conservation and mangrove rehabilitation etc). Word cloud analysis has indicated that *forests*, *restoration*, *blue carbon*, *coastal* and *communities* were dominant keywords. Results of the scientometric analyses of Sri Lankan mangrove studies indicated an increment in mangrove related publications ($p = 0.001$, $R^2 = 0.85$). The relationship between annual Gross Domestic Production (GDP) and the number of publications was positive ($p = 0.001$, $R^2 = 0.83$). In contrast to that, a few Sri Lankan authors and institutes/universities dominated in mangrove related publications ($n=105$). Keyword analysis of mangrove related publications indicated that studies on family Rhizophoraceae ($n=38$) were prevalent in the scientific literature. Findings of the present study indicated that expanding the mangrove related research to other institutions and facilitating research infrastructure is essential. Furthermore, scientific dissemination of these research findings in social media platforms is highly encouraged.

Keywords: Twitter™; Scopus®; Mangroves; Data mining; Topic modelling; R Programming

Fluctuation of Sea Surface Temperature (SST) Over Shallow Coral Reef Ecosystems in Eastern Coast of Sri Lanka During the Past 15 Years Period

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Coral reefs are dynamic and complex marine habitat which are highly sensitive to elevated Sea Surface Temperature (SST) than their optimal maximum temperature (27°C). Elevated SST directly affects coral bleaching and services they provided. Satellite remote sensing data can be effectively and efficiently used for spatial and temporal analysis of SST. The 1km Multiscale Ultrahigh Resolution (MUR) Level 4, SST data from NASA from 2005 to 2020 (15 years) were used for this study. Highly biodiverse and popular shallow reefs (<10m) along the Eastern coast i.e., Pigeon Island, Parrot Rock, Adukkuparu, Kayankerni and Passikudha were selected for this study. The area of reefs extended less than 10m water depth were demarcated by field surveys followed by polygon layers created by Google Earth Pro (7.3.3). The annual average SST for the period of 2005-2020 were as 28.95°C, 28.96°C, 28.71°C, 28.71°C, 28.71°C respectively. They will be expected as 29.29°C, 29.29°C, 29.31°C 29.39°C, 29.75°C by 2030 and may cause the extinction of most of the remaining live corals. Predominantly extreme SST recorded between 30°C to 31°C in April to May in 2010, 2016 and April to June in 2019 due to El Niño conditions and they were more severe in Kayankerni reef (30.23°C, 30.18°C in 2010 and 30.60°C, 30.30°C in 2016 and 30.86°C, 30.75°C, 30.75°C in 2019) and Passikudha reef (30.23°C, 30.23°C in 2010 and 30.60°C, 30.30°C in 2016 and 30.87°C, 30.87°C, 30.79°C in 2019). In addition, the mean SST levels recorded in the East coast during the Northeast monsoon period and the Southwest monsoon period were Significantly different ($p < 0.05$). During the past fifteen years period, the mean SST value during the Southwest monsoon (May to September) was calculated as 29.22°C and the mean SST value during the Northeast monsoon (December to February) was 27.48°C. The mean SST for Southwest monsoon differs 1.74°C from mean SST in Northeast monsoon. Therefore, these findings are highly important when implementing coral conservation and replanting projects in particular areas and declared areas as seed banks to replenish more susceptible site.

Keywords: Coral bleaching; Satellite remote sensing data SST; Thermal stress; El Niño, Coral reefs in Sri Lanka

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Anti-inflammatory and Free Radical Scavenging Activities of Aqueous Extracts of Coriander Seeds Roasted at Different Temperatures

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In traditional medicine, roasted coriander (*Coriandrum sativum vulgare* Alef) seeds are boiled with water and commonly used as a beverage to fight viral infections and flu. As roasting enhances therapeutic properties, effect of roasting of coriander seeds at 120, 140 and 160 °C for 15 min on colour of seeds and free radical scavenging and anti-inflammatory activities of aqueous extracts were studied and physical properties of the seeds were determined. Moisture contents of unroasted seeds and those roasted at 120, 140 and 160 °C were 6.5 ± 0.6 , 2.3 ± 0.1 , 1.5 ± 0.1 and $1.2 \pm 0.1\%$ respectively. Geometric mean diameter of 4.31 ± 0.19 mm, surface area of 58.61 ± 5.05 mm², sphericity index of 91.2 ± 4.7 and aspect ratio of 89.86 ± 7.41 were evident for seeds having a length of 4.74 ± 0.34 mm, width of 4.25 ± 0.26 mm and thickness 4.0 ± 0.3 mm of 100 seeds, measured using a vernier caliper. Thousand kernel weight and bulk density were 19.77 ± 0.38 g and 236 ± 2 kg m⁻³ respectively. Colour of unroasted and roasted coriander seeds was analyzed using a Chromameter and expressed as L*, a* and b* values. The lowest L* value of 30.73 ± 0.58 and the highest a* and b* values of 17.9 ± 0.2 and 29.75 ± 0.42 respectively, were evident in seeds roasted at 160 °C. Decoctions were prepared by heating the powdered samples at 60 ± 5 °C in clay pots for 150 min while maintaining a solid to water ratio of 6:100 (g mL⁻¹). Decoctions of coriander seeds roasted at 140 °C had the highest DPPH radical scavenging activity ($87.48 \pm 2.35\%$ inhibition) among those from unroasted and roasted at 120 and 160 °C. Inhibition percentage of haemolysis ranged from 50.16 ± 3.30 to $58.10 \pm 0.41\%$. Decoctions prepared from the seeds roasted at 140 °C for 15 min showed the highest inhibition percentage of haemolysis. Therefore, roasting of coriander seeds at 140 °C for 15 min can be recommended for preparing decoctions and or any other industrial applications.

Keywords: Coriander; Inflammation; Free radical scavenging activity; Roasting

Identification of Potential Spoilage and Pathogenic Microorganisms Associated with Production of Thermally Processed King Coconut Water (*Cocos nucifera* var. *aurantiaca*) in Sri Lanka

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Thermally processed king coconut (*Cocos nucifera* var. *aurantiaca*) water is one of the fastest growing export commodities in the food and beverage sector in Sri Lanka. Microbial safety of thermally processed king coconut water is demanded by Food and Drug Administration to ensure safe consumption. This study aimed to identify potential spoilage and pathogenic microorganisms associated with king coconut water processed in Sri Lanka. King coconut water samples were collected at pre-identified sampling points; P₁-Nut water extraction, P₂-Bulk collection, P₃-Standardization/Acidification, P₄-Pre-heating prior to hot filling and P₅; Sterilization/Pasteurization in three processing facilities; F₁ (semi-automated), F₂ (automated) and F₃ (manual), where Pasteurization (100 °C/12.5 min), UHT Sterilization (140 °C/3s) and Pasteurization (100 °C/20 min) were practiced, respectively. Serially diluted king coconut water were plated on Nutrient Agar, Potato Dextrose Agar, Eosin Methylene Blue Agar and Reasoner's 2A Agar, incubated at 30 ± 1 °C for 48 h, 25 ± 1 °C for 2 - 5 days, 37 ± 1 °C for 48 h and 37 ± 1 °C for 48 h, respectively. Purified bacterial and fungal colonies were morphologically characterized. A total of 29 bacterial isolates and 24 fungal isolates were identified by 16S rRNA and 26S/5.8S rRNA/ITS gene amplification, respectively followed by sequencing using 27F/1492R and ITS-1/ITS-4 primers, respectively. Evolutionary relationships of identified species were predicted using MEGA 7. The study revealed that thermal resistant, facultative-anaerobic, spoilage and pathogenic bacteria (*Pantoea dispersa*, *Bacillus siamensis*, *Pseudomonas stutzeri*, *Acinetobacter lactucae*) and fungi (*Candida carpophila*, *Pichia kudriavzevii*, *Debaryomyces nepalensis*, *Microdochium fisheri*, *Penicillium citrinum*) were survived in the thermally processed finished product. Further, potential risk of *Klebsiella pneumoniae*, *Enterobacter rogenkampii*, *Enterobacter kobei*, *Escherichia fergusonii*, *Bacillus nealsonii*, *Serratia rubidaea*, *Trichosporon asahii*, *Wickerhamomyces anomalus*, *Saccharomycetales* species and *Fusarium* species were identified at initial processing steps (P₁-P₃) in studied processing facilities. In conclusion, the study revealed that the existing thermal treatments are not sufficient for the destruction of identified potential spoilage and pathogenic microorganisms associated with studied processes. Thereby, suggesting thermal process validation, while targeting identified potential harmful microorganisms with optimum time-temperature combinations to ensure product safety.

Keywords: King coconut water; Spoilage and pathogenic microorganisms; Molecular identification; Thermal processing

Evaluation of Polycyclic Aromatic Hydrocarbons (PAHs) in Smoked Catla (*Catla catla*) Harvested from Selected Reservoir with Different Combustion Materials and Storage Conditions

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Smoking is one of the oldest techniques of fish preservation and at present smoked fish has higher consumer demand due to their specific taste and aroma which is generated using partial combustion of woods. But, accumulation of carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) through the wood smoke is a major problem associated with smoked fish. Hence, the present study was carried out to evaluate the carcinogenic PAHs levels and their penetration with the storage time in smoked Catla (*Catla catla*). Freshly harvested Catla fishes (2.5 – 9.7 kg) were (n=3) brought from Handapanagala reservoir, Monaragala and equal size (6 × 5 × 2.5 cm³) fish cubes were smoked in electrical smoker (180 °F for 1.5 hrs.) using Cinnamon (*Cinnamomum verum*) and Mahogany (*Swietenia macrophylla*) wood smoke separately and stored at -20 °C. Acetonitrile extract of smoked and raw fish samples were treated with a mixture of anhydrous MgSO₄: NaCl followed by a mixture of MgSO₄: silica propylsulfonic acid cation exchanger to extract and purify PAHs at predetermined time intervals as day 1 and day 7(QuEChERS). Outer layer and center part of the smoked fish were analyzed for sixteen PAHs by Dionex Ultimate 3000 UHPLC system equipped with Hypersil Green PAH column (250 mm x 4.6 mm x 5 μm) and Diode Array detector (254 nm, 1 ml/min, Acetonitrile: water gradient elution) separately and compared with standards. Moisture content and crude fat content of raw fish samples were also analyzed. Indeno[1,2,3-*cd*]pyrene was detected in one of the raw fish sample, while Benzo[*a*]pyrene, Benzo[*ghi*]perylene, Indeno[1,2,3-*cd*]pyrene were detected in fish samples smoked with Cinnamon wood. Indeno[1,2,3-*cd*] pyrene was found to be the most abundant PAH and it varies between 198 – 212 μg kg⁻¹. No pattern of penetration of PAHs to center was observed. Detectable amounts of PAHs were not found in any of the samples smoked with Mahogany wood. Therefore, it can be concluded that modern smokers under controlled conditions produce lower levels of PAHs and Mahogany wood could be a suitable wood type to smoke *Catla catla*.

Keywords: Polycyclic aromatic hydrocarbons; Catla; QuEChERS method; Cinnamon; Mahogany

Identification of Biological Resources for Potential Applications in Solid State Fermentation from *Eucalyptus grandis* Plantations

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Solid state fermentation (SSF) is one of the methods used to produce Cellulase enzyme. It is therefore important to discover new low-cost substrates and fungal species that can provide Cellulase enzyme in a cost-effective and efficient manner in SSF. Hence this study had investigated the potentials of using *Eucalyptus grandis* (*E. grandis*) leaf litter as the substrate and fungi growing in them as the efficient cellulose degradable fungi for better extraction of Cellulase enzyme in SSF process. Twelve species of fungi were isolated from *E. grandis* leaf litter using Standard Nutrient media (SNM). Then they were screened for the capability to grow on cellulose using by carboxymethyl cellulose (CMC) plate assay with (Congo red -CR) test. The best cellulose hydrolysis fungus was selected by the measuring the diameter of yellow colour halo zone around the fungal colony. Using the selected substrate and isolated fungi, SSF was carried out and cellulose content was determined before and after the SSF. As controls sterile distilled water was employed instead of the SNM solution; whereas, in the second control, plant litter were substituted by an inert matrix of commercial inorganic material). The final spore concentrations (fungi spores per gram of plant litter) were determined using a Neubauer chamber. C: N (carbon: nitrogen) ratios of the plant litter and the inoculated solid substrate at the initial and final levels were determined using CHN analyser. After the SSF process *E. grandis* plant litter with SNM media indicated the highest spore concentration. The spore concentration increased from 2.05×10^5 spores per gram to 1.64×10^7 spores per gram. There was a significance difference of spore concentrations among the sample types after SSF ($p = 0.00$). The pH of leaf litter after the SSF had significantly decreased from 6.27 to 5.78 ($p = 0.00$). The reason of this reduction could be metabolized sugar, derived from the breakdown of the lignocellulosic material. After the SSF Carbon, Nitrogen, Hydrogen ratios of plant litter with SNM media distinctively decreased 54.39: 2.24: 7.04 to 49.93: 2.2: 6.45 and plant litter with distilled water decreased to 54.39: 2.24: 7.04 to 50.64: 2.14: 6.59. The cellulose content of plant litter after the SSF also significantly decreased ($p = 0.003$). SNM media with plant litter cellulose content had decreased (from 0.5974 g to 0.3793 g) compared to control (*E. grandis* plant litter with distilled water) (from 0.5974 g to 0.3912 g)). Therefore according to the results we can conclude that selected cellulose degradable fungi are significant in producing cellulase enzyme. Thus to obtain Cellulase enzyme more efficiently *E. grandis* leaf litter can be used with isolated fungi which is highly cost effective.

Keywords: Solid State Fermentation; Cellulase enzyme; *Eucalyptus grandis* leaf litter; Cellulose, Fungi

Effect of Boomi Tree (*Litsea glutinosa*) Wax on Internal Quality and Sensory Attributes of Chicken Eggs Stored Under Room Temperature

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Shell eggs having a short shelf life at room temperature. Surface coatings can be used to extend the shelf life and minimize economic losses. Edible mineral oil is used as a coating material but several drawbacks are associated. Waxes are most commonly used hydrophobic film forming materials. Boomi tree (*Litsea glutinosa*) is found throughout Sri Lanka and its bark mucilage consists of hetero-polysaccharide used in ayurvedic medicine. However, information on boomi tree wax coating on egg quality attributes does not exist. Hence, this study was done to check the effect of boomi tree wax as an external coating material on shelf life, internal quality and sensory attributes of chicken eggs stored under room temperature. Total of 270 freshly laid brown, medium sized, clean eggs were purchased from a layer farm in Demodara. Eggs were individually weighed and coated with boomi wax and mineral oil separately while non-coated eggs were used as the negative control and kept in room temperature. Weight loss, air sac volume, Haugh unit, yolk color, albumen and yolk pH, yolk index, FTIR analysis, *Salmonella* test and sensory attributes were weekly determined. Albumen and yolk pH were increased. But the increment in the mineral oil coated was significantly lower than the other two ($p < 0.05$). Haugh unit (75.0 to 53.6) and yolk index (0.44 to 0.22) decreased during storage in wax coated and non-coated eggs ($p < 0.05$). Grades of non-coated and boomi wax coated, eggs changed from AA to B within 04 weeks whereas those of mineral oil coated eggs remained in AA. Weight loss of wax coated eggs were significantly higher compared to mineral oil coated eggs ($p < 0.05$). *Salmonella sp.* were detected in several weeks during storage conditions showing permeability of the microorganisms. FTIR analysis revealed that no chemical changes occurred due to the wax. Increase of air sac was higher in noncoated eggs (5.39 ± 0.3 mm) after 42 days compared to wax (4.59 ± 0.2 mm) and mineral oil (1.19 ± 0.3 mm) coated eggs. In 3 week of storage sensory data was showed significant in sensory parameters. In conclusion, this study showed that Boomi wax is not a suitable coating material for chicken eggs.

Keywords: Boomi tree wax; Chicken egg; Haugh unit; Yolk index; Mineral oil

Functional Properties of Hydrolysates of Bioactive Peptides Extracted from Water Soluble Crude Protein from *Hilsa kelee*

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Hilsa kelee also known as “Karattaya” is a marine pelagic, seasonal fish species which has a high catch during April to September. It is mainly used to produce fish meal and used as baits even though it has high nutrients. In addition, it has a low market value and a demand due to its bony structure leading to high wastage and production of fish protein hydrolysates (FPH) can be an alternative. 20 mg/ml concentrated water-soluble crude protein extractions were mixed with Protease from *Bacillus licheniformis* (60°C, pH 6.5-8.5), Papain from papaya latex (65°C, pH 5.8-7.0), α -chymotrypsin from bovine pancreas (50°C, pH 7.8) and Elastase from porcine pancreas (37°C, pH 7.8-8.5) separately in 1:100 (enzyme: substrate) ratios. Each sample was incubated at different time intervals (0, 3, 6, 9, 12 and 24 hr) in predetermined optimum pH and temperatures. Then, 15% SDS-PAGE was used to determine the best hydrolysis condition. Bulk hydrolysates were prepared with Papain-6 h, Protease-3 h, α -chymotrypsin-3 h, Elastase-6 h followed with heat inactivation at 100°C for 15 minutes for further experiments. Then, TBARS assay, Ferrous chelation activity and antibacterial activities by agar well diffusion method was conducted. All treatments were triplicated (n=3). According to the results obtained from TBARS assay, FPHs from papain showed the highest antioxidant properties (5.84±0.05 MDA mg/L) compared to other treatments (p>0.05). Fe (II) chelation activity analysis revealed the FPHs produced from α -chymotrypsin showed the highest chelation (20.81±0.02%) (p<0.05). None of the hydrolysates showed any antimicrobial activities for tested microorganisms up to 20,000 ppm. Thus, FPHs produced using papain for 6 h followed with heat inactivation at 100°C for 15 minutes contain strong antioxidant activity

Keywords: *Hilsa kelee*; Fish Protein Hydrolysates (FPH); Antioxidant; Metal Chelating; Antibacterial activity

Use of *Trichoderma* in Controlling Black Rot Disease and Increasing the Shelf Life of Carrots (*Daucus carota* L.)

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Carrot (*Daucus carota* L.) is one of the most widely grown and eaten vegetable but it is more vulnerable to many postharvest diseases such as black rot, which is caused by the fungus *Alternaria radicina*. Since there are many disadvantages of using fungicides, it is important to find an effective biocontrol method to control *A. radicina*. In the present study, the use of fungus *Trichoderma asperellum* in controlling *A. radicina* was investigated. Pure cultures of *A. radicina* which were isolated from infected carrot taproots were tested against *T. asperellum* using the dual culture technique. As the control *A. radicina* pure culture was used without *T. asperellum*. The *A. radicina* radial growth reduction percentage was found to be 58.33%. Then the effect of *Trichoderma* spp. in control of black rot was studied by making a small wound in healthy, organic, disinfected carrots and inoculated them with 1 mL of *A. radicina* conidial suspension. A 1 mL of *T. asperellum* (2.46×10^{10} spores per 1 mL) was added to the wounds after 48 hours. Positive control was the fungicide, Mancozeb and the negative control was sterilized distilled water. After 10 days of incubation at room temperature, *T. asperellum* reduced *A. radicina* by 72.63%, which is approximately similar to the effect of the positive control. *T. asperellum* had significantly ($p < 0.05$) decreased disease occurrence and severity. In addition, inoculation of *T. asperellum* had greatly improved the minimum keeping time of average 13 days without characteristics symptoms which is seven days higher than the negative control. It can be concluded that, biological control of postharvest diseases by *T. asperellum* is an alternative to the use of fungicides and it could be a good solution for black rot disease in carrots.

Keywords: Carrots; Biocontrol; *Trichoderma asperellum*; Black rot; *Alternaria radicina*

Effect of Physico-chemical Properties of Local Bee Honey on the Sensory Properties of Developed Honey Wine

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Honey wine is an alcoholic beverage developed by the fermentation of natural bee honey. It is a better way of imparting nutraceutical value to an internationally recognized beverage type, where today's health concerned consumer patterns have a developing trend towards nutraceuticals. Additionally, it adds value to local bee honey production. In this study, the effects of Physico-chemical parameters; pH, Brix, titratable acidity, and colour of the bee honey on the sensory and Physico-chemical properties of developed honey wine were examined. Bee honey samples were collected from two different geographic areas of the country, Anuradhapura and Matale. Initially, the pH, Brix, titratable acidity, and colour of the bee honey were measured using standard AOAC methods. Honey wine was developed using both the samples and kept for maturation for 30 days under similar conditions at room temperature (around 30⁰ C). A sensory evaluation was conducted to identify the organoleptic properties of honey wine, using a 30-membered panel using a 5-point hedonic scale. The bee honey sample collected from Anuradhapura showed, pH, Brix, titratable acidity, and colour values, 3.87±0.02, 73.73±0.49%, 0.52±0.03 g/100ml and (L*=55.73, a*=29.15, b*=59.35) respectively. While the same parameters, of bee honey sample collected from Matale, showed 3.5±0.01, 80.2±0.21%, 0.65±0.21 g/100ml and (L*=62.03, a*=20.66, b*=49.87) respectively. Those Physico-chemical properties were significantly different from each other for the two bee honey samples whereas, the honey wines prepared from two bee honey samples also showed a significant difference in sensory properties. The developed wine using bee honey from Anuradhapura showed better organoleptic preference; for colour, appearance, aroma, mouthfeel/body, taste, alcoholic flavour and overall acceptability than the Matale honey wine. The Physico-chemical properties of both wines have also differed from each other. A higher alcohol production (8.1%±0.21 V/V) was also evident in Anuradhapura wine samples as the only sugar source for the fermentation process was given by bee honey. This concludes that even though developed honey wine with local bee honey is a success, a prior standardization of bee honey is needed in commercialization. Therefore, the researchers suggest further research on standardizing the bee honey and optimizing the fermentation process for scaling up for commercial level bee honey wine production.

Keywords: Honey wine; Bee honey; Organoleptic properties; Physico-chemical properties

Extraction and Purification of Chitin and Chitosan from *Portunus pelagicus* Crab Shell Waste

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Crab (*Portunus pelagicus*) shell waste is highly accumulated in Sri Lankan seafood processing factories, but not many efforts have been taken on utilizing it for commercial level chitin and chitosan extraction with a higher percentage purity. Therefore the objective of this study was to modify and develop a scale-up, simple, and high-yielding chemical method for extraction and purification of chitin and chitosan from locally underutilized *Portunus pelagicus* crab shell waste. A modified process including pre-demineralization (acetic acid), demineralization (citric acid), deproteinization (NaOH), decolourization (*n*-butanol) deacetylation (NaOH), and purification (EDTA and SDS) was optimized to obtain a new combination of treatments. Pre-demineralization was introduced as a new step when developing the process. Citric acid was found as the best alternative organic acid to replace HCl in demineralization. The final product was characterized by X-Ray Diffraction (XRD) Spectroscopy and Fourier Transform Infrared (FTIR) Spectroscopy and various physicochemical and functional properties were analyzed. Control chitin and chitosan samples were produced using a conventional method for comparison. The yields of crude chitin, crude chitosan, and purified chitosan were 32.52±0.68%, 26.28±0.47%, and 21.78±0.34% respectively whereas in the control chitin and chitosan the yields were 20.34±0.72% and 13.79±0.93% respectively ($p < 0.05$). Percentage purity of the final product on a weight basis was 82.54±1.73% with a degree of deacetylation of 85.84±2.45%. The XRD data revealed that chitosan extracted from the developed methodology is a semi-crystalline compound with two characteristic crystalline peaks at $2\theta = 9.05^\circ$ and 19.1° and Crystallinity Index of 67.22%. FTIR analysis revealed that developed chitosan was comparable with control chitosan. Chitosan produced from the developed method showed higher results in physicochemical parameters namely moisture (5.27±0.39%), ash (1.95±0.22%) whiteness index (72.37±0.66%), and functional properties namely water binding capacity (318.74±0.48%), fat binding capacity (351.663±0.69%) DPPH free radical scavenging activity (61.12±0.59%) and ferrous chelating activity (40.19±0.47%) compared with the control ($p < 0.05$). Developed chitosan had no antimicrobial activity for *Salmonella* and *Micrococcus* but showed positive antimicrobial activity against locally isolated *Escherichia coli* at 2.5mg/ml. Thus the developed methodology can be used to obtain high purity and high-quality chitosan with better physicochemical and functional properties from crab shell waste

Keywords: *Portunus pelagicus*; Shell waste; Chitosan; Pre-demineralization; XRD; Percentage purity

Development of an Alginate Based Edible Coating and its Application on Unripen Pre-cut Jackfruit (*Artocarpus heterophyllus Lam*)

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Jackfruit (*Artocarpus heterophyllus Lam*) is a fruit which is highly demanded by Asians. It is a large fruit which is difficult to peel, therefore consumers prefer to buy it ready to cook. The objective of this study was to investigate the effect of application of an alginate based edible coating on quality parameters of pre-cut jackfruit samples. Alginate is a polysaccharide which can be used in development of coatings and films using its gelling property. Alginate for the study was extracted from *Sargassum sp.* by hot extraction method. An FT-IR analysis was done to confirm the presence of functional groups of extracted sodium alginate. FT-IR analysis resulted peaks at wavenumbers (cm^{-1}), 1562.973, 849.208, 949.176 and 3461.391. According to previous literature, appearance of peaks at these wavenumbers indicated the presence of carboxylate, mannuronic acid, uronic acid and an O-H groups respectively. 1% alginate based edible coating was developed using extracted alginate to apply on pre-cut jackfruit samples which are to be stored for 5 days under refrigerated conditions ($6\pm 1^{\circ}\text{C}$). Total soluble solid content (TSS), weight loss percentage, titratable acidity, pH and ascorbic acid content of coated and uncoated jackfruit samples were measured for a period of 5 days. According to the results, TSS and pH of both coated and uncoated samples has increased. On the fifth day, a significantly higher TSS and a pH value was observed in the uncoated sample. Weight loss was observed in both coated and uncoated samples. During the storage period of 5 days, a significantly higher weight loss percentage was observed in uncoated sample than the coated sample. Titratable acidity decreased during the storage period. Significantly higher decrement in the titratable acidity was observed in uncoated sample. Ascorbic acid content was decreased during the storage period but there was no any significant difference in the decrement of ascorbic acid content between coated and uncoated sample. Thus, within 5 days of storage lesser weight loss and better-quality values of Tss, titratable acidity and pH were obtained for jackfruit samples coated with 1% alginate. Microbial analysis and sensory analysis of the study is in progress.

Keywords: Jack fruit; Alginate; Edible coating; Packaging; Shelf life

Comparative Study on Physicochemical Properties of Sunflower Oil, Palm Oil and Virgin Coconut Oil Available in Sri Lankan Market

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Sunflower oil (SO), palm oil (PO) and virgin coconut oil (VCO) are three different types of widely consumed edible oils, in Sri Lanka. At the time of purchasing the physicochemical parameters among the same oil type can be varied. The study was designed to evaluate the quality attributes of randomly picked oil samples in Sri Lankan local market at the moment of purchasing. Twelve samples (Three brands of SO, four brands of PO and five brands of VCO) of oils were purchased from the supermarkets in Badulla and Colombo area. Specific gravity, viscosity, colour, free fatty acid (FFA) and peroxide value (PV) of all the oil samples were measured. PV and FFA values of SO ranged from 14.80 ± 3.02 meq/kg to 7.67 ± 0.70 meq/kg and $0.86 \pm 0.30\%$ to $0.53 \pm 0.11\%$ respectively. The recorded PV values of some brands of SO are complying with the SLS standards and PV values of remaining brands and all FFA values are not complying with SLS standard (946: maximum FFA as oleic acid: 0.25% and maximum PV: 10 meq/kg). Specific gravity, viscosity and colour of the three brands of SO were significantly different ($P < 0.05$). PV and FFA of PO ranged from 0.36 ± 0.12 meq/kg to 0.25 ± 0.02 meq/kg and $11.13 \pm 1.43\%$ to $7.07 \pm 0.69\%$ respectively. Thus, the recorded PV and FFA of some brands comply with the SLS standards (720: maximum FFA as palmitic acid 0.25% and maximum PV: 10 meq/kg). The colour and specific gravity of PO were significantly different ($P < 0.05$) within the three brands but viscosity was not significantly different ($P > 0.05$). PV and FFA of VCO ranged from 3.07 ± 0.17 meq/kg to 2.27 ± 0.13 meq/kg and $0.31 \pm 0.03\%$ to $0.20 \pm 0.05\%$, respectively. Thus, the recorded PV values and FFA values are complied with some brands while some are not conformity with SLS standard (32:2002) (maximum FFA as lauric acid: 0.2% and maximum PV: 3 meq/kg). Values for specific gravity, colour and viscosity of three brands of VCO were not significantly different ($P < 0.05$). In conclusion, the physicochemical properties of some brands in three different oil types do not comply with the SLS standards and also show significant differences within the brands.

Keywords: Edible oil; Free fatty acid; Peroxide value; Sunflower oil

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Production of Bioactive Peptides from Ovotransferrin using Two Enzyme Combinations and Determining the Functional Properties of Its Hydrolysates

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Peptides from food sources possess numerous bioactivities which make them useful in improving human health and preventing diseases. Although many studies related to egg protein hydrolysis are available, less work has been carried out on the production of bioactive peptides from ovotransferrin using two-step enzyme hydrolysis. Objectives of the research were to produce bioactive peptides from ovotransferrin using two enzyme combinations and to determine the functional properties of its hydrolysates. Lipolyzed ovotransferrin was prepared with 20 mg/mL concentration and treated with protease (3hr at 55°C) (Pro), papain (3hr at 37°C) (Pap), elastase (24hr at 37°C) (Ela), and α -chymotrypsin (3hr at 37°C) (Chy) as the first enzyme treatment. Hydrolysate of first step hydrolysis was treated with the above enzymes in different combinations and incubated for 0-24 hours at the optimal temperatures. 15% SDS - PAGE was used to select the best incubation time for each treatment. Best combinations were used to test for antioxidant, metal chelating, and antimicrobial activities using *E. coli* and in Total Plate Count. Protease + Papain (ProPap), Protease + α -chymotrypsin (ProChy), α -chymotrypsin + Protease (ChyPro), α -chymotrypsin + Papain (ChyPap), Elastase + α -chymotrypsin (ElaChy), Elastase + Papain (ElaPap), Elastase + Protease (ElaPro) treatments with immediate enzyme addition and heat treatment for 100°C for 15 minutes, Papain + Protease (PapPro), Papain + α -chymotrypsin (PapChy) incubated for 3h followed with heat treatment were selected as the best. Hydrolysates produced with ChyPap treatment showed some level of metal chelating activity (4.11±0.28%) and Ela (-2.88±0.16%), ElaChy (-7.80±0.28%), and ElaPap (-6.38±0.14) showed metal releasing activities. ChyPap (0.59±0.08 MDA mg/kg) treatment followed by ProChy (0.74±0.07 MDA mg/kg), ProPap (0.78±0.04 MDA mg/kg) and ChyPap treatments showed strongest antioxidant activity than ovotransferrin (0.98±0.07 MDA mg/kg) and hydrolysates produced with single enzyme treatments (p<0.05). However, none of the hydrolysates showed any antimicrobial activities against locally isolated *E. coli* and in Total Plate Count. Accordingly, hydrolysates produced with two enzyme combination treatments showed strong antioxidant and some metal chelating activities which are important in food processing industries.

Keywords: Ovotransferrin, Hydrolysates, Enzyme combination, TBAR

Nutrient Composition, Antioxidant Activity and Qualitative Phytochemicals Screening of *Acrostichum aureum* (Kerenkoku) Extracts

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Hundreds of wild edible species, which are capable of contributing to improve healthy dietary patterns are available in Sri Lanka. Although *Acrostichum aureum* (Kerenkoku) is an important wild edible species, its nutritional properties are still unexplored. This study was carried out to determine the nutrient composition, antioxidant activity and to screen the phytochemicals in different crude extracts of *A. aureum*. Different organic solvents including hexane, ethanol and chloroform were used to prepare crude extracts. Different crude extracts were tested to determine the antioxidant activity using DPPH assay. The proximate nutritional composition including, ash, moisture, crude protein, crude fat and crude fiber were determined using AOAC standards. In DPPH assay, IC 50 values of crude extracts varied between 1.53 mgmL⁻¹ to 4.3 mgmL⁻¹. According to the results, the highest antioxidant activity was found in chloroform extract followed by ethanol and hexane extracts. Qualitative In vitro phytochemicals screening for all crude extracts had shown the presence of alkaloid, phenol, flavonoid and quinine compounds. Moreover, ethanol extract contained tannin and saponin compounds. On the other hand, all the crude extracts did not show positive results for coumarin and steroids. Moisture and ash contents were 86.90% and 0.03% of fresh weight, respectively. The corresponding values for crude fat, crude fiber and crude protein were 2.80%, 7.53% and 3.53% respectively in dry weight basis. Nutritional compositions of *A. aureum* showed similar values to most leafy vegetables in Sri Lanka, while the identified crude fiber level was higher than the other common leafy vegetables. In conclusion, most of the screened phytochemicals in *A. aureum* are potent antioxidants and have corresponded to free radical scavenging activity. *A. aureum* has a good potential to be used as a food source due to its significant nutritional values. Accordingly, these underutilized plants can play an important role in improving human dietary patterns as well as to fight against food insecurity in future.

Keywords: *Acrostichum aureum*; Antioxidant activity; Proximate composition; Phytochemicals

Antibacterial activity of entomopathogenic fungi isolated from a beetle (*Harmonia* sp.) in Sri Lanka

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Majority of human pathogenic bacteria has become resistant to the existing antibiotics causing a human health crisis in the world. Thus discovering novel antibacterial drug leads has become an urgent concern. Entomopathogenic fungi (EPF) infect insects and kill or disable them. Previous research have shown entomopathogenic fungi exhibit various bioactivities. Thus, the objective of the current study was to isolate entomopathogenic fungi from a beetle, a *Harmonia* sp. in Sri Lanka and evaluate their potential of producing antibacterial compounds. EPF were isolated from surface sterilized insect cadavers collected from Balangoda area in Sri Lanka. Isolated fungi were grown in potato dextrose agar and broth media, incubated close to sporulation, harvested and extracted into ethyl acetate. The obtained weights of the crude extracts of solid and liquid cultures were compared using ANOVA. Antibacterial activity of the crude extracts were evaluated using agar disc diffusion bioassays at 400 µg/disc, against two Gram-positive bacteria, *Staphylococcus aureus* (ATCC 25923), *Bacillus cereus* (ATCC 11778) and two Gram-negative, *Escherichia coli* (ATCC 35218) and *Pseudomonas aeruginosa* (ATCC 9027). The positive control used was Gentamycin and the negative control was methanol. Seven morphologically different EPF were isolated from *Harmonia* sp. The crude weights of the solid cultures were significantly higher than the crude weights of the liquid cultures (ANOVA, $p < 0.05$). This result showed fungi have preferred to synthesize more metabolites under solid culture conditions than liquid. Six out of the seven fungi showed antibacterial activities against at least one bacterium tested. EPF cultures BET 06, 08 and 10 showed high inhibition zones against the *S. aureus* and *B. cereus*. According to ANOVA there was a significant difference between the antibacterial activities of the crude extracts ($p < 0.05$). None of the fungal extracts showed activity against *P. aeruginosa* while BET 05, 06 and 08 showed mild activity against *E. coli*. According to the microscopic characteristics the fungi were tentatively identified as belong to *Penicillium* and *Aspergillus* species. A bioautography study revealed the presence of several bioactive compounds in BET 05, 06, 08 and 10 extracts. The results of this study showed that entomopathogenic fungi are potential sources for isolating antibacterial compounds.

Keywords: Antibacterial; Entomopathogenic fungi; *Harmonia* sp.; *Penicillium*; *Aspergillus*



Development and Evaluation of the Effectiveness of a *Kappaphycus alvarezii* Seaweed-based Coating Solution for the Shelf-life Extension of Banana (Variety: Cavendish)

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Application of biodegradable coating solutions is a novel approach to extend the shelf life of fresh fruits and vegetables. A variety of raw materials are used to develop cost effective coating materials. Studies focusing on the development of seaweed-based coatings are still scarce in Sri Lanka. Therefore, the aims of the present study are to formulate fruit coating material from *Kappaphycus alvarezii* seaweed using glycerol as the plasticizer and to determine the applicability of formulated coating for the shelf life extension of Cavendish bananas. Seaweed extract (obtained by hot water extraction) and 10%, 15% and 20% (V/W) glycerol concentrations were used to produce three different types of coating solutions (glycerol concentrations were selected based on potential bioplastic strength). Cavendish bananas (ripening index 5) were coated with the prepared coating solutions and percentage weight loss, change in firmness (fruit hardness tester), total soluble solid (TSS) content (refractometer) and the peel browning (visual observation) were evaluated for six days. Percentage weight loss was highest for non-coated bananas compared to coated bananas and the least weight loss was observed in the bananas coated with 20% glycerol added coating solution ($p < 0.05$). After six days of storage, total percentage weight loss of non-coated bananas was 23.97% and 11.54% for bananas coated with 20% glycerol added coating solution. A continuous loss in fruit firmness was observed in all the four types of samples. The rate of firmness reduction was highest (32%) in non-coated bananas than coated bananas ($p < 0.05$). There was a significant difference in TSS content of non-coated bananas compared to coated bananas during storage ($p < 0.05$). The rate of TSS increment was higher (8%) in non-coated bananas than coated bananas. Lowest degree of peel browning was observed in the banana coated with 20% glycerol added film forming solution while peel browning was greatest in control samples. Accordingly, percentage weight loss, loss of firmness and peel browning can be effectively reduced by applying seaweed-based coating solutions. Effectiveness of coating solution increases with the increasing glycerol content. It can be concluded that the 20% glycerol incorporated coating solution is a viable coating material for the shelf life extension of Cavendish bananas

Keywords: Coating solutions; Glycerol; *Kappaphycus alvarezii*; Seaweeds; Shelf life extension

Isolation of Antibacterial Compounds from an Entomopathogenic Fungus Isolated from a Beetle, a *Harmonia* sp.

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Antibiotic resistance of bacteria is a major human health concern in the world which requires research priorities. Therefore discovering new and effective antibacterial drug leads has become an urgent necessity. Entomopathogenic fungi act as parasites of insects which kill or disable them. However these fungi are known to synthesize various bioactive secondary metabolites. Thus, the objective of the current study was to isolate the antibacterial compounds from an entomopathogenic fungus isolated from a beetle (*Harmonia* sp.) in Sri Lanka. The fungus BET 05, which was microscopically identified as an *Aspergillus* sp. was grown in potato dextrose agar (PDA) and broth (PDB) media. After an incubation period of 06 days, both solid and liquid fungal cultures were extracted into ethyl acetate (EtOAc). The solid culture (30 large and 13 medium PDA dishes) yielded 804.8 mg of crude while the liquid culture (400 mL x 3) gave 436.7 mg. The solid and liquid crude extracts were subjected to an agar disc diffusion bioassay to determine the antibacterial activity and the inhibition zones diameters were 11.5 and 11.3 mm respectively, against the Gram positive *Staphylococcus aureus* (ATCC 25923) at 400 µg/disc concentration. The positive control used was Gentamycin, while the negative control was methanol. The main active compound in the extract was isolated using bioassay guided chromatographic techniques. The crude extract (436.7 mg) was first fractionated by solvent-solvent partitioning, using hexane and methanol/water (9:1), chloroform and methanol/water (6:4) and, EtOAc and water. The active chloroform fraction was purified by Sephadex LH20 size exclusion chromatography using methanol as the eluent. Fractions collected were grouped according to their TLC profiles and the combined fractions (A-F) were tested for antibacterial activity using a bioautography. The active fraction B was further purified by normal phase silica chromatography using 60:40 hexane: EtOAc to methanol solvent systems. A bioautography revealed, the combined fraction E contains main active compound while fraction C and G are also having some active compounds. Finally a preparative TLC was conducted using EtOAc as the mobile phase to get the main active compound purified (4.1 mg). This study reveals that entomopathogenic *Aspergillus* sp. (BET 05) is a potential producer of antibacterial compounds.

Keywords: Antibacterial; Antibiotic resistance; Entomopathogenic; *Aspergillus*

Development of Omega-3 Fish Oil Fortified Functional Stirred Yoghurt by Incorporating *Annona muricata* (Soursop)

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Fish oil is an ideal source of Omega-3 polyunsaturated fatty acids (PUFAs) which lower the risk of numerous non communicable diseases. Consumption of fish oil is not popular in Sri Lankan community. This study aimed to develop a fish oil fortified functional stirred fruit yoghurt to deliver Omega-3 PUFAs and to evaluate the effect of fortifying yoghurt with fish oil on sensory, physicochemical properties and oxidative qualities. Initial sensory analysis for fish oil fortified yoghurt was performed by adding 5% (w/w) three different fruit juices including soursop, mango and pineapple by thirty untrained panelists. Fish oil fortified soursop added stirred yoghurt showed the highest score for overall acceptability as 7.32 ± 0.85 ($p < 0.05$). Results of second sensory analysis have shown that addition of soursop up to 15% (w/w) level was considerably masked the fishy odor and flavor of fish oil (1% w/w) fortified yoghurt. Fish oil emulsion was prepared with guar gum, gelatin and glycerol using Nano emulsion technique. Physicochemical and oxidative qualities were compared among fish oil emulsion added soursop yoghurt (FOESY), fish oil fortified plain yoghurt (FOPY) and bulk fish oil fortified soursop yoghurt (BFOSY) during the storage of 21 days at 4°C. Peroxide values (PV) were analyzed to determine oxidative stability. Syneresis values increased in all yoghurt samples during storage. The highest syneresis value of 45.18 ± 1.98 was recorded by FOPY on day 14. BFOSY and FOESY showed significantly lower syneresis ($p < 0.05$). pH values gradually decreased and titrable acidity values as lactic acid increased in all treatments during storage. The pH values of both FOESY and BFOSY was 4.5 ± 0.01 at day 14. FOESY recorded the lowest ($p < 0.05$) PV (4.64 ± 0.12 mEq O₂ kg⁻¹) at day 21 compared to BFOSY and FOPY. The *Escherichia coli* and coliform counts were complied with the requirements of SLS but yeast and molds counts had exceeded SLS limits after 14 days. This study demonstrated the potential of producing fish oil emulsion fortified functional yoghurt with acceptable level of sensory characteristics, physicochemical properties and oxidative stability by incorporating soursop juice.

Keywords: Omega-3; Fortification; Fish oil; Yoghurt; Soursop

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Evaluation of Proximate Composition and Mineral Content of Raw and Processed *Artocarpus nobilis* (Ceylon Breadfruit) Seeds

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Nut and seeds are recommended for a healthy diet as being recognized as a source of high-quality protein, lipids with bioactive compounds. Although many indigenous species of edible nuts could address food insecurity in developing countries, there are not enough researchers to explore its possibilities of using them to improve the nutritional status of people. *Artocarpus nobilis* Thwaites (Ceylon breadfruit, Wal del/ Bedi del) is a native underutilized tree nut in Sri Lanka that is yet to be explored for its nutritional and functional properties. This study investigated the proximate composition and mineral content of raw and processed (roasted, microwaved, and boiled) *A. nobilis* seeds. Mature seeds of *A. nobilis* were collected from eight locations. Moisture, lipid, crude protein, ash, dietary fiber, and carbohydrate contents were analyzed according to the AOAC (2000) methods. The mineral content was evaluated using Inductive coupled plasma-optical emission (iCPA 7000 series, Thermo Scientific). The proximate composition of the raw *A. nobilis* seeds was as follows: 12.92±1.08% moisture (fresh weight), 11.73±0.25% crude protein, 26.45±0.86% lipids, 2.33±0.01% ash, and 30.08±0.28% dietary fiber on dry matter basis. The available carbohydrate content of raw seed was around 29.41% and raw seed provided 16842kJ of energy per kilogram of dry matter. Further, these seeds were rich in healthy minerals such as potassium (5398.31±338.39 µg/g) and magnesium (1120.69±58.39 µg/g), along with a lower level of sodium. Iron (21.58±1.99 µg/g) was the predominantly found microelement in raw seeds followed by zinc (16.77±1.82 µg/g). Processing method modulated the proximate composition in studied samples. According to the data, pan roasting and microwaving significantly increased the lipid and protein content of the raw *A. nobilis* seed. A higher energy value was observed in the processed samples than in the raw state. However, processing did not modulate the mineral composition in studied samples. The current study concluded that *A. nobilis* seeds are a good source of macro and micronutrients and both pan roasting and microwaving are preferable processing methods to improve their nutritional value.

Keywords: *Artocarpus nobilis*; Processing method; Underutilized, Nuts, Nutrients

Assessment of the Omega-3 Fatty Acids Composition and Heavy Metals Content in Fish Oils in Sri Lankan Marine Fishes

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The consumption of fish oil provides numerous speculated health benefits due to the presence of long chain omega-3 polyunsaturated fatty acids (PUFA). These health benefits may be challenged by the presence of heavy metals in fish oil. The objective of the present study was to compare the health benefits of omega-3 fatty acids and assess the risk of some heavy metals in fish oil extracted from marine fish. Sixteen species of fish were collected (n=3) from the Trincomalee fish market and fish oils were extracted using standard Bligh and Dyer method. Fatty acid composition of extracted fish oils were quantitatively determined by Gas Chromatography - Mass Spectrometry (GC-MS). The Arsenic (As), Cadmium (Cd) and Lead (Pb) contents were determined by using Inductively Coupled Plasma - Mass Spectrophotometer (ICP-MS). The amount of fat present in fish varieties was varied over a wide range of 0.619% (*Acanthocybium commersoni*) to 8.626% (*Carangoides fulvoguttatus*). Among these species, the omega-3 content ranged from 7.814% - 31.818% of total fatty acids and the highest of omega-3 content was showed in *Hemiramphus* sp. (9.20 mg/100 g) and lowest level was reported in *Auxis thazard* (0.036 mg/100 g). In all species studied, Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) are the major omega-3 fatty acids and amounts of EPA and DHA have been exceeded 70% of the total omega-3 PUFAs. The content of As in extracted fish oils were ranged from 2.4353-18.3975 mg/kg in *Nemapteryx caelata* and *Elagatis bipinnulata* while Cd content were varied from 0.0262 - 1.2305 mg/kg in *Scomberomorus commersoni* and *Nemapteryx caelata* respectively. *Platax* sp. reported the lowest Pb content (0.467 mg/kg) while *Acanthocybium commersoni* reported the highest (2.282 mg/kg). Some of the fish oil samples had exceeded recommended human daily intake values of heavy metals, thus benefite of omega-3 fatty acids is challenged.

Keywords: Fish oil; Omega-3 fatty acids; Heavy metals; GC-MS; ICP-MS

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Development and Characterization of a Herbal Extracts Incorporated Confectionery with Immune Enhancing Active Compounds

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Immune enhancement is a widely discussed area in the world. Several medicinal herbs namely ginger, shallot, coriander, and green tea have been found out to be possessing active compounds which aid in enhancing the immune function by stimulating innate and cell mediated immune responses. The aim of this study was to develop a confectionery using convenient herbs available in Asian regions to enhance human immunity. Initially ethanolic extracts of ginger, shallot, coriander and green tea were obtained using soxhlet extraction and Gas Chromatography Mass Spectrometric (GCMS) study was done. The candy was developed with incorporated herbal extracts and the optimal amounts were calculated using previous research data. Flavor profile was characterized with concentrated lime juice. The herbal candy with no added lime juice, 0.7%, 1.0% and 1.3% citric acid from concentrated lime juice were given to a semi-trained sensory panel of 36 panelists and the sensory data were used to perform one way ANOVA to compare the preference. The final product was tested for immune boosting active compounds using GCMS analysis. Analytical tests for moisture, ash, titratable acidity, reducing sugar, polyphenols, texture and test for yeast and moulds were also done. The product with 1.0% citric acid was the best formula. Six active compounds, namely Quercetin, Linalool, Zingiberene, Gingerol, Caffeine and Shogaol were present in the final product out of the 8 main active compounds detected in plant extracts. The main immune boosting active compounds in shallot and coriander respectively were Quercetin and Linalool. Ginger was detected with Gingerol, Shogaol, Zingerone and Zingiberene, and green tea was detected with Epigallocatechin gallate and Caffeine as the main immune boosting active compounds. Product contained 2.137% of moisture, 1.313% of ash, 31.22% of reducing sugar and 0.138 mg GAEg⁻¹ of total phenols. A total of 0.970% titratable acidity was also present in the candy. Texture analysis with 50 kg load cell, at the first hardness cycle resulted a 54500.00g with 1.79 mm deformation. Yeast and mould test was negative after five days of incubation. As the final outcome, a herbal extracts incorporated hard candy was developed with 75% of targeted immune boosting active compounds.

Keywords: Immunity; Herbal candy; Ginger; Shallot; Green tea; Coriander

***In vitro* Screening of Total Phenolic Content, Flavonoid Content and Antioxidant Capacity of Soups Prepared by Commercially Available Traditional Rice Varieties in Sri Lanka**

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Rice (*Oryza sativa*) is one of the major staple foods in the world. Sri Lankans also consume rice soups (Bath kenda in Sinhala language) as a nutritional and medicinal supplement by boiling rice with water. Although there were studies carried out on the phytochemicals and antioxidant activity in the Sri Lankan traditional rice varieties (TRV) upto-date there were no studies reported on phytochemical content and antioxidative properties of the rice soups prepared from TRVs. Thus, the objective of the present study is to evaluate the antioxidant capacity, total phenolic content (TPC) and the total flavonoid content (TFC) of the boiled rice soups prepared from commercially available TRVs. A percentage of 80% methanolic extracts were prepared from the water fraction separated from the boiled rice seeds of four TRVs named as Kuruluthuda(KT), Kalu Heenati(KH), Pachcha Perumal(PP) and Neeroga(RB). Percentage yield of the methanolic extract of four rice soups KT, KH, RB and PP were 0.18%, 0.15%, 0.24% and 0.21% respectively. Antioxidant capacity was evaluated using 1,1- diphenyl-2-picryl-hydrazyl (DPPH) radical scavenging (n=3) assay. TPC was determined using folin-ciocalteu reagent based spectrophotometric method (n=3) while Aluminium Chloride based colorimetric assay (n=3) was used to evaluate the TFC. Mean radical scavenging activity against DPPH was in the range of IC₅₀ 60 - 433 ug/ml and the order of mean radical scavenging activity was KT> PP > RB> KH. Mean TPC was in the range of 4.9± 0.40 - 7.3 ± 0.21 mg GA/g (Gallic Acid/g) while order according to the means of TPC was PP>KT>KH>RB. The mean TFC was in the range of 3.1 ± 0.20 - 5.7 ± 0.24 mg EGCG/g (epigallocatechin gallate)/g) and the ascending order according to the means of TFC was KT>NB>PP>KH. Results revealed that there is a bioactivity in rice soup of TRVs but need to be carried out on further research on the bioactivity of the soups prepared by commercially available traditional rice varieties in Sri Lanka.

Keywords: Traditional rice; Antioxidant assay; DPPH; Flavanoid; Phenolic content

Anti-Oxidant Activity and Tyrosinase Inhibitory Activity of Ceylon Black Tea Extracts: Water Extract of Ceylon Black Tea Regulate Anti-Melanogenic Activity by Suppressing Tyrosinase, TRP-1, TRP-2 and MITF in B16F10 Melanoma Cells

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With the growing popularity of skincare products around the world, cosmetic applications of plant extracts are gaining continuous attention in cosmeceutical industries. Therefore, this study aims to investigate the anti-melanogenic effect of Ceylon black tea extracts. In this study five different black tea extracts were prepared with distilled water (extraction by autoclave, extraction at 80°C for 2 h) and organic solvents (ethanol, methanol, acetone). Each extract of black tea was tested for total phenol content, total flavonoid content, DPPH radical scavenging activity and tyrosinase inhibitory activity. Finally, different concentrations of tea extract were tested in B16F10 melanoma cells for cytotoxicity and protein suppression levels. According to the results of this study, the highest yield of 42.93% was obtained from the ethanol extraction followed by 40.19% from acetone extraction. Highest total polyphenol contents were obtained from ethanol and acetone extractions with 240.30±1.40 µg/g and 240.20±4.70 µg/g concentrations. The highest total flavonoid content was obtained from acetone extraction with the concentration of 57.49±4.70 µg/g. Distilled water extract of Ceylon black tea exhibited the highest inhibitory activity on tyrosinase with an IC₅₀ value of 0.016±0.001 mg/ml whereas ethanol extract exhibited the highest DPPH radical scavenging activity with an EC₅₀ value of 0.009±0.000 mg/ml. Treated concentrations of 10 to 50 µg/ml were not cytotoxic to B16F10 cells and exhibited more than 80% cell viability at all treated concentration. Further, western blot results revealed the suppression of tyrosinase, TRP-1, TRP-2 and MITF protein expression levels in dose dependent manner. Therefore, we suggest the applicability of distilled water extract of black tea as a novel melanogenesis inhibitor and skin-whitening agent in Sri Lanka cosmeceutical industries.

Keywords: Cosmeceuticals; Black tea; Anti-melanogenic; Green extraction; Tyrosinase

Assessment of the Association between Selected Socio-demographic Characteristics with Food Safety Knowledge, Attitudes and Practices of School Children in Colombo, Sri Lanka

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Having felicitous knowledge and positive attitude on food safety with proper execution of safe food handling practices since childhood make school children more confident in facing food safety risks as adults in future. This work was conducted to assess and analyse the relationship between some selected socio-demographic factors on the food safety knowledge, attitude and practices among school children in Colombo Education Zone, Sri Lanka. Data were collected using a self-administered questionnaire which contained 44 close ended questions on four basic areas; students' experiences with food preparation, students' attitude on food safety, students' food safety knowledge and their self-reported practices. Three hundred and eighty volunteer students (14-16 years old) from government schools of Colombo Education Zone were participated in the study. Three Scores were given to evaluate food safety knowledge, attitude and practices of students separately. The mean food safety knowledge, attitude and practice scores of students were 59.94 ± 0.83 , 84.33 ± 0.44 , 79.59 ± 0.61 respectively. Mann-Whitney u test indicated gender wise significant differences in food safety knowledge score ($p = 0.035$) and food safety practice score (0.000). Positive correlations were found ($p < 0.05$) between food safety knowledge score and parents' education background, student's academic ranking, Science marks. Significant positive correlations were shown between food safety practice score and student's academic ranking, Science marks. Similarly positive correlation-coefficients were recorded between food safety attitude score and parents' education background and students' Science marks. Results from the regression model indicated that food safety knowledge score significantly decreased if education level of parents, academic rank and Science marks of students ($p < 0.05$) are decreased. Although food safety knowledge score of males is higher than females, poor food safety practices were common among males and students with lower Science marks ($p < 0.05$). In conclusion, gender, parents' education background, students' academic ranking and Science marks can be effectively used as parameters to further improve food safety knowledge, attitude and practices among school children.

Keywords: Food safety; Knowledge; Practices; Attitude; Socio-demographic factors; School children

Development and Quality Evaluation of Avocado (*Persea americana*) Based Nutritious Supplement Food

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Postharvest loss of avocado (*Persea americana*) is very high due to lack of proper indices for maturity detection, seasonality, uneven ripening, and less attention for using product development. This study was aimed to develop avocado-based nutrient-rich supplementary food using dehydrated avocado powder. The avocado fruits in proper maturity were selected and dehydrated using an air dryer(55°C), heat pump dryer(40°C), and freeze dryer(-55°C) followed by blanching and without blanching. The pretreatments (1.5g/L) were used such as citric, ascorbic, combination of citric and ascorbic, and control. The best treatment was selected based on Browning Index (BI). Supplement food was prepared using a different combination of avocado (40%, 50%, and 60% w/w). Proximate composition, physicochemical properties, and sensory properties of the avocado powders and initial physicochemical properties (as; pH, total soluble solids (TSS), lightness (L*), red/green coordinate (a*), yellow/blue coordinate (b*)) for the final product was determined. Sensory data were analyzed by Friedman's non-parametric test using 7 points hedonic scale by 20 untrained panelists. Physicochemical properties data analyzed using ANOVA test by MINITAB 17. The lowest moisture (7.57±0.01%) and highest ash (3.86±0.00%) content were recorded by heat pump-dried samples, while the highest crude protein (14.84±0.00%) was recorded by freeze-dried samples, and the highest crude fat (20.31±0.00%) was given by the sample dried using air dryer. A significant difference (P≤0.05) was observed in all physicochemical properties. The TSS content was significantly increased while pH, ascorbic acid content, and colorimetric measures were reduced during the two months of storage period. Heat pump dried without blanching ascorbic acid-treated (BI=56.03±3.28) avocado powder was selected as a qualitatively and economically best treatment for product development based on its properties. Initial physicochemical properties of the product as pH, TSS, L*, a*, b* were 5.67±0.03, 1.53±0.05%, 63.86±0.26, -4.40±0.40, 27.32±0.13 respectively. Based on sensory evaluation the 50:50 avocado powder can be used for product preparation with oats, soybean, *Centella asiatica*, and vanilla in 25:15:5:5 ratio. The dehydrated avocado powder can be successfully used to develop avocado-based nutrient-rich supplementary food. Further studies are needed to evaluate its shelf life and select a suitable packaging.

Keywords: Supplement food; Avocado powder; Blanching; Citric; Ascorbic



Development of Soursop (*Annona muricata* L.) Incorporated Probiotic Frozen Yoghurt Fermented by *Lactobacillus acidophilus*

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Soursop (*Annona muricata* L.) is an underutilized tropical fruit grown in Sri Lanka with the promising nutritional and therapeutic value. The study was conducted to develop soursop incorporated frozen yoghurt (SFY) and to determine its physicochemical properties. Two different wiped cream levels (5% and 10% w/w) and three levels (10%, 20% and 30% w/v) of pasteurized soursop pulp was tested. The best product accepted from sensory evaluation, was tested against the control (without added fruit) for physicochemical, microbial, shelf life and therapeutic value. Results showed that 80% fresh milk, 20% soursop fruit pulp were the best combinations for SFY ($p \leq 0.05$). According to the proximate analysis moisture, protein, fat, fiber, ash and carbohydrate content of SFY were $71.82 \pm 0.4\%$, $4.36 \pm 0.2\%$, $6.29 \pm 0.2\%$, $0.91 \pm 0.1\%$, $0.93 \pm 0.1\%$ and $15.84 \pm 0.2\%$, respectively. During storage, pH and titratable acidity of developed SFY were varied from 4.54 ± 0.01 to 4.47 ± 0.02 , and 0.93 ± 0.05 to 4.53 ± 0.01 accordingly. Total soluble solid content, water holding capacity and syneresis of SFY contain $26.83 \pm 0.2\%$, $14.33 \pm 1.5\%$ and 13 ± 0.1 respectively. Yeast and mold count did not exceed the Sri Lankan Standard Institute (SLSI) recommended values during the 8 weeks of storage. By measuring probiotic count the therapeutic value was measured in SFY. Probiotic count of SFY was exceeded the minimum therapeutic value during the storage period. Incorporation of 20% (w/v) of soursop into frozen yoghurt is possible and the product can be safely stored for 8 weeks.

Keywords: Fermentation; Frozen yoghurt; Milk; Probiotics; Soursop

Evaluation of Changes in Polyphenol, Amino Acid and Catechins Content during Tea Wine Fermentation

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Tea Wine is an alcoholic beverage prepared by fermenting sugar enriched tea infusion with yeast (*Saccharomyces cerevisiae*). The Tea Research Institute of Sri Lanka developed this process with the intension of introducing diversified product of tea. Information on the changes of important tea constituents during tea wine fermentation will be useful for commercialization of this product. However, there is hardly any recently reported information on the changes in chemical constituent during tea wine fermentation. Polyphenols, catechins and amino acid mainly contribute to the characteristic organoleptic and therapeutic properties of tea. Therefore, the present study was undertaken to investigate changes in polyphenol, catechins and amino acid contents during tea wine fermentation. Filtered black tea infusion with 2% soluble solids (2 °Brix) was obtained and its Brix value was adjusted to 22 by adding sugar. Then this sugar enriched tea infusion was fermented with yeast in glass canisters fitted with fermentation trap in triplicate for six weeks. Changes in catechins, polyphenol and amino acid were investigated in weekly interval during the fermentation period. Total polyphenol contents of the samples were determined by Foilin Ciocalteu colorimetric method and catechins contents were determined by High-Performance Liquid Chromatography method whereas the total amino acid contents were determined by the Ninhydrin colorimetric method. Total polyphenol, total catechin and total amino acid contents of the initial sugar enriched tea infusion (in mg/100ml) were 425.21 ± 16.00 , 30.67 ± 0.24 and 4.46 ± 1.11 respectively whereas contents of the these constituents in tea wine at the end of the six weeks of fermentation (in mg/100ml) were 307.06 ± 7.77 , 28.86 ± 0.74 and 3.89 ± 0.06 respectively. Final product contained appreciable quantities of tea constituent known for therapeutic properties. Further, Tea wine contained significantly higher amount of total catechins (30.67 mg/100 mL) as compared to commercially available red wines (2.7 – 9.6 mg/100mL). Therefore, this rich chemical composition will be advantageous in marketing tea wine. Further, to make this investigation complete, studies on change in other important constituents such as caffeine, theaflavins and thearubins during tea wine fermentation will be required.

Keywords: Amino Acid; Catechins; Fermentation; Polyphenols; Tea Wine

Developing a Non-dairy, Probiotic Three-in-One Instant Tea Premix

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Instant tea products are becoming popular due to on the go eating and drinking habits of people. Current instant tea market clearly lacks a non-dairy instant tea product to fulfil the requirements of vegetarians. Being health conscious and willingness to boost immunity, people tend to use probiotic products. Hence, present study was focused to develop a non-dairy, probiotic three-in-one instant tea premix using soy milk powder, *Bacillus coagulans* as probiotic, hot-water-soluble instant black tea powder, sugar, fructooligosaccharides as sweetener and non-dairy creamer. Five recipes were prepared by using above mentioned ingredients with three replicates. Samples were packed as 27 g each sachet. Sensory properties of these samples were evaluated using 5 points Hedonic scale by ten trained panelists. Anti-oxidant activity, polyphenol and caffeine contents and viable plate count of the selected samples were analyzed to determine its functional properties. Shelf life stability of the selected product was studied under accelerated conditions at 37 °C for 6 weeks. Sensory data were analyzed by Friedman test and means were compared at 95% significance level. Anti-oxidant activity, total polyphenol content and caffeine content of the selected product in mg per 100 g were 740.9±15.32 Ascorbic acid equivalent, 897.3±40.52 Gallic acid equivalent, and 605.97±3.23 respectively. Its total viable plate count remained at around 1×10⁹ throughout the study period enabling it to be claimed as a probiotic which supports immunity and digestive health. In conclusion, the developed product with its significant viable plate count, anti-oxidant activity, polyphenol and caffeine contents will be a refreshing dietary supplement for vegans.

Keywords: *Bacillus coagulans*; Instant tea; Polyphenol; Soy milk powder

Evaluation of Changes in Theaflavin, Thearubigins, Caffeine and Alcohol Content during Tea Wine Fermentation

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Tea made from tender shoots of tea plant (*Camellia sinensis*) is renowned for its refreshing and health promoting properties. A process for manufacturing wine using tea extract was developed by the Tea Research Institute of Sri Lanka. As a diversified product, tea wine will broaden market for tea. Parties interested to commercialize this product are eager to know the chemical changes undergo during tea wine fermentation. Therefore, the present study was undertaken to investigate the changes in theaflavin, thearubigins, caffeine and alcohol contents during tea wine fermentation. Tea Infusion of 2°Brix was obtained by brewing black tea (Broken Orange Pekoe grade) with boiling water and it was enriched with sugar to form a 22 °Brix must. This prepared must was fermented with *Saccharomyces cerevisiae* in glass canisters fixed with fermentation traps for a period of six weeks. Chemical composition of fermenting wine was determined in weekly interval. Theaflavins and thearubigins contents were determined by (Roberts and Smith, (1963) method whereas caffeine and alcohol contents were determined by ISO 14502, (2005) and hydro meter methods respectively. This experiment was conducted in triplicate. Initial theaflavin (16.06±3.5 µg), thearubigins (809.23 ±39.11 µg) and caffeine (93.58±0.54 mg) contents per 100 mL of 22°Brix must decreased to 15.56 ±0.60 µg, 547.23 ±12.92 µg and 86.33±1.20 mg per 100 mL respectively at the end of the fermentation period. Alcohol content of the final product was 11.78% (volume by volume). Theaflavins and thearubigins are black tea polyphenols which contribute to much of physicochemical, organoleptic and therapeutic properties of tea. Further, caffeine is known as a central nervous system stimulant. Therefore, tea wine with its appreciable quantities of theaflavins, thearubigins and caffeine will be a better alternative to other types wines

Keywords: Tea wine; Fermentation; Theaflavins; Thearubigins; Caffeine; Alcohol

Developing a Low - Calorie Green Tea Based Ready-to-Drink Beverage using Brahmi (*Bacopa monnieri*), Ashwagandha (*Withania somnifera*), Stevia (*Stevia rebaudiana*) & Ceylon Cinnamon (*Cinnamomum zeylanicum*)

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There is increasing demand for low-calorie functional beverages as consumers are becoming health conscious. Conventional ready-to-drink products consist higher sugar content causing health issues. Green tea (*Camellia sinensis*) is known for various health benefits. Brahmi (*Bacopa monnieri*) and Ashwagandha (*Withania somnifera*) possess anti-stress, energy and memory boosting like functional properties. Cinnamon (*Cinnamomum zeylanicum*) is having pungent flavor and antimicrobial activity. Stevia (*Stevia rebaudiana*) is a natural non-calorific sweetener. Therefore, this research was conducted to develop a green tea based sugar-free natural functional beverage using these herbal extracts. Green tea, Ashwagandha, Brahmi and Stevia infusions were obtained by brewing in hot water. Cinnamon water extract was obtained by Soxhlet extraction. Several recipes were prepared with different combinations of above extracts and sensory properties were evaluated using nine point Hedonic scale by thirty untrained panelists. Results were statistically evaluated by Friedman test. Physicochemical properties of the selected recipe were evaluated and its keeping qualities were evaluated for a period of one month against Sodium benzoate (0.1% w/v) as the positive control and sample without cinnamon as negative control. The selected recipe contained 0.2% of Green tea and Ashwagandha, 0.05% of Brahmi and Cinnamon and 0.14% of Stevia in the basis of soluble solid (g/100 ml). Changes in pH, titratable acidity and total soluble solids of cinnamon incorporated sample were very much similar to that of positive control. At the end of the storage period, its total plate count (6.6×10^2 CFU/ml) and yeast and mold count (5.2×10^1 CFU/ml) were less than the negative control (1.74×10^3 , 3.9×10^2 CFU/ml respectively) and higher than positive control (2.25×10^2 , 0 CFU/ml respectively). Total polyphenol content, DPPH scavenging activity (IC_{50}), pH, titratable acidity and total soluble solids content of the beverage were 59.68 ± 0.05 mg GAE/100ml, 126.23 ± 0.53 μ g/ml, 6.36 ± 0.01 , $0.488 \pm 0.21\%$, 0.7 ± 0.021 respectively. With appreciable physicochemical, organoleptic and keeping qualities, the developed green tea based Ready-to-Drink beverage will be a healthy alternative. Analysis of chemical compounds which contribute for the functional properties will be useful to confirm the health benefits of the product.

Keywords: Green tea; Cinnamon; Brahmi; Ashwagandha; Stevia

Development of Plant-based Protein Tea Premix Using Tea Cream, Pea (*Pisum sativum*) and Rice (*Oryza sativa*) Protein Isolates

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Tea is well known for its refreshing and health promoting properties. Tea cream is the precipitate formed as the tea cools. All the important tea constituents are concentrated in tea cream. It is produced as a byproduct during cold-water-soluble instant tea manufacture. Generally, vegetarian diets are not wholesome in terms of quantity and quality of protein supplied. Therefore, there is a potential to deliver high quality plant-based protein in a concentrated form via tea which is renowned as a healthy beverage. This study was carried out to develop a plant-based protein tea premix. Tea cream was prepared using the discarded fraction during tea manufacture which is known as ‘refuse tea’. Recipes of protein tea premix were prepared by incorporating different levels of Pea (*Pisum sativum*) protein isolate (38%, 45%, 49%, 53% and 60%) and Rice (*Oryza sativa*) protein isolate (60%, 53%, 49%, 45% and 38%) with a constant level of tea cream (2%). Sensory properties; colour, aroma, taste, mouth feel, appearance and overall acceptability of the samples were evaluated using 9 points Hedonic scale by 30 untrained panelists and the best recipe was selected for further analysis. Protein, moisture, ash, crude fat and crude fiber contents of the product were determined using official AOAC methods. Total phenolic content was determined as gallic acid equivalent (GAE) by Folin Ciocalteu colorimetric method. Total antioxidant capacity was determined by assessing the DPPH free radical scavenging activity. The selected protein tea premix contained $82.58 \pm 0.40\%$ protein $8.00 \pm 0.34\%$ moisture and $3.06 \pm 0.08\%$ ash whereas crude fiber and crude fat were not detected in the sample. Total polyphenol content of the product was 16.64 ± 0.57 mg GAE g⁻¹ and its inhibition concentration (IC₅₀) was found to be 137.10 ± 0.55 µg ml⁻¹. Therefore, the developed plant-based protein tea premix with its high protein content and appreciable levels of polyphenol and antioxidant activities would be a healthier and appealing protein source.

Keywords: Tea cream; Protein isolate; Pea; Rice; Proximate composition

Isolation of Colourants from Crude Green Tea Extracts as a Substitute for Commercially Available Synthetic Food Colourants

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A natural food colour is any dye, pigment or any other substance obtained from a natural source. The demand for natural food colours in the international market is increasing rapidly due to the increasing public awareness on the harmful effects of synthetic food colourants. Hence this study was aimed at isolating food colourants using green tea based refuse tea and dust grade as a value added product. Accordingly, colour extraction of refuse tea (8 % moisture, 5.58 % ash, 15.51 % crude fiber, 2.06 % fat and 19.68 % protein) and green tea dust (6.06 % moisture, 5.63 % ash, 14.55 % crude fiber, 2.07 % fat and 15.57 % protein) was initially done by sonication and simple water bath techniques. The most desirable samples were then selected based on the colour intensity values (b^*) and absorbance values. The selected samples were stabilized with 3 % carrageenan which converted the filtrate into a gel. The stability of the colourants was studied against pH, concentration and time-temperature combinations. The consumer preference for the products were studied using a structured sensory evaluation. According to the results yellowness (5 Y8/10 to 5 Y8/12) could be expected in 3 to 4 pH range in refuse tea based colourant and yellowness (5 Y8/6 to 5 Y8/10) could be expected in 3 to 6 pH range in the green tea dust based colourant. It was observed that with the increase of the temperature darkness of the colourant significantly rises, especially from 60 °C and above, which resulted in a hue approximated to caramel black. Both colourants showed yellow hues from 0.3 to 2 % v/v concentration level. Moreover both colourants are having considerable levels of polyphenol content, antioxidant activity and caffeine content, which contribute to human health promotion. Therefore, it can be inferred that developing colourants using crude green tea extract to be sustainable and safe alternative for synthetic colourants used in the food industry.

Keywords: Dust; Extraction ; Green tea; Natural food colour; Refuse tea

Probiotic Ice Cream Incorporated with Blue Pea Flower (*Clitoria ternatea*) and Dehydrated Banana Flour

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Ice cream is an ideal matrix for introducing probiotics in the human diet to offer health benefits to the consumer when administered in appropriate amounts. This study was carried out to develop a probiotic ice cream incorporated with Blue Pea Flower (*Clitoria ternatea*) powder as a natural colourant and dehydrated banana flour as potential prebiotic ingredient. Unripened *Ambun* banana at full maturity stage was sliced, oven dried at 60°C for 26 hours (until moisture content reach (10%) and ground to a fine powder. Banana flour was analysed for moisture content, total soluble sugars, protein, fat and ash contents and used to substitute milk powder in ice cream preparation. Blue Pea flowers (BPF) were oven dried at 40°C for 24 hours, ground to a fine powder and was analysed for moisture content, total anthocyanin content (pH differential method) and colour (colouri meter). Probiotic dairy ice cream were prepared using single strain *Bifidobacterium animalis* - Bb-12 with varying levels of banana flour (0%, 10%, 20%, 30% w/w) and constant level of (0.67% w/v) BPF powder. Colour, pH and viability of Bifidobacteria during frozen storage of ice cream were determined at 7 day intervals. Sensory quality was evaluated under seven-point hedonic scale using 30 untrained panelists. Total anthocyanin content of BPF powder was 1168.92 mg L⁻¹. Moisture, fat, proteins, fiber, total soluble carbohydrates and ash contents in banana flour were, 10.98%, 0.48%, 1.50%, 26.59%, 25.65% and 2.58%, respectively. No significant differences in probiotic counts were observed among banana flour incorporated ice creams and the control. Bifidobacteria counts were not significantly reduced during 7th, 14th, 21st days of frozen storage. However, the viability of probiotics during the storage were higher than the recommended minimum level (10⁹ CFU mL⁻¹). Ice cream with 20% of banana flour was selected as the most acceptable treatment with significantly higher (p<0.05) preference for sensory attributes. Banana flour can be successfully utilized to replace milk powder in probiotic ice cream. Probiotic ice cream with live Bifidobacteria and natural blue colour would be an innovative product to the market.

Keywords: Probiotic; Ice cream; Blue pea flower; Banana flour

Development of a Herbal Tea Bag from Sweet Potato Leaves (*Ipomoea batatas* (L.) Lam) and Evaluation of its Physicochemical and Sensory Parameters

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Sweet potato (*Ipomoea batatas* (L.) Lam) is an economically important nutritious root crop that was considered the 7th most important food crop in the world. Though sweet potato plants are typically grown for their sweet tubers, leaves also a rich source of nutrients. However due to lack of awareness of its nutritional composition and health benefits, still sweet potato leaves remain underutilized. Therefore, this study was conducted to develop a herbal tea from sweet potato leaves and to evaluate its quality parameters. Two varieties of sweet potato leaves (Red variety ‘Ama’ and yellow variety ‘CARI 426’) were selected and proximate composition, antioxidant activity and total polyphenolic content were analyzed by AOAC 2000, 2,2- diphenyl-1-picrylhydrazyl radical scavenging assay and Folin-Ciocalteu methods respectively. Moisture, total fat, crude fiber, ash, protein and carbohydrate content of fresh leaves of ‘Ama’ variety was 86.78±0.72%, 11.73±0.12%, 19.35±0.59%, 19.44±0.73%, 22.5±1.36%, 26.98% respectively while for CARI 426 values were 85.79±0.24%, 9.94±0.23%, 13.56±0.58%, 17.9±0.64%, 14.72±0.39%, 43.88% respectively. For fresh leaves, antioxidant values were obtained as 59.33±1.24%, 41.05±2.18% for Ama and CARI 426 respectively at 500µg/mL while total polyphenolic content was obtained as 5.56g/100g and 3.17g/100g at dry weight respectively. The results obtained for antioxidant values, for freeze dried Ama and CARI 426 leaves were 69.66±1.24% and 41.66±2.05% respectively at 500 µg/mL while total phenolic content was 6.94g/100g and 4.55g/100g at dry weight. Ama variety was chosen to prepare the herbal tea considering its highest antioxidant and total phenolic content. Four different herbal teas were prepared by adding strawberry, vanilla, orange flavor and control was used without adding any flavor. Sensory analysis was carried out with 30 untrained panelists using a 9-point hedonic scale to determine the best herbal tea product. Among those flavors, orange flavored herbal tea shows the best sensory acceptability. It can be concluded that sweet potato leaves can be used to develop a value-added herbal drink. However further studies should be needed to evaluate its functional properties.

Keywords: Sweet potato leaves; Freeze drying; Antioxidant activity, Sensory properties

Quality Evaluation of *Caryota urens* (Kitul) Palm Treacle

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Though *Kitul* based production is an important venture in Sri Lankan society, it is crucial to get quality products with inherit health benefits. The study was aimed to evaluate the physicochemical and spectroscopic characteristics of *Kitul* treacle obtained from six suppliers in Badulla district. Measurements were taken from six original samples (1-6) and a 7th sample which was processed by mixing original samples. A Friedman sensory test was performed for 1-6 samples and Sample 1 was identified as the highest ranked sample. When considering the physicochemical parameters, all treacle samples were acidic with pH values ranging from 5.38 to 6.52. The analytically obtained total acidity values of the samples were ranging between 13.66 mEq/kg and 33.66 mEq/kg. The highest brix value (74.93 °Brix) was obtained for the sample 7, which is the composite product of 1-6 samples. Potential alcohol as volume percentages were ranged between 50.66 %V/V to 56.90 %V/V (Potential alcohol %V/V = g/L of Sugar / 16.83). Water activities were ranging between 0.76 and 0.82 and moisture percentages of the samples were ranging from 14.36% to 21.86%. The Chroma meter values were within the yellowness range (+b). The values were significant for these parameters except for the brix value where regression p value was 0.245. Fourier Transform Spectrophotometer (FTIR) data were obtained within a 500-4000 cm⁻¹ range. Spectrum of sample 6 was significantly differed from the spectra of other samples. The greatest intensity of the bands was at a level of 3265 cm⁻¹. In conclusion, physicochemical and spectroscopic characteristics of selected samples were changed depending on the supplier. Thus, physicochemical and spectral measurements were effective in differentiating and evaluating the quality of the *Kitul* treacle samples

Keywords: *Caryota urens*; *Kitul*; FTIR Spectroscopy; Physicochemical characteristics; Quality evaluation

A Case Study in Analysing Chemical and Microbial Properties of Orthodox Black Tea Manufactured in Uva High Region

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Sri Lankan teas are accepted as the finest tea produced in the world. Quality of tea is determined by its physical, chemical and microbiological properties. But very few research studies shown the variation of quality parameters during black tea manufacturing against the manufacturing method and selling catalogues. Therefore, this case study was conducted to investigate the variation of selected quality parameters of Orthodox black tea from Uva high region during its manufacturing process. In Chemical analysis, Total polyphenol content (TPC) (ISO 14502-1;2005) and radical scavenging activity of 2,2-diphenyl-1-picrylhydrazyl (DPPH) (AOAC International standards) were determined with some modifications to the standard analytical methods. Samples were taken (n=3) from six stages of manufacturing process. The IC₅₀ values of DPPH radical scavenging activity changed from 7.96±0.08 ppm (withering) to 69.79±3.73 ppm (winnowing), indicating that withering stage has highest antioxidant content. The TPC ranged from 1.46 ±0.03 to 6.08 ±0.11 mg GAE g⁻¹ dry leaves but no linear relationship exists between TPC and antioxidant activity (p>0.05) (R² = 0.4803). In microbial analysis, Total plate and Yeast and mold counts were determined (Sri Lanka Tea Board - SLS 516: part 1 and SLS 516:2;1991) and highest microbial counts were identified in winnowing stage as 6.22x10⁶ CFU g⁻¹ (Total plate count) and 2.82 x10⁶ CFU g⁻¹ (yeast and mold count) respectively. However, the tea collected from packing, had not exceeded the acceptable levels of minimum requirement for exportation (ISO 3720:2011). Research findings exhibit that the tea manufactured in respective factory, is satisfied the minimum requirements for exportation but hand hygiene practices, and cleanliness of contacting surfaces may be the cause of highest microbial counts of tea samples in winnowing. This study recommends further studying of microbial parameters to investigate the contaminations of tea in tea factories.

Keywords: Orthodox black tea; Uva high region; Selling Catalogue; Antioxidant activity

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Factors Influencing Organic Tea Purchasing in Boutique Hotels (Special Reference to Central Province Sri Lanka)

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In the recent past, consumer demand for organic food products has increased rapidly due to the various health benefits it offers. The hospitality industry is one of the key economic contributors in Sri Lanka and in -comparison to the other hotels, boutique hotels are classified as luxury hotel categories serving upscale, niche market segments. The main aim of this study is to determine the key factors influencing organic tea purchasing in Boutique-hotels. The study also takes efforts to explore the difficulties faced by the hoteliers in the organic tea purchasing process and the hotel Managers' perception towards organic product purchasing. The qualitative research method applied for the study to in-depth examines the scenario. Further, purposive sampling and structured interview techniques were employed in data collection and the thematic analysis method was used for data analysis. Primary data were gathered from 12 boutique hotels listed in Sri Lanka Tourism Development Authority. The central province of Sri Lanka was chosen as the study location. Accordingly, the findings of the study revealed that upscale tourists prefer to consume more health-conscious products while considering the long-term health benefits. And it was also highlighted that boutique hotel guests' consumer patterns are quite different from traditional hotel guests where they usually tend to spend more on the quality and the value aspects of a certain product regardless of the price. Additionally, Product and Process related issues including climatic changes, poor packaging, lack of education and awareness, and inadequate government support, etc factors were highlighted as some of the key challenges faced by the hotel management in the organic tea purchasing process. Some practical implications are proposed for organic tea suppliers, tea purchasing hoteliers, the government, and the other stakeholder groups to ensure a conducive environment for organic tea consumers and suppliers.

Keywords: Organic tea; Purchase intention; Boutique hotels; Hospitality industry

Impact of Workplace Bullying on Employee Job Performance in Hotel Industry; Special Reference to Four-star and Five-star Hotels in Southern Province

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In today's competitive business environment, human resources are one of the most critical assets particularly for service-based organizations. One of the most important factors which may affect employees' job performance is workplace bullying from employers and colleagues at large. It is considered as a negative and unethical issue which may degrade, humiliate, and create a risk to a healthy working environment. Bullying at the workplace is a very serious issue and can be found in every other organization. This study mainly focused on identifying the impact of workplace bullying on employee job performance in the hotel industry in Southern Province, Sri Lanka, further it investigates the dimensional (i.e. work-related bullying, person-related bullying) impact on job performance. The study adopted a questionnaire survey for a sample of- 132 respondents selected through convenience sampling from four-star and five-star hotels. In order to achieve research purpose, three hypotheses were tested. The results of the correlation and regression tests found workplace bullying negatively impacts on employee job performance. Hence the employees who experience bullying at work should be given adequate support in order to reduce the negative consequences of bullying on employee well-being and job performance. Moreover, the findings of the study provide numerous implications for human resources practitioners to increase employee performance and maintain a bullying free environment in the Hotel industry. Further, it hopes that outcomes of the study will contribute to the current knowledge of workplace bullying and job performance. According to the study findings, workplace bullying negatively impacts employee job performance in the hotel industry in Southern province, Sri Lanka and person-related bullying is the most influential factor for job performance in that industry.

Keywords: Workplace bullying; Work related bullying; Person related bullying; Job performance; Human resources; Hotel industry

Impact of the Working Environment on the Job performance of Operational Level Employees in Hotel Industry

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Job performance is a significant element in the hotel industry. The organization must be able to provide a safe & comfortable working environment, attract & retain & enhance the performance of existing employees. Therefore, this study aims to identify the impact of working environment factors on job performance. The foremost objective of this study was to identify the relationship between physical environment factors & psychological environment factors with motivation. Furniture, sound, spatial arrangement, temperature & color were identified as physical environment factors while supervisor support & quality of leadership were indicated as psychological environment factors. The study was based on the quantitative research approach & operational level employees in three, four & five-star graded hotels in Western Province, Sri Lanka were investigated using a sample of 200 employees. The convenience sampling method was used to select the representative sample. A self-administered close-ended questionnaire was used to collect primary data from the field. The data were processed and analysed using descriptive analysis & multiple linear regression analysis in SPSS and structural equation modelling in Smart PLS. The findings of the study provided evidence on the impact of the working environment on employees' job performance. Findings revealed that furniture, spatial arrangement, temperature, lighting & color as the physical environment factors have a positive effect on employee performance while sound factors hurt employees' job performance. Furthermore, supervisor support impacts employees' job performance more than the quality of leadership as psychological environment factors. The finding indicates that motivation as a mediator significantly impacts 40.6% of physical environment factors on the employees' job performance while 50% of psychological environment factors impact the job performance of the employees. It indicates that motivation has a more significant impact on the psychological working environment than the physical working environment through the employees' job performances. Based on the findings, the study recommends that hotel management & government or any other authorized parties should design the workplace in a comfortable & attractive way to support employees' satisfaction and well-being while enhancing job performances.

Keywords: Job performance; Mediator; Motivation; Physical environment factors; Psychological environment factors

Impact of Engagement in Leisure and Recreational Activities on the Undergraduates' Performance; Evidence from Tourism Undergraduates in State Universities, Sri Lanka

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Leisure & recreation is important to reduce stress and enhance the performance of anyone. Leisure is an important tool that is chosen by youngsters who are willing to deal with risk and adventure and their choice is supported by the youngsters who doubt engaging in risk and adventure. Undergraduates are a significant category within the youth and the education system. Learning and assessments, strikes, and financial burdens make them stressed. Hence, there should be some alternatives to overcome such stress, otherwise that will adversely affect their academic performance. Hence this research aims to examine the impact of leisure & recreational activities on the undergraduates' performance with the mediating impact of the stress of the undergraduates of tourism degree programs in state universities. The study was carried out quantitatively to get the outcome. Purposive sampling technique and simple random sampling technique was used to select the population and sample accordingly. A total of 200 respondents were given an online structured questionnaire representing undergraduates from tourism degree programs in state universities, Sri Lanka. The outcome obtained from the analysis illustrated leisure and recreational activities including home environment activities, sports, outdoor recreations and leisure tourism activities were individually impact positively on undergraduates performance with the significant P value ($P < 0.05$) while cultural activities and having high social content activities were jointly impact positively ($P > 0.05$) on undergraduate performance. Stress significantly mediated the relationship between leisure & recreational activities and undergraduates' performance. Their engagement in leisure and recreational activities help to reduce stress and enhance their performance. Accordingly, it can be concluded there is a positive relationship between the engagement in leisure and recreational activities and undergraduates' performance. This study shows that there should be an enhancement of engaging leisure and recreational activities as sports, especially the indoor sports activities, because most of the undergraduates are interested in engaging indoor sports when they are free. Furthermore, this study suggests that facilitating undergraduates to engage in leisure and recreational activities within university premises is necessary to reduce their stress.

Keywords: Leisure; recreation; undergraduates' performance; stress

Exploring the Demand for Organic Food Consumption in Casual Dining Restaurants in Western Province; from the Restaurant Managers’ Perspective

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Food tourism is a rapidly growing segment in the hospitality and tourism industry with great potential. Further, its exponential growth has resulted in exploring the niche market for organic foods in the restaurant industry. At present, it has become a trend to consume organically grown foods at ‘dine-in’ in restaurants. But, contradictory ideas exist in the literature regarding organic and conventional food consumptions. Based on the identified research gap, the objectives of the study were aimed to identify the demand for organic food consumption in restaurants from the restaurant managers’ perspective in Sri Lanka, to examine the promotional strategies used for organic foods in restaurants, and to identify the limitations of promoting organic foods. Primary data were collected from 18 restaurant managers in casual dining restaurants in the Western Province of Sri Lanka, which are registered at Sri Lanka Tourism Development Authority and also operated in the Western Province of Sri Lanka. The purposive sampling technique was used to formulate the sample and semi-structured interviews were used to collect data. Under the qualitative research approach, collected data were transcribed and analyzed by using the content analysis method. The findings of the study revealed that there is a growing demand for organic food consumption by customers and they are highly attentive to consume organic products when they ‘dine-in’ in restaurants. Further, the study explored that the demographics and the perceptions of the consumers to consume healthy have impacted to consume organically. Therefore, restaurant managers are also willing to promote organic foods in their daily food operations in restaurants. But, it was revealed that organic promotional strategies are complicated to be performed specifically due to the limited access in restaurants to expand the organic theme in their daily food operations. Therefore, the recommendations of the study have exposed the potential to expand organic food production in the restaurant industry under the government's concerns and restaurant managers are also recommended to be engaged in delivering healthy consumption patterns by enhancing organic dining-in within the industry. The study will further provide the significance of developing a sustainable environment in the Sri Lankan restaurant industry.

Keywords: Dining-in Organically; Organic Food Consumption; Qualitative Content Analysis; Restaurant Managers

A Comparative Study on Usage of Marketing Strategies by Themed Hotels and Traditional Hotels in Southern Province of Sri Lanka: from the Managerial Perspective

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During the past decades, Sri Lanka has reported a dramatic increment on their hotel establishments. As a result, huge competition exists among hotels in marketing themselves. Hence, hotel management needs to be more customer-oriented and competitive by adopting marketing mix strategies in order to reach its target customers. Therefore, this paper aims to comparatively analyze the usage of different marketing strategies used by themed hotels and traditional hotels in Southern Province of Sri Lanka. In compliance with this trend, this paper investigated theme hotels and traditional hotels in marketing strategies development. Furthermore, it figures out the difference between themed hotels and traditional hotels, with regards to marketing mix strategies. The sample to the study being managerial employees in 7 theme hotels and 6 traditional hotels, data was collected through semi-structured interviews. In the empirical data, the researcher collected data from interviews with hotel managers through the combination theories of seven P's of marketing mix strategies, and resource-based view. Data was analysed through content analysis. According to the results, it has been highlighted that the theme hotels prioritize internal design, premium price, experiential environment, narrow advertising tools, exclusive greeting patterns in developing marketing strategies, meanwhile traditional hotels focus on standard facilities and amenities, seasonal pricing, broad advertising tools, personalized service, comfortable environment. But, both types of hotels depend on products and physical evidence in marketing their properties. Specifically, the study suggests spreading the marketing campaigns of themed hotels via digital platforms and developing experiential strategies in marketing plans by traditional hotels.

Keywords: Marketing Strategies; Resource based view; Marketing mix strategies; Accommodation industry; Competitive market

A Study on Employee Readiness on Inventory Control Practices in Hotel Industry in Sri Lanka; with Reference to Five Star Hotels in Southern Coastal Belt

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The hospitality industry plays a vital role in economic development in any country. Accordingly, to maximize the return hoteliers execute cost controlling strategies that specifically covers the inventory cost. Notably, inventory cost also reflects the significant amount of the total cost of hotel operation. But, paying less attention to inventory control practices by hotels and lack of actual employee readiness in inventory control are major concerns which should be considered by hoteliers. Because, a substantial space is available for theft, pilferages, shortages, wastages, inappropriate accounting, inadequate record-keeping, and other losses. Hence, the present study attempts to identify the inventory control practices in hotels in the southern coastal belt followed by another two objectives; to identify employee readiness for inventory control practices and identify the consequences of employee readiness on inventory control practices towards hotels. Primary data collected from 10 department heads of five-star hotels in the research area and structured interviews were used with the purposive sampling techniques. Data were transcribed and analyzed by using content analysis which is one of the qualitative data analysis techniques. The findings revealed the existing unique inventory controlling practices in each department and issues among those departments related to inventory control. And Also, the study shows that there is a 100 percent influence of employee readiness on inventory control practices in hotels like effective and efficient controlling procedure, time saves, income earning, minimize wastages and accuracy of the procedures. Further, this study recommends addressing the issues affecting the readiness of employees involved in inventory control and achieving an effective control process. This study provides an overview of the importance of increasing employee readiness for inventory control in the hotel industry in Sri Lanka.

Keywords: Inventory control practices; Employee Readiness; Hotel industry; Southern Coastal Belt

Residents' Perception on Post War Tourism Development Activities in Northern Sri Lanka

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The strategic contribution of the tourism sector towards the recovery and development of post war destinations is relatively very high. Northern Sri Lanka was severely affected by thirty years of ethnic war and has immensely invested its resources for diverse tourism components moving forward as a most sought travel destination while reaping many benefits. However, this transition has put the community under much pressure and their day-to-day life was significantly affected. Conforming the capacity of tourism development to change resident's traditions and way of living. As the northern community was notably going through very sensitive vibrations over years, the impact of fast growing tourism waves on their human life should be carefully managed in order to avoid long term social issues in the area. This study extended to identify the potentials and tourism development in Jaffna. A sample of fourteen local residents was drawn using purposive sampling. Primary data were collected by using structured interviews. Based on the information given, the researcher has developed the research. The researcher has used the thematic analysis method to analyze the data using Microsoft Excel 2010 software. Finally based on the findings of the study, the researcher draw five main conclusions: (1)Peace is play vital role on the development of the Jaffna's tourism industry after the civil war.(2)Culture of the Jaffna, poor tourism planning, lack of the community engagement are seen as a major challenges to the development of the tourism in Jaffna. (3) Jaffna residents have stronger cultural perception and they strongly demanded cultural protection. (4)Tourism related infrastructure development in Jaffna is very low when compared with other districts. (5)Land of Jaffna is more polluted by the local tourists than the foreign tourists through the tourism activities. Based on the findings of the research some recommendations have been made that could help to formulate appropriate policy and strategy.

Keywords: Postwar destination; potentials; Resident's perception; Tourism development; Impact of tourism

Impact of Internal Marketing on Employee Performance of Star Class Hotels in Colombo District: Mediating Role of Employee Commitment

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In the organizations' perspective, employees are considered as internal customers of the organization. Hence, top managers need to pay more concentration regarding employee satisfaction, employee performance levels, and employee commitment since these are the crucial factors of a successful organization. Internal Marketing strategy is a motivational strategy used by the organizations to increase employee commitment and performance. This study discussed the impact of Internal Marketing and Employee Commitment on Employee Performance in star class hotels by proposing a single-mediator Structural Equation Model (SEM) which has still not been adequately researched in the Sri Lankan context. The researcher has distributed 150 self-administrated online survey questionnaires to operational level employees in star class hotels in the Colombo district. The findings were completely in line with the established objectives and hypothesis. Accordingly, Training, Supportive and Participative Leadership, Internal Communication and Reward Systems can be identified as crucial internal marketing dimensions that lead to a direct positive impact on Employee Commitment. Furthermore, Internal Marketing has positively affected Employee Performance. At the same time, Employee Commitment partially mediated the relationship between Internal marketing and Employee Performance. Accordingly, this study recommends the managers to maintain close relationships with the employees and let them feel that employees are one of the valuable resources of the organization. These findings form the basis for theories in internal marketing and employee commitment, as well as present managerial implications to enhance the employee' performance.

Keywords: Employee commitment; Employee performance; Internal marketing; Star class hotels.

A Study on the Future Prospects of Tourist Hostel Operations under Covid – 19: Hostel Operators’ Perspective in Western Province of Sri Lanka

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“Tourist hostel” being a novel concept of accommodation category shows an exponential growth potential in the emerging backpacker market. Backpackers are budget-oriented, shared rooms, and a non-threatening communal space for travellers who value social interaction (SI) during their stay. Due to the COVID 19 epidemic, the largest global health pandemic in the century, Tourist Hostel Operators in Sri Lanka currently deal with substantial controls on hostel operations mainly imposed on maintenance of social distance and travel restrictions and unable to allow social interaction which is vital for backpacking and hostel culture. Hence, this study focuses to identify the nature of the tourists staying at tourist hostels; to explore the nature of tourist hostel operations before Covid-19 pandemic, and to identify specific challenges faced by tourist hostel operators under the new normal condition of Covid-19; from operators’ perspective. Primary data were collected through semi-structured interviews from 15 selected tourist hostel operators in the Western province of Sri Lanka which has been listed on Hostelworld website. Purposive sampling was used to formulate the sample under qualitative research approach, collected data were transcribed and analyzed by using the content analysis method. As results illustrated, backpacker travelers were the main customer base mainly from Europe. Budget, SI and travel independence were identified as the major motives to accommodate in tourist hostels. Before the pandemic, operators had more focused on enhancing SI with physical and service attributes. However, SI has been challenged specifically and financial instability, lack of local demand, government regulations as well due to health concerns during the new normal condition. Even so, operators willingly encourage SI further without focusing alternative concepts; moving towards non-tourism activities, focusing alternative tourism concepts such as volunteer tourism, community based tourism etc. due to reduction on conventional mass tourism. Further, recommending a mechanism to adopt by highlighting sustainable approach for hostel operations while adhering to mandatory health and safety protocols imposed by the National Health Authorities.

Keywords: Backpackers; Covid-19 outbreak; Hostel Operators; Social interaction; Tourist hostel

The Impact of HRM Practices on Career Succession Plans (With Special Reference to Sri Lankan Hotel Industry)

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Tourism is one of the largest and rapidly developing industries in the world. In Sri Lankan context, the hospitality and tourism industry plays a significant role in the economy and labor market. As far as the hotel sector is concerned, it is one of the highly people oriented businesses that largely depends on the quality of the services provided. Thus, employee development has been recognized as one of the most vital aspects in the hospitality industry. Accordingly, this study aims to examine the impact of HRM practices on career succession planning in the hotel industry. In particular, the study limited its focus to the operational level employees occupied in 4-star and 5-star hotels in Colombo district. Further, the study adopted a mix-methods approach to in-depth analyze the scenario. For the quantitative analysis study collected primary data from 100 operational level employees while employing convenience sampling and structured questionnaire methods. Qualitative data were collected from 40 respondents and a semi-structured interview method was applied in data collection. Finally, quantitative data were analyzed while using descriptive analysis; Pearson coefficient correlation, regression analysis and the qualitative data were analyzed with the thematic analysis method. Accordingly, the findings of the study reveal that there is a strong positive relationship between HRM practices and Career succession planning. Further, it was evident that training and development, job rotation and empowerment and compensation schemes have a positive impact on career succession planning. The findings depict that unique HRM practices are one of the key success factors in employee development, retention and long term sustainability. Study recommendations will be useful for the hotel industry specifically, HR managers and government policy makers and the business organizations to recognize and facilitate for employee development and to achieve business success.

Keywords: Career Succession Planning; Hospitality Industry; Human Resources Management Practices; Operational level Employees

Strategic Human Resource Management and Managing Gender Diversity in Hotel Industry: Southern Province – Sri Lanka

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The growth of the hospitality and tourism sector has been rapidly growing in recent years and therefore, an increase in tourism business has become increasingly popular with it. The tourism industry is estimated to be worth over 183.98 USD million annually. Employment generated in the tourism sector (both direct and indirect) increased to 359,215 in 2017. Yet currently women account for less than 10% of those employed by the tourism sector. Further, with its exponential growth, the business owners pay much concern on Human Resource Management practices and managing gender diversity. Consequently, the need to manage their human resources effectively and efficiently in order to achieve economic significance is recognized. Hence, this study set out to examine how gender diversity affects in managing employees, to see whether strategic human resource management practices can provide a solution to manage the gender diversity problems, to identify the current Human Resource strategies can be effectively use in hotel industry and to investigate gender diversity problems demarcated in the hotel sector. Qualitative data analytical method was employed and the collected data were transcribed and analyzed by using Thematic Analysis. Primary data is captured at selected above 3-star hotels with twelve employees at HR management level and 10 employees randomly selected from each hotel located in Down-South area. The findings of the study revealed that the majority of the hotels (90%) are practicing Strategic Human Resource Management and identified limited evidence of managing gender diversity based on Strategic Human Resource Management practices. Further, the recommendations of this study support the view that the importance of implementing Strategic Human Resource Management practices and how they improve the managing gender diversity problems of the organization.

Keywords: Hospitality industry; Strategy; Strategic Human Resource Management (SHRM) practices; Gender diversity

Identifying the Potentials to Promote Ayurvedic Tourism during the Covid 19 Pandemic (Special Reference to Western Province)

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Ayurvedic tourism is one of the niche markets identified as a potential segment to promote in Sri Lanka and in recent times, there was a shift in attention towards Ayurveda due to the COVID 19 pandemic. However, the outbreak of COVID 19 pandemic has severely affected the progress of the tourism industry. Even though the number of tourists arriving Sri Lanka in 2019 has decreased, there has been a significant increase in the number of tourists arriving Sri Lanka for the purpose of Ayurveda treatment. In such a context, the aim of this study is to identify the potentials to promote Ayurvedic tourism during the COVID 19 pandemic. This study enabled us to make proper use of the resources of the country and to identify Ayurvedic business opportunities. The study mainly depends on the primary data that has been collected from the stakeholders. Primary data collected from 14 respondents in selected Ayurveda hotels who have registered in Sri Lanka Tourism Development Authority, Ayurveda centers, Ayurveda practitioners in the western province and Sri Lanka Tourism Development Authority. The samples were selected using purposive sampling technique and structured interview techniques were used to analyze the collected data using content analysis. The results of the study showed that Sri Lanka has all the key elements: attraction, available packages, accessibility, amenities, activities and ancillary services to develop the Ayurvedic tourism industry. Further, Ayurvedic medicine, issues related to Ayurvedic doctors, government support, fraud committed by those involved in the Ayurvedic industry and promotions identified as barriers and challenges to promote Ayurvedic tourism. This study concludes with some recommendations for Ayurvedic tourism such as promotion in different countries, improving the knowledge of the staff, introducing new Ayurvedic related products with the COVID 19 pandemic, increasing government support etc.

Keywords: Ayurvedic Tourism; COVID 19 Pandemic; Tourism Industry; Stakeholders

Economic Resilience of the Hotel Industry in Sri Lanka: A Capital Based Approach to Crises and Disasters (With Special Reference to 3, 4 & 5 Star Graded Hotels in Southern Coast)

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Ensuring economic resilience assists to minimize the negative impact of crises and disasters on the hospitality industry in Sri Lanka. The study applied a Disaster Resilience Framework for Hotels (DRFH), a capital-based approach to explore economic resilience to crises and disasters within the hospitality industry with special reference to 3,4 & 5 star graded hotels located in the Southern coast of Sri Lanka. The purpose of this study is to observe the existence of such an evaluation system and also to examine the impact of economic capital on economic resilience of the hotel industry. Study adapted both quantitative and qualitative analysis methods (Mixed method). Twelve 3-5 star class hotels located in the South Coast were selected for the study and 12 financial managers and 120 employees who worked in hotels were selected using Purposive Sampling Technique to collect the required data. The semi structured questionnaire uses 15 identified indicators categorized under 4 predictors and 4 indicators to measure the economic capital and economic resilience respectively. Predictors of the economic capital were obtained to identify economic resilience to crises and disasters that should be presented within the hotel industry. SPSS statistical software version 24 was used to analyze the data and analytical tools such as Descriptive analysis and Pearson's coefficient correlation were used to assess the association between the variables. According to the study, the most affected predictors of economic resilience were the availability of resources, diversification of income and financial strengths of the hotels. Content Analysis was applied to identify the barriers of economic resilience observed and that lack of disaster preparedness, insurance policy issues and lack of government support were the major economic resilience barriers. The overall result confirms that economic capital has a positive impact on the economic resilience of the hotels during the disasters and crises. Furthermore, this concept can be applied for hotels to measure and build economic resistance in times of crisis and disaster.

Keywords: Economic Resilience; Economic Capital; Disaster Resilience Framework for Hotels (DRFH)

Determinants of Entrepreneurial Intention of the Undergraduates in Hospitality and Tourism Management Degree Programs in State Universities in Sri Lanka

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Entrepreneurs play an important role in the growth and development of a country's economy. As a fast-growing segment in the globe, tourism is considered a good-looking field to carve nascent entrepreneurs. Many researchers have examined the variables that inspired the individual performance to become an entrepreneur, specifically, with an attentive look at the entrepreneurial intention of university undergraduates. Consequently, this study was extended to examine the entrepreneurial intention of hospitality and tourism management undergraduates in state universities in Sri Lanka who are stepping to immense global opportunities. This study was carried out in a quantitative approach. A sample of 205 undergraduates was selected using the snowball sampling method and an online questionnaire was distributed among third-year and fourth-year undergraduates in Uva Wellassa University, Rajarata University, Sabaragamuwa University, and Kelaniya University in Sri Lanka. Descriptive analysis, correlation, and multiple regression were performed to analyze the data with the use of the SPSS analytical tool. Furthermore, personality, economic, social, psychological, political, and technological factors were considered as the determinants of entrepreneurial intention in the conceptual model. The study weighted more on female responses than males' presence which analyzed a novel trend of interest of the females towards entrepreneurial intention than males in the sample predicting more interest in it. And the analysis exposed that, there is an almost affable state with entrepreneurial intention, personality, social, psychological, political, and technological factors, while there is reasonable cordiality of undergraduates with economic factors. This result exposes higher attention towards personality and social factors, emphasizing the opportunities in the local arena for innovation, family business involvement, and most importantly, educational reinforcement on entrepreneurial intention. It is a prominent factor that financial benefits, job safety, and government positive intervention in the arena show a moderate concern among the respondents. The overview result of positive associations between independent and dependent variables, personal factors exert the strongest association between entrepreneurial intentions. And also investigates motives and barriers for engaging entrepreneurs and examines the relationship between entrepreneurial intentions. And easily examine their goals and career aspirations in undergraduates.

Keywords: Entrepreneurship; Entrepreneur; Entrepreneurial intention; Hospitality and tourism undergraduates

Passenger Service Agent's Perception on Health and Safety Practices at CMB Airport during Covid 19 Pandemic

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The global aviation industry is one of the most sensitive industries in the globe. The serious spread of the Covid 19 pandemic across the globe introduced a new social distancing culture to the entire world. Since airport service staff are highly exposed to this virus with the travelling crowds this study aims to examine the effectiveness of newly introduced health and safety practices for the passenger service agents at the Bandaranaike International Airport in Colombo, Sri Lanka (CMB). To in-depth understand the scenario study employed a qualitative approach while conducting structured interviews. Study gathered data from (X) respondents and analyzed them with thematic analysis. Accordingly, study findings revealed that pre Covid health and safety practices and novel practices positively contributed in maintaining an appropriate worker perception to conduct their job roles at the airport. In particular, the study findings will be useful for the front-line staff working in the tourism and hospitality industry to take necessary actions to prevent the rapidly spreading Coronavirus. Further, findings will disclose important health and safety related information to the HR managers, health authorities and other business stakeholder groups to better understand the critical situation. Further, findings will also provide valuable insights on the significance of establishing prompt monitoring mechanisms and implementing effective and preventive measures to control the spread of Covid-19 global pandemic

Keywords: COVID-19, Airport service agents, Employee perception; Health and safety practices

A Study on the Impact of Employee Engagement Techniques to Ensure Employee Obedience on Hotel Policies and Procedures (With Special Reference to Boutique Hotels in Kandy District)

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The concept of employee engagement has become a significant concern in the corporate world as a highly engaged workforce helps to increase innovation, productivity, and overall performance. For employees to be engaged in their job tasks and enhance their performance, they should know what an organization expects from them. Rules, regulations, guidelines, or standards are the directive bodies that guide employees to meet organizational goals and objectives. The employee obedience concept explains employee's loyalty towards the organization. The hotel industry, as a service sector, requires a high degree of interaction of employees and it is essential in obeying hotel policies and procedures to enhance the customer experience. This study seeks to identify the impact of employee engagement techniques and their importance to ensure employee obedience to hotel policies. A quantitative study was conducted involving 110 employees who work in boutique hotels in Kandy District, Sri Lanka applying a convenient sampling technique. A structured questionnaire was used for collecting data, which was analyzed through descriptive statistics and multiple linear regression analytical methods. As results revealed, employee engagement techniques illustrated a mixed type of impact on employee obedience on hotel policies and procedures. Further, reward and recognition, training and career development, and compensation show combined impact while employee relationship management and work environment display the individual impact on employee obedience on hotel policies and procedures. Compensation shows a negative impact on employee obedience to hotel policies and procedures. Further, results highlight the unavailability of properly established or universal employee engagement methods techniques. The study recommends that employee engagement strategies should be based on organizational culture, objectives, and goals, and the capacity of the organization to ensure employee obedience on hotel policies and procedures. This study suggests regulating and maintaining employee engagement techniques under the supervision of management. Besides, an organization needs to be concerned about the work environment and managing employee relations rather than typical employee engagement practices to ensure employee obedience to hotel policies and procedures. However, this study suggests identifying the relationship between employee engagement, organizational performance, and commitment in the service sector in future research, as it is important to validate the findings of this study.

Keywords: Employee engagement; Employee engagement techniques; Employee obedience; Hotel Policies and Procedures

Impact of Capital Structure on Profitability “An Empirical Analysis of Listed Hotel Sector Companies in Sri Lanka”

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The primary purpose of conducting this research is to measure the impact of the capital structure on profitability. At present capital structure is crucial to the firm's value, and it is a very important factor in determining the firm's financial performance. Accordingly, in this study, the capital structure plays the most significant role in the firm's financial decision making process. This decision-making process may have a wide range of policy issues and may cause fluctuation in the organization's profitability. Previous research stated that capital structure is highly influenced by the financial performance of the organization. Therefore, this study focuses on examining the impact of capital structure on profitability. This research is basically based on 27 listed hotel companies in the Colombo Stock Exchange. This study used secondary data which were collected from annual reports of the 27 listed hotel companies over the period of 2011-2020. Descriptive statistics, correlation analysis and regression analysis were conducted using Eviews software in order to accomplish the objectives. Total debt to total assets (DTA), total debt to total equity (DTE) and interest coverage ratio (ICR) were used to measure the capital structure and both return on assets (ROA) and return on equity (ROE) were used to measure the profitability of the firm. According to the results of correlation analysis, both ROA and ROE show negative relationships with the capital structure. Considering the regression analysis, the researcher identified the positive impact of capital structure on ROA. However, it shows the negative impact of capital structure on ROE. This study also demonstrates that capital structure is a combination of debt and equity, and it reveals that debt should not be higher than equity in listed hotels. This study implies the optimal combination of the debt and equity relevant to the listed hotel companies. Besides that this study is most important to makers to an organization. It will provide a way of increasing profitability by using the optimum combination of debt and equity.

Keywords: Capital Structure; Profitability; Listed hotel Companies

Developing Mandaram Nuwara as a Rural Tourism Destination; Context, Perceptions and Potentials

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The Tourism sector significantly contributes to the Gross Domestic Production (GDP) of Sri Lanka by enhancing the service sector. The industry is also related to the community lifestyle and a significant amount of community inhabitants of Sri Lanka depend on the tourism industry. Hence, community based tourism has been recognized as an emerging trend in tourism, despite traditional tourism avenues are also important. However, community based tourism has not been paid sufficient attention as such destinations are located remotely with less facilities. The current study was conducted to identify the community perception on developing *Mandaram Nuwara* as a tourism destination and also its potential economic benefits. The required data were collected from 70 residents and 06 officials through conducting a survey and interviews respectively. The collected data were analyzed through a descriptive analysis and a thematic analysis. As the results of respondents it was concluded that, the tourism industry in *Mandaram Nuwara* is in a developing stage and the community perception is at a moderate level. Also, according to the study it is found that there are very few residents and other stakeholders in Mandaram Nuwara who are aware of the tourist resources and their potential. Their knowledge of the tourism industry as well as positive attitudes should be further developed. For that, the public sector should take the lead and build an efficiency mechanism. Also, through that mechanism, all interested parties should be integrated and a system should be built. The study also recommends that the existing resources in *Mandaram Nuwara* should be further promoted. Through that, it has the potential to generate benefits from the natural resources of the destination by attracting local and foreign tourists and attracting external investors. Also, the study emphasizes that *Mandaram Nuwara* could be transformed into a rural tourism destination village through further tourism-centric promotion and regulation of the existing agricultural lifestyle and other small scale industrial entrepreneurship (SME) in the area.

Keywords: Potential benefits ; Community Perception ; Tourism mechanism ; Tourism regulation ; Rural Tourism ; Destination Development

Are We Ready to Hit?; The Preparedness of Hotel Sector to Grab the New Normal Market Bloom – Evidence from Major Chain Hotels in Sri Lanka

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The COVID -19 pandemic has made the global tourism industry more vulnerable. Many developing economies mainly relying on tourism are strongly challenged in industry resources and operational procedures hence demands a paradigm change. Consequently, the Sri Lankan hospitality industry is also tremendously affected from this pandemic. Currently, the hotels are seeking to reopen accepting the new normal condition, while adhering to the social restrictions and strict health regulations and emphasizing the importance of assessing the preparedness for the new normal pandemic situation. Hence, the current study was extended in order to investigate the impact of COVID-19 pandemic on the Sri Lankan hotel sector, to investigate the preparedness of the Sri Lankan hotel sector for the operations during the new normal condition of COVID-19 pandemic, and to examine the challenges ahead for the operations of hotel industry in preparing for the new normal condition of COVID-19 pandemic. Qualitative research approach was adapted to provide a more comprehensive overview of the context. A representative sample of ten management level employees representing three major hotel chains in Sri Lanka were employed in data collection process selected through purposive sampling. In order to understand the context more deeply and elaboratively, the structured interviews were occupied to gather primary data in this study. The key findings indicated that hotels have been affected severely by the pandemic in terms of financial and operational aspects. Hotels have assessed their departments and established safety protocols to ensure a seamless hotel operation prioritizing the adherence to SLTDA operational guidelines introduced recently. It also revealed that lack of travel motivation of the public, high switching costs, various travel restrictions, challenge of ensuring safety of the guest and staff, human resource management practices, continuity of service quality, and competitiveness as key challenges faced by hotels due to the pandemic. Moreover, focusing more on the domestic segment, additional and redesigned training to employees, contactless services, promoting ayurvedic treatments and immunity boosting foods, are recommended for the Sri Lankan hotel industry. In conclusion, the study revealed that the Sri Lankan hotel sector is well prepared to operate under the new normal condition of COVID-19 pandemic.

Keywords: Hotel Sector; COVID-19 Pandemic; Preparedness; Impact and Challenges; New Normal Condition; Sri Lanka

An Analysis of Impact of Rural Tourism Development on Local Communities in Sri Lanka (With Special Reference to Haputale Area)

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Tourism is one of the important industries that help the development of local areas. Tourism results in more benefits to the local communities including improvements in their livelihood. However, active participation of local communities and proper coordination among all stakeholders are more important in gaining benefits from tourism activities, otherwise, it can be disturbed the activities of the local communities by tourism development. This research mainly aimed at identifying expected benefits of tourism, to identify the levels of impact and the problems and issues of local tourism development in the Haputale area. The study utilized a qualitative research approach with 30 samples in the community members in Haputale division. The researcher adopts the focus groups and structured interviews to gather primary data. Collected data were transcribed and analyzed manually using thematic analysis. According to the findings of the study, there were more economic benefits than the other social and cultural benefits and environmental benefits from tourism. The study found that tourism provides many employment opportunities for the residents in the area. Nevertheless, there were some problems and issues faced by the community and expectations such as the need for awareness programs, development of infrastructure facilities, agricultural facilities and economic resources and deforestation issues while developing rural tourism areas. Finally, there are some recommendations such as Regional development planning, Maximize the awareness about the importance of education, Provide public transport facilities where necessary to enhance accessibility, Government involvement of making policy framework to improve community participation in tourism benefit gaining in Sri Lanka.

Keywords: Rural tourism; Tourism benefits; Local community; Problems and issue

Identifying the Potential to Promote Wildlife Photography Tourism in Sri Lanka (Empirical Evidence from Yala National Park in Sri Lanka)

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Wildlife Photography Tourism is an untapped market for study, it caters tourists who are interested in Wildlife photography to travel from one destination to another. The ability to influence travel affects different industries including the tourism market. Therefore, within destinations promoting the wildlife photography market as a niche tourism market may be a better opportunity for the tourism industry. However, Sri Lanka is highly ranked in terms of species and endemic species per unit area, for the key groups of species that wildlife travellers are interested in. Wildlife photography tourism stands as a special interest tourism apart from the traditional wildlife tourism, which has still not clearly identified the potential of the Wildlife photography tourism market in Sri Lanka. This study aims to identify potentials to promote wildlife photography tourism in Yala national park. Primary data was collected from 15 respondents by using structured interviews and the sample was selected by using the purposive sampling method. The content analysis method was used to analyze qualitative data. Abundant potentials, issues and challenges, and market opportunities have been identified to promote wildlife photography tourism within Sri Lanka. The study's findings indicated attractions, accommodations, and accessibility as the key attributes of a destination in promoting wildlife photography tourism in Yala National Park. Besides, the lack of government's contribution was identified as a major issue to promote wildlife photography as a niche tourism market segment. Prominent findings highlighted the market opportunity to attract wildlife photographers and this study was able to identify various types of market opportunities to promote wildlife photography tourism. Furthermore, based on the salient findings, study advocates to promote wildlife photography tourism by implementing a proper destination marketing program, innovating wildlife photography tours by the tour operators, integrating with other niche tourism markets, and gaining a competitive advantage.

Keywords: Wildlife Photography Tourism; Niche tourism

Impact of COVID 19 Pandemic on Camping Organizers in Sri Lanka

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Camping is a form of popular entertainment activity and an inexpensive form of alternative accommodation closely associated with nature. Although this sector is far neglected by academic researchers, the segment has been extensively popular and holds a strong interest from travellers around the globe during the last decade. However, subject to the outbreak of the COVID 19 pandemic over the world, the camping organizers had to completely suspend the operations and struggled to re-start ensuring the health and safety of visitors. Hence, the purpose of this research is to identify the impact of the COVID 19 pandemic situation on camping organizers in Sri Lanka and the strategic initiatives taken in order to re-start the operations in new-normal conditions. The qualitative research approach has been occupied in order to achieve the objectives of the study. Sample units were selected using snowballing sampling techniques and structured interviews were conducted for 12 camping organizers in Sri Lanka until reaching the saturation point. Data collection was carried out from October to December 2020. The data analysis was done using content analysis and transcribed data were coded and interpreted manually. Results of the study revealed the impact of the COVID 19 pandemic situation on camping organizers in Sri Lanka under a few specific areas. Sri Lanka's camping organizers face an uncertain future and the hardest hit by economic fallout due to the global COVID 19 outbreak while occurring unprecedented challenges. Moreover, the results reflected that camping organizers perceive a negative attitude towards COVID 19, and the impacts, challenges, and strategies are concluded at the level of their perception. As short term strategies and long term opportunities, the concept of Virtual Reality (VR) camping could be adhered to under the new corona conditions. However, an integrated approach, such as awareness programs that progress to improve risk reduction measures, financial arrangements, and the issuance of a specific license from the government with more cohesion and assistance, would be supportive and adequate for camping operators to fast retrieve in future pandemics.

Keywords: COVID 19; Camping; Camping Organizers; Impacts; challenges; Sri Lanka

Potentials to Develop Artificial Intelligence for the Hotel Industry in Sri Lanka (Special Reference to Star Class Hotels in Colombo District)

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Artificial Intelligence (AI) has made great changes in various industries in response to the incessant technological revolution. Equally, such changes have affected the global hospitality and tourism industry at large. AI technology was originally used in the aviation industry and subsequently in the hospitality and tourism industry. It was used not only to satisfy the customers' needs but also as a mechanism to reduce cost and increase revenue. Furthermore, AI technology applied in the hospitality and tourism industry as it was used in the aviation industry. Currently, this technology is used globally in the hotel industry. Highly competitive and unpredictable challenges in the hotel operations have created the need of applying new technology to provide better services for their customers and maximize the efficiency and effectiveness of the Sri Lankan hotel industry too. The key objectives of this study were to examine different AI tools applied in the hotels in Sri Lanka, examining the perception of managers in the hotels on AI and identifying the barriers for AI implementation in hotels in Sri Lanka. A sample of ten General Managers and IT Managers from star graded hotels from Colombo district was drawn for the study using purposive sampling technique. Structured interview method was used to investigate perceptions, potentiality of implementation as well as barriers of implementation. Primary data was transcribed and analyzed using thematic analysis. Results indicate that, Sri Lankan hotels are not much familiar with the AI technology and have limited knowledge on AI application. All participants had a positive perception on AI technology use in the hotel industry. The paybacks of AI technology, rewards of AI to the hotel operations and facilitating factors that are needed for hotels, also were identified in this study. Based on the findings, researchers recommend fully developed AI technology for new and up-coming hotels for improved performance. AI tools can also be used in the existing hotels in Sri Lanka.

Keywords: Artificial Intelligence, Benefits and Barriers, Hotel Industry, AI Tools, Maximize Efficiency and Effectiveness, Provide Better Service

Determining Innovative Event Professional Competencies for Event and Exhibition Industry in Sri Lanka

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Event management is an industry that has a wide range of sub-categories made up of different requirements. Creative and knowledgeable employees are essential to survive in the event management sector. Numbers of developing countries and developed countries have upgraded their national skills and competencies standard system to cater to tourism and events. Purpose of this study was to understand the concept of competency and to determine the need for an innovative competency model for the Sri Lankan event and exhibition industry. The objectives of the study were to identify existing awareness of the event and exhibition industry professionals on the need of innovative competencies and to identify the key competencies which are currently practiced by the event professionals. Primary data collected through semi-structured interviews from eleven event and exhibition industry professionals representing eleven organizations out of twenty-eight event management organizations in Sri Lanka with the membership of Sri Lanka Association of Professional Conference, Exhibition and Event Organizers (SLAPCEO). This study utilized content analysis in the analysis and the findings of the study reveal that industry professionals have an average level of knowledge regarding the benefits of innovative competencies. But they are using some general competencies in their existing working environment and the researchers could identify five main competencies among them and they can be named as time management, human resource management, marketing skills, work under pressure, and creativity. And four main innovative competency categories emerged from the analysis namely operation management, entrepreneurial skills, and personal characteristics and communication competencies. Based on those four main categories the researcher listed all the identified competencies that were included in the gathered data and developed a competency model. Interpretation and commentary assist event and exhibition industry professionals in Sri Lanka to determine the importance of innovative competencies and the competitive advantage of using them to intelligently capture the opportunities.

Keywords: Events and exhibition industry; Innovative competencies; Industry professionals; Event competency model

Does “SERVEQUAL” Model Impact on Food and Beverage Service Quality in Customer Retention during COVID 19 New Normal? ; A Study Reference to Family Restaurants in Western Province, Sri Lanka

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The service quality is considered to be a critical factor in contemporary and changing Hospitality and Tourism industry. COVID 19 New Normal has created an exceptional paradigm in the recent tourism, creating a detrimental effect on the restaurant industry. Immediate recovery of the tourism during “dramatical” New Normal needs to possess the service quality excellence at its highest to regain the customer retention in the food and beverage sector. In consonance with that, this study aims to identify whether “SERVEQUAL” model impact on food and beverage service quality in customer retention during new normal COVID 19 in family restaurants in Western Province, Sri Lanka. A questionnaire based telephone Interview series was conducted by selecting 50 family restaurants in the Western Province as the sample through judgemental sampling technique. After the comprehensive literature review, the study decided to adopt the deductive approach over quantitative design. Initially, a multiple regression analysis was performed to diagnose the impact of SERVEQUAL dimensions: Reliability, Assurance, Tangibility, Empathy and Responsiveness on the customer retention. The results disclosed that, there is a strong direct and significant impact of SERVEQUAL on Customer retention for family restaurants, especially during New Normal. Further, empathy and assurance of service quality of food and beverage were highlighted as the most apprehensive and decisive influences on customers’ retention during New Normal. Advancement in the smart electronic service practices and changes in the behavior, attitudes and hygienic appearance of service staff need to be aggrandized in order to retain customers with family restaurants during new normal. Moreover, studies on the moderating effect of customer satisfaction for SERVEQUAL model in retaining customers in food and beverage industry can be carried out.

Keywords: SERVEQUAL Model; Service Quality; New Normal; Customer Retention; Food and Beverage

The Role of Marketing Mix Factors in Shaping Spectator Loyalty: Evidence from Fox Hill Supercross, Sri Lanka

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Spectator loyalty is a critical component in the event industry. Both first time and repeat spectators are significant and in the event industry loyal spectators are an asset. There are limited studies conducted on shaping spectator Loyalty for sport events, in Sri Lankan context in the field of marketing. Objectives of the study are to investigate most significant marketing mix factor shaping spectator loyalty, to investigate the relationship between marketing mix factor and spectator loyalty and, to investigate the relationship between marketing mix factor and spectator loyalty through the perceived quality and satisfaction Fox Hill Supercross, Diyathalawa. Marketing mix is the independent variable, perceived quality and satisfaction were mediators. Dependent variable was spectator loyalty in the proposed model. A self-administered questionnaire consisting of 42 questions was fielded using purposive sampling technique to secure 160 responses. Descriptive analysis and Structural Equation Modeling were used to analyse the data using SPSS and SmartPLS tools. Findings revealed that both local and foreign spectators were not highly satisfied with the existing level of the event. Marketing mix factors influenced both the positive and negative relationship between spectator loyalty through perceived quality and satisfaction. Most significant marketing mix factor was found to be product. Price, Promotion, Place items in the final refined model elucidated the significant factors in event marketing mix. The study extended the event marketing literature while detailed implications to the event marketing and management personnel were discussed based on the hypothesis testing results. Research provides recommendations for Promoting event tourism. Strategies to popularize the events catering & promote event destination accommodations and attractions. Hence the main objective is to touch the global market, the attractions of the spectators are highly expected. Further, developed marketing mix factors in the event sector can increase spectator loyalty.

Keywords: Spectator Loyalty; Event Management; Perceived Quality; Foxhill supercross; Marketing Mix

Study on the Impact of Attraction, Service Quality and Perceived Value on Tourist Behavioural Intention for Performing Arts in Sri Lanka (Special Reference to Kandy District)

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As with the cultural heritage, the performing arts reflected humanity's intangible cultural heritage and it is major for the development of cultural and heritage tourism as valuable resources. In addition to performing arts being a tourist attractive product the performing arts serve as a resource for tourist behavioural intention. Although the scholars have found the determinant of behavioural intention of tourists, this study was conducted to study the impact of attraction, service quality and perceived value on tourist behavioural intention for performing arts in Sri Lanka to provide an enhanced understanding of performing arts tourism in Sri Lankan context. Hence, the study is coming under deductive approach; this research is basically depending on quantitative analysis. The primary data collected by researchers from 150 tourists using convenience sampling techniques and questionnaires consist of 38 questions. By employing SPSS 22 and MS Excel quantitative data were analyzed using descriptive statistics, spearman's correlation analysis and multiple linear regression analysis. According to the visitor profile, the majority of tourists are male and most of them are coming from Europe for leisure purposes and who are under 21-30 age category. Surprisingly most of the tourists are degree holders and they have come to watch performing arts for the first time. The finding of the study reflects that there is a positive relationship between attraction, service quality and perceived value with behavioural intention. Moreover, it reveals that the above independent variables significantly influence tourist behavioural intention for performing arts in Sri Lanka. Educate the tourist through social media by giving information, introducing new blogs and launching the creative promotional campaigns directly effect on tourist behavioural intention for performing arts in Sri Lanka.

Keywords: Attraction; Behavioral Intention; Perceived Value; Performing Arts; Service Quality

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Livelihood Environmentalism and Judicial Activism: A Critical Review of Sri Lankan Experience

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Environmentalism refers to the methods and tools used for the protection of the environment from the adverse effects caused upon it by the humankind. While the concern is common, the approaches utilized under environmentalism has differed across the rich and the poor where the poor have advocated for a livelihood approach for the protection of environment where the environment protection is advocated as a means of protecting their livelihood. When one considers this situation from a Sri Lankan perspective, the livelihood approach has been utilized and is responsible for invoking the judicial activism of the courts in acting as a protector of the environment through its adjudication process. Using a qualitative method by employing the doctrinal approach, this article looks at the intersection of the livelihood approach and the judicial activism in advancing a right to a clean and healthy environment. The results have shown that, the courts have played an active role when it has been called to adjudicate on environmental matters that involves a livelihood aspect and this has led the judiciary to take a conscious effort in getting itself involved in the protection and preservation of the environment in the absence of Constitutional provisions which specifically grants a justiciable right to a clean and healthy environment. The judiciary has been bold enough to declare that a meaningful interpretation of Article 12(1) of the Constitution should include a right to a clean and healthy environment. However, it is concluded that, while the livelihood approach has made a significant impact on the judicial law making in the country when it comes to advocating for a right to a clean and healthy environment, having a specific right to a clean and healthy environment under the fundamental rights chapter of the Constitution itself must be the final endeavour in helping those who to vindicate their right to a clean and healthy environment through fundamental right adjudication.

Keywords: Livelihood Environmentalism; Judicial Activism; Right to Environment; Sociology

Socio-economic Challenges Faced by Newly Resettled Families (NRF): A Case Study of a Post-war Village in Jaffna

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Many factors have contributed to the recent changes in families in Sri Lankan society and most of the factors are interlinked with the war. Socio-economic challenges faced by families due to resettlement became an essential topic in the post-war Jaffna due to many reasons. Therefore, the objective of the study is to identify the determined social-economic challenges faced by families after 30 years of resettlement, considering a case study of Myliddy North (J/246) village in Valikamam Jaffna. As a research method, qualitative and quantitative data techniques were used. The investigation is bifocal: one is at the community level and the other is household level. At the community level, primary data collection methods were meetings and interviews with key resource persons. At the household level with purposive and convenient sampling techniques, a total sample of 74 families were questioned through three-date collection tools namely, questionnaire surveys, in-depth interviews, and focus group discussion. As for the findings of the study through qualitative and quantitative analysis, it has been identified that the significant social and economic challenges faced by NRFs. One of the significant challenges that the people in the village face is the inability to obtain the use of land and the issues of landlessness (landless disabilities, landless women-headed family). Due to the military occupation, large scale of cultivated lands was destroyed, neglected, and abandoned by the owners which have created a lack of income with a new environment. Further, housing issues and homelessness tremendous, loss of community life, lack of leisure and other socio-cultural activities, and less safety and high-security zone issues disrupt the social life of the NRFs. The NRFs issues have become a central part of the development and social work discourses in the post-war villages in Jaffna. This study helps in identifying the kind of approaches and policies that need to be formulated to address NRFs challenges and grievances.

Keywords: Post-war; Resettlement; Family structure; Socio-economic challenges.

Exploring Potential Tax Compliance Approaches during a Pandemic Situation

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COVID-19 has triggered a severe economic collapse in Sri Lanka. Tax revenue has declined steeply, with businesses closed and operating at reduced hours. The rapid decline of the economy and uncertainty about the future revenue generation and foreign aids persuade tax policymakers to take immediate action and explore potential avenues that will support in dealing with the crisis. However, it is essential to consider the taxpayers' ability to contribute to revenue generation in a pandemic situation rather than implementing unbearable strategies abruptly. This research aimed to analyze different tax players' perceptions of the possible approaches to increase tax revenue during the pandemic. The study uses a qualitative method by collecting data through in-depth interviews with thirty-five taxpayers. The sample for the analysis was selected from the small and medium taxpayers who do business in the Colombo district in Sri Lanka. Focused Group Discussions were conducted to collect data from people playing various roles in the tax field. The results found possible actions to reduce the tax burden on people and increase tax compliance. Besides, the researchers attempted to uncover perspectives of the different actors in the tax field, which will give some insight into what the taxpayers expect in a pandemic situation. The study suggests that granting additional time for taxpayers to attend tax matters due to lockdown, allowing to re-schedule default tax payment plans, approving extensions to pay current taxes, and speeding up the process of refunds are required as urgent interventions in the tax field. Also, the study found that making available more online tax services will support reducing non-compliance. Easy access to new tax file openings, penalty concessions, audit policy changes, and introduce more benefits for the taxpaying community will keep the tax compliance level uninterrupted. The study highlights the requirement of policy changes and the revisions to tax administration during COVID-19 in Sri Lanka.

Keywords: COVID-19; Focused Group Discussion; Revenue; SME Taxpayers; Tax Compliance

Study on the Stress and the Copying Strategies among the First-Year Students of the University of Jaffna

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This study aims to investigate the level of University Students' perceived stress, find the coping mechanism and suggest measures and strategies for successfully handling the stress of the first-year students of the University of Jaffna. The data is primarily garnered from a self-administrated questionnaire, nonetheless, as a caveat, a small-scale exploratory study conducted. The samples for the study were selected through the stratified random sampling technique; participants were selected from the First-Year Students both male and female of the three faculties (Faculty of Arts, Faculty of Management and Commerce, and Faculty of Sciences). The population of the study is 1359 first-year students and the sample size were 310 and 286 students responded. The student's stress analysis provided support for a six-factor model comprising the categories of academic, relationships, equity, parenting, practical, and health. The students' stress scale demonstrated good internal consistency as measured by *Cronbach's alpha* ($\alpha = .824$). Total Coping scale shows good consistency ($\alpha = .846$) and individual item of active copying ($\alpha = .815$) and passive copying ($\alpha = .730$). The students' perceived stress were significantly high among the Faculty of Science and Faculty of Management & Commerce. The Students from the Faculty of Arts show low stress. Similarly, Faculty of Science and Faculty of Management & Commerce students were showed a significantly higher level of active coping and Arts students show a high level in passive coping. The female students recorded a higher level of stress and copying strategy. Finally, most of the students adopted a positive coping style of active coping. Students' perceived stress and coping style were positively correlated and parental stress was negatively correlated. The findings will have many social implications. The social implications might be based on proper utilization of public funds, cost of well-being, and other pertinent social costs. Further, this study will be served as guidelines for Administrators of the University in the implementation of policies, for instance, in the counselling and training strategy and program.

Keywords: Perceived Students Stress; Coping Style; Active Coping; Passive Coping

Effect of Eight Week Training Programme to Develop Agility in Tennis

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Tennis is an open skilled racket sport. Agility is one of most important physical qualities that should be developed in the very beginner level of the tennis players. This research was conducted to evaluate the effectiveness of a planned training programme for improving the agility of female tennis players at the beginner level. The selected population was beginner female tennis players in year I semester II from the Faculty of Social Sciences and Languages, Sabaragamuwa University of Sri Lanka. Sample was divided as treatment group and control group. Eight-week training programme was applied to the treatment group and the control group was not involved in the particular training. Before starting the specific training, Illinois agility test was done with both groups. The mean time of the treatment group was 21.238s and that of the control group was 21.152s. After eight weeks of specific training applied to the treatment group, Illinois agility test was conducted again with both treatment group and control group. There, the mean time was 20.196s in the treatment group and that of the control group was 21.178s. It could be concluded that the specific training programme had made an effect to improve timing of the agility test. Then the paired t-test was carried out to conform the effectiveness of the training programme. There, the p-value for the treatment group was calculated as 0.012. It was less than the significance level 0.05. For the control group, p-value was calculated as 0.874. It was higher than the significance level, 0.05. It could be concluded that the planned eight week training programme was effective to improve the agility of the sample. It can be recommended that the training plan used in the study can be applied to improve the agility among beginner tennis players.

Keywords: Tennis; agility; Illinois test; Beginners



Exploring the Determinants of Science Undergraduates' Satisfaction with the Library

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University libraries play a prominent role in the information society through providing quality information effectively and efficiently to the scholarly community. The astronomical proliferation of Information Technology has made information easily accessible for anyone from anywhere while eliminating the need to physically visiting a library to seek information. In this digital era, it is inevitable for university libraries to adapt to technological changes and deliver innovative services to satisfy technically-competent user needs. It is important that the library management identify the most influential factors that could enhance the satisfactory level of undergraduates towards the library. In the current study the students' satisfaction was assessed by means of a proposed research model whereby the dimensions of Library services, resources and staff were incorporated. Further, the simultaneous effects of these variables on satisfaction were also investigated. Data were collected by a questionnaire-based survey performed among 442 Science undergraduates of University of Peradeniya, Sri Lanka and the model was tested using path analysis with multiple regression techniques. Findings indicated that Library services, Library resources and Library staff were strong determinants of the undergraduate satisfaction. Moreover, Library facilities (including all independent variables) accounted for 41.1% of the variance of students' satisfaction. Based on the results it is recommended that the library management should focus on developing and tailoring Library facilities such as services, resources and staff in order to enhance the level of undergraduate satisfaction towards the library.

Keywords: Undergraduates; Facilities; University; Satisfaction; Sri Lanka

Effectiveness of Activity Based Learning in Grade 10 Science: A Case Study in Maho Education Zone

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Science is an important subject for students in all grades from primary to secondary level. Science is a core subject in General Certificate of Education Ordinary Level (G.C.E. O/L). However, the students' achievement level of G.C.E. (O/L) science is less than the expected level. The aim of this study was to investigate the effectiveness of activity-based learning on Grade 10 science comparison to traditional learning with their motivation towards meaningful learning. The mixed methods approach was used for this study with experimental study design. The sample consisted of 142 Grade 10 students selected from a Type 1AB school and a Type C school. A pre-test was conducted to divide the sample into experimental and control groups. The study was carried out for four selected units in Grade 10 Science using activity-based teaching in the experimental group while using the traditional lecture-based method for the control group. A post-test was given to measure the students' performance after the intervention. Students' motivation towards science was investigated through a questionnaire with Likert scale. Qualitative data were collected through semi-structured interviews, informal interviews and observations. Six teachers and two in-service advisors participated for semi-structured interviews. Paired sample t-test and independent sample t-test for pre-test and post-test marks was conducted to test the difference between students' performance of two groups. T-tests were used to analyze quantitative data whereas content analysis technique was used to analyze qualitative data. The academic achievement for both groups were positively increased with compared to initial level. Moreover, motivation towards science learning of students in the experimental group increased significantly ($p = .000$). The study reveals that activity-based learning has a positive effect on students' performance and student motivation in learning science. Hence, the study suggests to focus on activity-based learning to empower students' meaningful learning in science.

Keywords: Activity based learning; Science; students' performance; Student's motivation

Effect of Aerobics on Anxiety Reduction

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Aerobics is a type of rhythmic exercise that is done using a rhythmic beat or music. In this study, the researcher attempted to test whether there is an effect of aerobic exercises on anxiety reduction among female university students. Population of the study consisted of final year female university students in the Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka. 70 students were selected as the sample as 35 in experimental group and 35 in control group. simple random sampling was used for sampling in the study. Pre-test was conducted for assessing the anxiety level of the sample using State Trait Anxiety Test. Scores gained by the two groups with their answers in the test were taken into consideration in measuring the level of anxiety where they were in particular situation and generally. Then the organized aerobics sessions were conducted by the researcher with experimental group for two days per week continuously for four weeks as one session consisting of 30 minute training. After the sessions, post test was conducted using the same testing tool used for the pre-test. Data collected from the test was analysed using paired t-test. According to the scores of the pre-test and post-test in experimental group, there was a significant difference between the pre-test and the post-test with a mean difference of 18.80 and a p value < 0.01. There was no significant difference in that of the control group. Therefore, it is evident that the aerobics training is effective on anxiety reduction among university girls. Researcher recommends to conduct aerobic training sessions for all university students in possible schedules to reduce study anxiety.

Keywords: Aerobics; Female university students; study anxiety; training

Effect of Evening Jogging on Anxiety Reduction among University Students

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University students face study anxiety during examination period. Researcher attempted to test whether evening jogging could be effective to reduce anxiety among male university students. Research population was 3rd year students in the Department of Sport Sciences and Physical Education, Faculty of Applied Sciences in Sabaragamuwa University of Sri Lanka. A sample of 70 students were selected for the study as 35 students for the experimental group and 35 students for the control group. State Trait Anxiety Test was used to test the anxiety level of the sample. Scores gained by the two groups with their answers in the test were taken into consideration in measuring the level of anxiety where they were in particular situation and generally. paired t test was used for data analysis. At the beginning, pre-test was conducted using the questionnaire with both experimental group and the control group. Then, evening jogging treatment was applied to the experimental group. Jogging was done for 30 minutes for twice a week continuously for four weeks. Mafter the treatment period, the post test was conducted with both groups using the same questionnaire used in the pre-test. Results of the scores collectd from the test showed a mean difference of 20.8 that shows a reduction in the anxiety level of the students. P value of the paired t test conducted for the test results showed a significant difference in the mean difference between the pre-test and post test results of the experimental groupas p value<0.01. There was no significant difference between the values of the pre-test and post-test of the control group.therefore it can be concluded evidently that evening jogging can effect to reduce the anxiety among male university students.

Keywords: Male students; Anxiety; Evening jogging; State trait anxiety test

The Impact of Part-Time Jobs on Student's Academic Performances

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Part-time jobs have been considered as one of the factors influencing students' academic performances. This study aims to examine the impact of part-time jobs on student's academic performances in the faculty of humanities and social sciences, University of Sri Jayewardenepura. A quantitative approach was used. Three hundred and sixty (360) students were chosen as the samples of this study. Students' academic results in the form GPA, the amount of time spent on a part-time job, as well as types of jobs the students involved in, scrutinized to see the relation between part-time jobs and their academic result. Using a Simple random sampling method collected data from students of 13 departments in the faculty of Humanities and Social science. It was taken equal proportion respectively. Kie square test, factor analyzing, and Anova test used for data analysis. The results of the data analysis, 68% of the total student ratio is in part-time employment and 32.7 percentage is not involved in part-time employment. Thus, the median test of two independent samples using the GPA is used to study whether part-time employment has an impact on the academic performance of undergraduates. The average of grades obtained by the students at the end of the second and third years was examined separately. Two hypotheses were tested. H1 hypothesis is accepted. That means there is no significant difference between education performance and engaging on or off part-time jobs. According to the study, results can be identified as there is no impact on education performance whether engaging on or off part-time jobs. Students were engaged 20 hours per week in part-time jobs and however, they covered their missed lessons before examinations. The main reason for engaging part-time job for to full fill the financial needs. If university students continue to focus on the jobs, they choose as part-time jobs and engage in jobs that are relevant to their field of study, then student productivity, as well as efficiency, will increase.

Keywords: Impact; Performance; Part-time; University; Students

The Law Relating to Unit Trusts in Sri Lanka

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The COVID-19 crisis has taken root across the globe significantly affecting the personal and economic lives of people. The pandemic has created a financial crisis for many Sri Lankans and institutions. With the reduction of the interest rates of fixed deposits, savers who depended on such earnings for living, now face enormous difficulty. These circumstances compel savers to explore alternative forms of investment such as Unit Trusts. Unit Trust can be identified as an extension of the concept of Trust into the contemporary commercial world. As defined by the Securities Exchange Commission of Sri Lanka, ‘Unit Trust means any arrangement made for the purpose, or of having the effect, of providing for the participation by persons as beneficiaries under a trust, in profits or income and capital gains arising from the acquisition, holding, management or disposal of securities or any other property vested in the trustee or such trust’. Unit Trusts are relatively new and has only become recently popular in Sri Lanka although a large portion of the general public remains unaware of the concept as well as the relevant legal framework. Hence, the objective of this paper is to critically analyse the laws relating to Unit Trusts in Sri Lanka and their applicability in the country to generate awareness of the regulations in the area. This research has adopted a doctrinal methodology that typifies distinctly legal research. The analysis of regulations demonstrates that the current legal framework in Sri Lanka provides for strict regulatory demands concerning the method of operation of the Unit Trusts to ensure the security of the funds invested by the general public.

Keywords: Laws; Regulations; Sri Lankan Context; Unit Trusts

A Study on Assessing the Awareness of the Risk Factors Causing Cervical Cancer among Women in Gampaha District, Sri Lanka 2020

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Cervical cancer is a malignant tumour that arises in the uterine cervix, which has been identified as the second leading cause of cancer deaths among women around the world including Sri-Lanka. A sexually contagious pathogen, the Human Papillomavirus (HPV), is often accountable as the aetiology. Having multiple sexual encounters, engagement in risky sexual behaviour, including the usage of oral contraceptives and possessing a compromised immune system, are considered risk factors. Therefore, the purpose of this study was to evaluate and ascertain the current level of awareness towards cervical cancer risk factors among the women in Gampaha district Sri-Lanka. Method includes a descriptive, cross-sectional study that was conducted on 150 women aged between 18 -50 years. Convenience sampling method was used. Data was collected using a closed-ended, self-administered online questionnaire. Microsoft Excel and SPSS version 25 was used as the analysis tools in the study. The study results put forth that out of the total, 84% of the participants were aware of cervical cancer while 16% were not. A minority (5.4%) believed that there is no method for early detection of cervical cancer. Most of the study participants (56%) were aware of the risk factors of cervical cancer. Among the 56% of the study subjects, 76% of the women identified unsafe sexual practices as one of the major risk factors. Some respondents further believed that avoiding the practice of smoking (2.7%) and unsafe sexual practices (10.7%), obtaining the HPV vaccination (32.7%) and conducting Pap smear test regularly (19.3%) could greatly reduce the chance of the developing cervical cancer and increases the chance of early detection and treatment. In Conclusion, even though the majority of the women were aware of the cervical cancer and their associated risk factors, further research studies and awareness programs should be conducted in the community to provide further information on the risk factors, disease prognosis and severity, enabling women to take the necessary precautions in the future.

Keywords: Awareness; Cervical cancer; Risk factors; Sri Lanka; Women.



The Effectiveness of “PREP” Pre-marriage Program among the Relationship of Undergraduate Couples

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Pre-marital counselling is a process, designed to enhance premarital relationships leading to more satisfactory and stable marriages with the intended consequence of preventing divorce. Pre-marital education programs are knowledge and skills-based training applications to improve relationships. The Prevention and Relationship Enhancement program (PREP) is an empirical based intervention program to support for the prevention of marital distress and divorce. It also helps to overcome marital distress and divorce with short- and long-term effectiveness. PPEP is the one of intervention program pave the path to measure pre-marriage counselling. The literature review has shown that little is known about pre-marital counselling and no prior research in Sri Lanka has evaluated the effectiveness of PREP on the relationship of undergraduate couples. The data were collected using the mix method approach comprising of pre and post-test quantitative questionnaire and semi-structured interviews. This research selected 15 undergraduate heterosexual couples (15females and 15males) from the University of Peradeniya for the quantitative analysis and 3 couples were selected for the qualitative analysis. The T-Test and thematic analysis were adopted as the data analysis method. The research findings indicated that the T-Test was statically significant at <0.05 levels indicating the program was successful. Moreover, there was a significant difference between before and after PREP ($t=15.040$, $p<0.00025$) in lessening vulnerability and risk in marriage by strengthening protective factors among the couples. The 15 university undergraduate couples mean score for the test was 146.13 (SD=14.738) before the PREP program and it increased to a mean of 176.47(SD=6.892) after they had participated in the PREP program. Couples stated that premarital programs are necessary for their lives and they recommended the PREP program for both married and unmarried couples.

Keywords: Pre-marital counselling; PREP program; Pre-marital programs; Effectiveness; Pre-marital couples; Marriage

Buddhist Teaching, Spirituality and Work Life Success of Graduate Employees Working in Badulla District

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The purpose of Buddhist life is to live peacefully, happily, successfully with a light heart and full of contentment. Success is twofold as worldly success and spiritual success. Unfortunately, people just ignore the spiritual part and majority of the people only focus on the worldly success. People tend to engage with many misconducts and illegal things seeking money and personal benefits unconsciously. The purpose of this study is to identify the relationship between the Buddhist teaching, spirituality and work life success of graduate employees working in Badulla District. Hence, this study examines the nature of the religious behavior of graduated employees who are currently working in Badulla district and how Buddhist teaching and Buddhist spirituality have influenced their work life. The snowball sampling procedure was used to select the sample and ten in depth interviews were conducted and observation method was used to gather data for this study. Gathered data has been analyzed qualitatively. Findings of this study revealed that there is a positive relationship between the Buddhist teaching, spirituality and work life success of graduate employees working in Badulla district. The findings of this study revealed that the graduate employees who are following Buddha's teaching are practicing neutrality rather than acquisition and demanding materialism or any other privileges. Moreover, the graduate employees who were more towards the spirituality and following Buddhist teaching were practicing concentration on work, integrity, honesty, neutrality, patience and smooth relationships with colleagues. As per the respondent's idea, it is recommended to become spiritualistic and follow Buddha's teaching to achieve both work life success and satisfaction during the work despite of any circumstances in workplace.

Keywords: Neutrality; Religious; Satisfaction; Spiritualistic

The Effectiveness of Online Learning over Face-to-Face Learning During Corona Pandemic: A Focus on Teaching German as a Foreign Language

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Online learning has become a significant component of the education system across the world during the Covid-19 pandemic. The shift of learning modes from face-to-face learning to online learning affected the foreign language learners of Sri Lanka making it a challenge for them. The paper mainly focuses on the effectiveness of online learning on foreign language learning and mainly discusses the efficiency of the students of German as a foreign language at the University of Kelaniya in the period of online learning during the corona pandemic. It compares the performance of the students in language learning between the periods of face- to- face learning and online learning and further discusses the improvements and issues faced by the students during the online sessions. The sample group consisted of 30 undergraduates of German as a Foreign Language at the University of Kelaniya, who followed the four-year Honors Degree program in German for the Bachelor of Arts Special Degree. To collect the quantitative data, the oral presentations and written assignments of the students during the face-to-face and online sessions were evaluated and compared. The qualitative data were collected through observations during the online sessions. It was concluded that although there were some technical issues faced by the students during the online sessions, the online learning was more effective in foreign language learning than face-to face learning and helped to improve the foreign language skills of the students to a greater extent in the challenging period of Covid-19.

Keywords: Online Learning; Face- To- Face learning; Corona Pandemic; Foreign Language Teaching; German as a Foreign Language

Investigating Information Literacy Skills of School Teachers in Sri Lanka as an Effective Factor for Information Seeking Behavior

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Information literacy (IL) is a fundamental skill that needs for lifelong learning, and particularly the teachers who are imparting knowledge to students are required that skill to influence their students in their endeavours to become lifelong learners. The cognizance of information literacy would be an advantage for the understanding of information-seeking behaviour (ISB) as IL and ISB are two sides of the same coin. There is a need for studying information resource usage of school teachers by linking information literacy to understand the factors influencing the information seeking process. It was identified from the literature that no studies have yet been carried out to explore the information resource usage and information literacy skills of school teachers in Sri Lanka. These types of studies would help policymakers and information professionals to design and develop smarter tools that can incorporate and make use of the knowledge of ISB to behave more intelligently and provide more effective support for the teachers. Therefore, the study was designed to examine information resource usage and information literacy skills of school teachers in Sri Lanka. The population of the study was in-service graduate school teachers who work in government schools in Sri Lanka, and a multistage cluster sampling method was used to select the sample. The study adopted a quantitative research methodology, and a self-administered questionnaire was distributed among 3200 teachers, and collected data were analyzed by using SPSS (21.0). The results affirmed that professional books, the internet followed by magazines, libraries, and workshops, respectively, were the most preferred with having more than 34 of average Standardized Total Information Scores that used to calculate the preference of information sources used by the teachers. The results revealed that most of the teachers were uncertain about most of the statements of perceived skills of information literacy. But the results further revealed that most teachers perceived that they could identify their information needs, followed by the ability to access information from various sources, the ability to utilize information and awareness of various sources of information with having more than 3.6 of mean scores for each statement. Although these results gave an insight that they have certain skills which are imperative for effective information-seeking behaviour but it should be recommended to conduct more training programs on information literacy for the teachers, particularly the skills relating to information-seeking behaviour.

Keywords: Information Literacy; Information Resources; Information Seeking Behavior; School Teachers; Sri Lanka.

Factors Affecting Carbon (CO₂) Emissions in Selected South Asian Countries: A Panel Data Analysis

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Industrialization, increase in the population growth and trade liberalization is playing a critical role in environmental pollution. Greenhouse gas emission and carbon emission are outcome of those activities. The causal relationship between economic activities and carbon dioxide emissions has received global attention in recent decade. At present this issue has become a political and economic choice. Many researchers have addressed this issue in internationally. But in Sri Lankan context a limited attention was given to this issue. Therefore, the Aim of this article is to empirically analyse the factors affecting for carbon emission across selected South Asian countries namely, Sri Lanka, Bangladesh, Pakistan, India and Nepal which was selected using simple random sampling method. This article incorporated annual time series data stemming from 1960 to 2019 and employed panel unit root test, Pedroni test of co-integration, panel Fully Modified Ordinary Least Squares (FMOLS), and Ordinary Least Squares (DOLS) and panel Vector Error Correction Model (VECM) to explain the factors affecting for carbon emission. From the panel co-integration test result, found a long-term relationship between the carbon (CO₂) emissions, GDP, trade openness and population. According to the FMOLS, it shows that all the three variables are significant to explain the carbon emission. Further, it shows that trade openness also leads for more carbon emission. Since that, the trade liberalizations should make efficient to reduce the carbon emission. Therefore, the findings suggest that carbon emission should be reduced by introducing low carbon technologies to gain a sustainable economic growth.

Keywords: Carbon Emission; Economic Growth; Trade Openness; Sustainable Development

Smart Classrooms in Schools in Sri Lanka: A Case Study on the Design and Use of Smart Learning Space

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The integration of information Technology with the educational process creates smart learning environments that facilitate student engagement, teaching and learning and evaluation through physical and virtual classroom settings. The transformations in classroom settings through the adoption of information and communication technology is generally solicited as a means for improving the educational outcomes. The transformation of learning space from the traditional classrooms to smart classrooms is mainly characterized by the infusion of technology into the pedagogical process of schools. Smart classrooms are expected to address the issues and demands of present context of education that emerge through the changes in the elements of education: students; teachers; curriculum; available resources for the process and; the social background of the schools. In this context smart classroom were introduced in the schools in Sri Lanka since 2017. This study examined the design and use of learning space formulated by interacting axes of domains of smart class rooms: the architectural layout and ergonomic structure; integration of technology and; appropriate pedagogical methodology in smart classrooms. A collective case study approach is used to investigate the research problem. Four schools belonging to 1AB, 1C, Type II and Type III categories were selected from the Valikamam Education Zone of Jaffna district of Sri Lanka as cases. The findings from analyses of cases indicated that the teachers did not perceive much technology enhanced smart learning space in their smart classrooms, while principals are not fully aware about the key characteristics of the three-interacting axis of domains in design and use of smart learning space. The layout and ergonomic structure of smart classrooms is satisfactory except their interior topology and furniture, which is not conducive for interactive learning. Integration of technology is very limited with the basic digital devices available only for the use of teacher while the students are engaged in the lesson only with their exercise books that impedes student centered learning and interaction with teacher and class through the technological platform. The pedagogical methodology is not suitable as the teachers still follow traditional way of teaching without the innovative and creative use of digital devices and the internet.

Keywords: Smart classroom; Smart learning space; Transformation in classroom; Technology integration.

A Social Comparison of Does Happiness Increase with the Income?

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There are numerous psychologists found that there is a small income effects on individual happiness. It has always been a challenge to prove that happiness is positively correlated with money, as it is widely believed and argued that “money can’t buy happiness”. Further previous scholars found out that more money is positively associated with greater happiness. Hence the research is a psychological evaluation attempts to disentangle the positive relationship between an individual’s monthly income and happiness. A quantitative study has been undertaken using convenience sampling and data were collected from 100 working individuals between the age group of 25 and 35 providing Oxford Happiness Questionnaire to calculate the happiness level. Further descriptive, correlation analysis conducted to generate results and to identify the impact of income in happiness of an individual. The received responses were numerically valued and the happiness score was found to be increasing with the higher amount of monthly income. The results obtained proved that there is a significant positive relationship between monthly income and happiness of an individual. However, it is not a strong relationship. Therefore, it is concluded that people who earn more are slightly happier than the people who earn less.

Keywords: Income effects; Individual happiness; Monthly income

The Effect of Gender Identity on Self-Esteem among Young Adults (Special Reference to Central Province)

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Social identity is being recognized as perceived self-concept of an individual based on the social group that they are belong to. Favorable comparison between persons automatically increase the self-esteem of them. People always contemplate on the emotions of their relatives (in-group) and resisting the emotions of others (out-group). Even though the theory of social identity explains the positive side of the intergroup discrimination and biasness, it does not sufficiently represent the negative of them and the symmetry is missing. Further there are only a few researches has been undertaken on the influence gender has on self-esteem among young adults and the results obtained are not significant as well. Therefore, the study on effect of the gender difference on self-esteem among the young adults in central province is performed to examine whether the gender identity of a person affects his/her self-esteem. A quantitative study was conducted by using convenient sampling to collect the sample of 100 young adults from central province have been selected for the study and Rosenberg Self-Esteem Scale was used to get scores of the self-esteem. The major findings were statistically analyzed using tables and a graph using SPSS Statistics Data Editor. With the overall results it was observable that men had a good self-esteem than women. However, the results obtained were found to be insignificant according to the t-test conducted. Therefore, the study concludes with the idea that self-esteem is not influenced by the gender identity as supporting the previous findings.

Keywords: Gender identity; Self-esteem; Social identity; Young adults

Challenges Faced by Female Workers in Trade Union Participation: A Study Based on Balmoral Tea Estate

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Trade union participation is a collective involvement of members in union related activities which are closely related to the effective functions of the union. Trade unions were emerged in Sri Lanka through the background of British colonialized period under the plantation economy system. Several trade unions are in operation at plantation platform. Female workers play a major role in plantation sector because, half of the plantation labor force are Females. They represent several trade unions based on their interest. This study explores the challenges faced by Female workers with the participation of the trade union activities. The study area is Balmoral tea estate which is located in the middle part of Nuwara- Eliya district. The research was based only from the female estate workers. The Primary data was collected from direct observation, in depth interviews and case studies. Secondary data was gathered from relevant books, magazines, and internet sources. The thematic analysis techniques were applied for data analysis. With the use of analyzed data, this study identified prominent causes related to this aspect such as lack of interest in trade union activities, lack of family support, dual burden, lack of awareness about the trade union activities as per the benefits which can be obtain from the union, lack of educational platform, hesitation to express their thoughts and ideas and existing patriarchal contradiction in the community influences on female workers which illustrates gender, class, ethnicity and caste based inequalities among them. Tea estate female workers are unable to participate enthusiastically in trade union activities because of several barriers due to their native structure. But in practical it is defined as a basic right of them. Females' participation is seen as a platform for them to solve their work place related problems on their own. This Study emphasizes the importance and value of the trade union participation of females. Apart from these, all authorized government and non-governmental sectors are expected to create policies and implement programmes to motivate women workers' trade union participation with adequate knowledge and awareness.

Keywords: Plantation; Participations; Trade union; Female workers

Sense-Datum Theory and Intentional Theory: As responses to the Problems of Perception

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This paper aims to comparatively analyze the approaches of sense-datum theory and Intentional theory on perception. In epistemology, the concept of perception has become a hotly debatable investigation area since the 17th century via the expansion of Empiricism. Various accounts had been created by the empiricists such as John Locke, George Berkeley, and David Hume, in relation to the problems of perception. Those accounts led to several theories in the contemporary period such as sense-datum theory, Adverbial theory, Intentional theory, Disjunctive theory, etc. However, each and every theory has pros and cons itself. Hence, among all the contemporary theories of perception, sense-datum theory and Intentional theory have been taken for comparative analysis. According to sense-datum theory, in our perception, we directly aware of sense data, but not the physical objects. In contradiction to this, according to intentional theory, perception is a kind propositional attitude, similar to belief. Both these theories accept perception as a valuable source of knowledge. Even though, the way they are addressing the solution for the problems of perception differs from one another. In this paper, comparative analysis between these two theories has been done in two ways. One is based on the three key principles of perception such as common factor principle, phenomenal principle, and representational principle, as all the perception theories end up rejecting one or more of them. Another one is based on the arguments for and against those theories. According to the analysis, in comparing with intentional theory, the sense-datum theory is the best approach as a response to the problem of perception. This research has been done based on secondary data especially from related books, scholarly articles from journals on related topics, and recognized sources of the web. The researcher has utilized the analytical, comparative, and descriptive methods for analyzing the data gathered.

Keywords: Problems of Perception; Principles of Perception; Sense datum theory; Intentional theory

Women Empowerment Led by Online SME: Untapped Potential for Growth

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Today, Women empowerment through women entrepreneurship is a common feature in most developing countries. It plays a major role in poverty eradication and economic growth. Unfortunately, in the Sri Lankan context the women-led online SMEs face number of constraints that impede their sustainable growth. This paper aims to investigate the current context of online SMEs led by women, challenges they encounter, future prospects, and directing policymakers towards effective policy implications in this regard. Data was collected using the snowball sampling method. Qualitative methods such as semi-structured interview questionnaires focus group discussions were used to collect primary data. Findings related to their motivation, approach, and creativity into business, competition, marketing methods are significant to novel comers and policymakers to design an effective policy background. Further, they encounter several challenges due to gender disparities, lack of financial support, and the legal system. The capacity development programs through the public-private partnerships are highlighted along with the provision of financial support under the lower interest rates that need to be encouraged. The article emphasizes how they have achieved national and international markets through a lower amount of capital and labor and it's an eye-opener for the whole economy to tap the untapped potential for growth. Inadequacy of precise secondary data was an obstacle in generalizing the results to the whole economy. The selection of the western province and the southern province as the sample have been done after an online survey. E-Commerce is a resource that can be spreader all over the country by giving proper guidance and training which leads to enhance the standard of living. Future research studies can be conducted upon shedding light on the designing procedure of Private-public partnership in capacity development and learning by comparison with other countries in the region who have gained successful impacts on their way towards sustainable economic growth

Keywords: Online businesses; SME; Women empowerment; Women entrepreneurs

The Portrayal of Epic in Director Maniratnam's Films (Special Reference with *Ramayanam* and *Mahabharatha*)

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Director Maniratnam has a specialty in dealing with the realistic and emotional issues like caste, religion and language that many people are afraid to talk about through the Mass Media of film. Maniratnam has expressed his ideas through several techniques as storytelling, visualization, and characterization to evoke the inner emotion through his films. The objective of this research is to shed light on the portrayal of Epic in Maniratnam's Films. The research focuses mainly on two films of a particular director *Thalapathy* and *Raavanam*. The prime focus of this study is to find out the portrayal of epic stories Mahabharatha and Ramayana respectively in his films. According to that this study investigates that, how director Maniratnam portrays the Epic themes in his films? And how director handles his characterization as a gradual shift from epic story to his film? The researcher has used descriptive content analysis to analyze the selected films of director Maniratnam and employed the sociological approach to analyze the qualitative data. As the theoretical framework of this study, the researcher used the Auteur Theory, which examines the control of the author over his/her media productions. The research found that the director Maniratnam uses film as a tool to reflect not only the story of epic but also to construct the political subtexts in every available point of views. Through a visual analysis of the approach the portrayal of characterization and themes are more different from epic. Director Maniratnam shows the epic story through his films in his own way. And he made a huge impact on the gradual shift from epic character to film main character. Manirathram tries to take the main ideas from the epic and adopting it to the lifestyle of ordinary people. Director used films to portray the political themes to convey the real issue to their audience.

Keywords: Hindu epic; Mahabharatham; Ramayanam director maniratnam; Portrayal

Contextual and Linguistic Analysis of Neologism Related to COVID 19

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Language is dynamic to accommodate new happenings in the society. Neology is the process of generating new lexical units by forging new forms or by revisiting the meaning of already existing forms. The emergence of COVID-19 has contributed in the formation of global neologisms. The objective of this research is to explore the formation and functions of neologisms that are coined in English during the outbreak of COVID-19. The linguistic and contextual analysis of neologisms will be undertaken. A descriptive qualitative method of analysis is used. The data are collected from articles, books, Oxford Corpus, social media retrieved from January to March 2021 around the issue of COVID-19. The study analyses all forms and functions of derivation such as portmanteaus or blending, acronyms and affixation and to show how words are related and are identified in different contexts. Various theoretical approaches to neologisms are discussed. MAK Halliday functional theory is used to account the changes in the language use. This study adds more validation to the COVID-19 neologisms which are followed as communicative and terminological strategies by institutions and media. These technical vocabularies have transcended linguistic boundaries. Neology continues to be the mechanism that generates new lexical forms, thus participating in the dynamism of the language to retain its status as alive. The emergence of neologisms reveals the vitality of the English language in order to respond to emerging situations in times of crisis. The neology helps in the process to preserve the vitality of a language. The study recommends that further research is to be carried out on the new terms in case to justify the vitality of English Language.

Keywords: Neologism; Covid-19; Linguistics; Communicative; Dynamism

Study on Factors Affecting Adoption of Control Measures for the COVID 19 Pandemic in Tea Plantation Sector in Badulla District

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Sri Lankan tea plantation sector is currently experiencing COVID -19 threats considerably. This will certainly create adverse outcomes in the health, social and economic settings in short, medium and longer terms in the tea plantation sector. To prevent any possible transmission of COVID -19 infections, stakeholders in the tea plantations are advised to adopt the guidelines at their workplaces. This study focuses on the factors affecting the adoption of control measures for the COVID -19 Pandemic in tea plantation sector in Badulla District. The study was conducted by selecting 20 tea estates using stratified sampling technique from Regional Plantation Companies in Badulla district. A Cross-sectional survey was conducted by administering a semi-structured questionnaire together with focus group discussions to collect primary data from 72 individuals from management staff, operational staff and workers of the selected estates. Correlation and Multiple regression models were applied to measure the degree of variation and relationship among the tested parameters using STATA 16 software. Among the operational staff and workers in tea estates, the most prominent control measures were wearing face masks and keeping social distance during working time. Checking body temperature before entering to duty was hard to implement for workers engaged in the field, and wearing gloves was made complications in the field and factory premises. Findings of this study confirm that the individual's complacency on probability of getting affected, severity of the negative outcomes of the disease, confidence on the social institutions and the information received were positively correlated with the degree of adoption for the control measures. It was also found that socio economic factors; gender, income, education, type of employer and the nature of work can affect on the degree of adoption to the control measures. Some constrains related to the working place such as inadequate of facilities, lack of time and impracticability of the control measures were identified. Findings of this study would be useful for relevant authorities to review the factors affecting on the adoption of control measures introduced against Covid 19 in the plantation sector and develop most effective strategic plans for controlling such pandemic situations in future.

Keywords: Adoption, COVID -19, Confidence, Constrains, Pandemic

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Geochemical Variations of Prospective Heavy Mineral Deposits Bordering the Coastline of Sri Lanka

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Heavy minerals with a specific gravity greater than 2.9 g/cm³ such as ilmenite (FeTiO₃), rutile (TiO₂), leucoxene (altered ilmenite), zircon (ZrSiO₄), monazite ((Ce,La,Nd,Th)PO₄), garnet ((Ca,Mg,Fe,Mn)₃(Al,Fe,Mn,V,Cr)₂(SiO₄)₃), sillimanite (Al₂SiO₅), and magnetite (Fe₃O₄) have gained global attention as a result of modern technological advances. In this regard, the mining and processing of these heavy minerals are a timely requirement to uplift the mineral industry and the economy of Sri Lanka. Therefore, the objective of this study is to investigate the geochemical variations of prospective heavy mineral deposits along the coastline in order to identify locations with economically significant concentrations of heavy minerals. Field excursions were carried out to identify the potential of heavy mineral placers in Sri Lanka. Sediment samples were collected from ten locations covering both the shoreline and raised beaches. X-ray fluorescence (XRF) analysis was used to determine the major and trace element compositions of sediments. When compared to average Upper Continental Crust (UCC) values, major and trace element variations show the enrichments of TiO₂, Fe₂O₃, La, Ce, Zr, Cr, Nb, Th, and V. The abundance of TiO₂, Fe₂O₃, and Zr, and visual examination of samples suggest the presence of higher concentrations of heavy minerals such as ilmenite, rutile, and zircon in the prospective locations. Moreover, the abundance of trace elements such as La, Ce, and Th implies the presence of rare earth elements (REEs) bearing heavy minerals such as monazite and zircon. In contrast, major elements (Al₂O₃, Na₂O, and K₂O) and large-ion lithophile elements (Ba and Rb) were significantly depleted compared to UCC values. Based on the XRF data and visual examination, it can be concluded that all the studied locations such as Verugal, Dickwella, Kosgoda, Payagala, Beruwala, Kalutara, Dharga Town, and Aruwakkalu can be identified as potential sites for heavy mineral placers. Finally, proper quantification is required to estimate economic grade and to determine mining feasibility.

Keywords: Heavy minerals; Geochemical variation; Economic concentrations; Coastline of Sri Lanka

Development of Green Colour in Topaz Using Diffusion Method

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Topaz is one of the abundant gem varieties in Sri Lanka with the chemical formula of $\text{Al}_2\text{SiO}_4(\text{F}, \text{OH})_2$, which has a hardness of 8 on the Moh's hardness scale. The colourless Topaz varieties have less market value compared to the coloured Topaz varieties. Irradiation and other methods are used traditionally to improve the appearance of Topaz. Nevertheless, conventional methods have drawbacks such as high manufacturing cost, less operational safety due to radioactivity related processes. Hence, the present study tested the diffusion effect of Chromium (II) chloride on colourless topaz with the aid of heat treatment. Seventy-two colourless Topaz samples were treated with Chromium (II) chloride. The selected stones were heated under reduced and oxidizing conditions with the Chromium (II) chloride at different temperatures ($600\text{ }^\circ\text{C}$, $700\text{ }^\circ\text{C}$, $800\text{ }^\circ\text{C}$, and $900\text{ }^\circ\text{C}$) and different soaking times (1, 2, and 3 hours). In both reduced and oxidizing conditions Chromium (II) chloride, diffused into the topaz by producing a shade of pale green to dark green colour. Colour shade becomes strong with the increase of the temperature. Produced colours created a desirable appearance on the stones. At $900\text{ }^\circ\text{C}$ the produced green colour was identified as 'GB/BG 7/2' in the GIA colour grading system. The durability of the coating was tested for acidic conditions (with HNO_3 and H_2SO_4 acids) and sonication. The produced surface coating was stable under acidic conditions as well as under the sonication. Oxidizing conditions in electrically operated furnace is economically beneficial over gas furnace in producing colours. Finally, colourless Topaz could develop the green colour by diffusion with the optimum temperature of $900\text{ }^\circ\text{C}$ with the soaking time of 1 hour under oxidizing conditions.

Keywords: Diffusion Treatment; Topaz Enhancement; Colour development of gemstones

Uniaxial Tensile Properties of Polyester Textile Waste Fiber Reinforced Thermoplastic Waste Composite

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The textile industry plays a significant role in the Sri Lankan economy. However, the management of textile waste has become a critical challenge faced by the industry. Most of the generated textile waste typically goes to open dumpsites, disposed of through open burning or incinerated. However, due to the large volumes of waste generation, the textile sector has paid clear attention to seeking better solutions to manage their waste. As such, there has been an increased interest to develop novel materials from industrial waste. Hence, the aim of this work is to develop and characterize composite materials using post-industrial polyester textile waste as fiber reinforcement and waste packaging materials as the polymer matrix as a new solution to the generated waste. The materials have been selected as polyester textile waste as the fiber reinforcement and thermoplastic waste packaging material as the matrix. Both materials were collected from the Sri Lankan textile industries. The composites containing 0% wt, 2.5% wt, 5% wt, 7.5% wt, 10% wt, 15% wt, and 20% wt reinforcement were manufactured using the compression moulding technique. No additional binders were added. The uniaxial tensile test was conducted according to the ASTM D 638 standard, and the Ultimate Tensile Strength and Young's Modulus were focused for the study. According to the obtained results, the Ultimate Tensile Strength and the Young's Modulus have increased up to a certain percentage of fiber reinforcement weight in the composite. Moreover, both uniaxial tensile strength and young's modulus have reduced with increasing reinforcement fiber loading when passing that particular percentage. Accordingly, among the seven types of composite materials developed with different fiber reinforcement weight percentages, 7.5% wt. waste polyester textile fiber-reinforced composite shows the best performance for the uniaxial tensile properties. Experimental findings show that the uniaxial tensile properties of the developed composite show a positive trend to use as a substitute for non-structural applications such as particleboards.

Keywords: Polyester textile fiber; Textile waste; Thermoplastic; Tensile properties

Synthesis of Thermally Stable Silicone Based Novel Electro - Conductive Grease using Sri Lankan Natural Vein Graphite

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Grease is a solid or semi-solid product which contains three main components such as base oil, thickener and an additive package. While reducing the contact resistance, repelling moisture and inhibiting the corrosion, the Electro-Conductive Grease (ECG) can prevent static buildup. Hence, they can be used as a gap filler in the moving parts of the electrical circuits. However, electric and electronic apparatus with moving parts generate heat and it is necessary to maintain ambient conditions for the normal operation. Therefore, to overcome such issues thermally stable ECG has been taken more attention recently. Most widely used silicone grease has dimethyl silicone oil as the base oil and can be performed -50 °C – 170 °C temperature range but unable to serve as conductors. Graphite is anisotropic, being a good electrical and thermal conductor within the layers. Further, the carbon layers can slide with respect to one another quite easily, thus making graphite a good lubricant. Therefore, mixing graphite and silicone grease would preferably combine the electro-conductive nature of graphite and thermal stability of silicone grease. Powdered natural vein graphite and the silicone grease were mixed at different weight ratios and stirred well. Three sample series were prepared based on different graphite powder sample sizes such as 75µm, 63µm and below 63µm. Each sample was tested with DC electrical conductivity and thermal stability. X-ray diffraction pattern of raw graphite was exhibited that availability of impurities such as pyrite which help to improve electrical conductance nature. Carbon content analysis showed that highest grade of graphite was used to develop the grease. The FTIR spectra were exhibited that characteristic stretching vibrations of functional groups attached to the samples. Out of the 3 sample series, the sample with 35% of 75µm size graphite powder with 65% of silicone grease shows the highest electrical conductivity of $2.86 \times 10^{-7} \text{ Scm}^{-1}$ and able to show the wide service temperature range of 10°C to 120°C.

Keywords: Electro-conductive grease; Sri Lankan vein graphite; Silicone grease

A Study on Sustained Drug Releasing Properties of Acarbose Intercalated Na-montmorillonite for Potential Pharmaceutical Applications

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Acarbose is a well-known synthetic drug, which commonly treats type II diabetes. For diabetic patients, acarbose must be administered multiple doses a day to keep a stable glucose level in the body due to short biological half-life. Therefore, drug formulations with sustained releasing properties are developed using stable carriers like, Montmorillonite (MMT) due to its unique structure and properties. In this study, acarbose intercalated clay formulations were synthesized and their sustained releasing properties tested. Acarbose solution (100 ppm) was stirred with MMT (1 g) for 24 h at 4–8 pH. The highest intercalation of acarbose was observed at acidic pH due to electrostatic interactions between negatively charges clay layers and protonated acarbose molecules. The concentration of acarbose in aqueous solution was determined using the UV-Vis spectroscopy method. The calibration curve (2–40 ppm) of standard acarbose ($r^2=0.9826$) at 426 nm, was used for calculating the acarbose intercalation percentages. 2.18 mg g⁻¹ (43.77%) and 5.1 mg g⁻¹ (52.27%) of acarbose intercalated into MMT at pH 6 and the interlayer space of unmodified montmorillonite has been increased from 1.185 to 1.310 nm and 1.403 nm upon acarbose intercalation at 50 ppm and 100 ppm initial acarbose concentrations, respectively. This concludes that acarbose has been successfully intercalated into the interlayers of montmorillonite and the intercalated amount increased with increasing the initial acarbose concentration. Increased intensity and broadening of the peak corresponding to vibrations of OH groups (3687–3125 cm⁻¹) was observed in FTIR spectra of acarbose intercalated montmorillonite, which may due to the presence of acarbose on or between the layers of montmorillonite. The *in-vitro* drug releasing properties of acarbose from acarbose intercalated montmorillonite was tested in artificial intestinal condition (pH 7.4 PBS solution) using dialysis tube method. Acarbose releasing from the montmorillonite matrix was gradually increased in the first 8 h and slow release was observed after that. Pseudo-second order kinetics model showed a good fit ($r^2= 0.9767$) for the acarbose releasing data suggesting the release of acarbose from MMT matrix involves chemical desorption. Overall, this study demonstrates the potential applications of montmorillonite as matrix material for sustained release drug formulations for future pharmaceutical studies.

Keywords: Acarbose; Montmorillonite; Sustained drug releasing; XRD; FTIR

Fabrication & Characterization of a Novel Soap Material Based on the selected Value-Added Sri Lankan Clay Minerals with Extracted Saponin from Dry Fruit of *Sapindus emarginata*

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Soap referred to as stain removal material as a result of a saponification reaction between lye solution and fat/oil. In some soap industries clay minerals are used as a filler material which facilitate the structure and riser attribute of soap. Instead of that these clay minerals have the ability to remove stain and exfoliate the dead skin and act as a moisturizer. There are many clay types that can be found locally which are related to kaolin. However, those clay types do not showcase some qualities such as anti-bacterial effect, anti-fungal effect, moisturizing effect, foaming effect related to skin care. Therefore, those natural clay types have not been used previously for cosmetic purposes. Under this investigation, a non-ionic natural bio surfactant called saponin which was extracted from the dry fruit of *Sapindus emarginata* (soapnut) was used to improve above mentioned lacking qualities. Saponin makes skin soft and acts as moisturizing agent, gentle foaming agent, natural exfoliant, and very good anti- fungal and anti-bacterial agent. Four clays were used for this investigation. Except montmorillonite clay, other three were obtained from different areas of Sri Lanka i.e; kaolin clay from Meetiyagoda, *kirimati* from Kandy, *Makulu* clay from Wadduwa. From each clay type, three samples were prepared by varying the clay amount as 2g (6.7 wt%), 4g (13.3 wt%) and 6g (20 wt%) by maintaining the temperature of the solution as 30 °C in order to find out the best clay species for soap production. Each of the sample were tested for the TFM value, total alkalinity content, moisture content, foam height and pH value. These values were compared with the international standards of soaps. Almost all the parameters of prepared soap samples were within the standard ranges. As per the results, Meetiyagoda clay and *Makulu* clay were the best clays for soap production and the best composition is 20 wt% which contain 6g of clay.

Keywords: Kaolin; *Sapindus emarginata*; saponin, montmorillonite; Saponification

Synthesis of Microwave-Assisted Low-cost Graphene Using Natural Vein Graphite in Sri Lanka

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Graphene is a planar monolayer of carbon atoms arranged into a two-dimensional honeycomb lattice. Due to the exceptional properties of graphene, it has a variety of industrial applications. Graphite remains the most popular precursor for large-scale graphene synthesis or low-cost production. The modified Hummers method and the Staudenmaier method are the popular techniques in which raw graphite is converted into a much valuable form of graphite called graphene oxide. As prepared graphene oxide, then reduce to prepare reduced graphene oxide (rGO). However, the Hummers method has some drawbacks and diminishes the physical properties of prepared graphene. As a result, alternative methods for synthesizing graphene from graphite are necessary. In this study, microwave radiation and low-cost, eco-friendly chemicals (H₂O₂ and commercial liquid hand wash) have been utilized to synthesize graphene from natural vein graphite in Sri Lanka. In this technique, the H₂O₂ and liquid hand wash intercalated natural vein graphite powder in an aqueous medium was microwave irradiated at 400 W for 5 min. Then, the microwave irradiated sample was sonicated for 30 mins to obtain the dispersion containing graphene flakes. The resulted graphite intercalated compound was characterized using the X-ray diffraction (XRD) method, and the prepared graphene dispersion was characterized using UV–visible spectroscopic technique. The XRD data exhibit a successful production of graphite intercalation compound. The UV-Visible data reveal that the sonicated aqueous dispersion contains graphene, although no indication of graphene oxide in the samples. This process has the advantage of manufacturing graphene quickly while using natural graphite and environmentally friendly chemicals.

Keywords: Sri Lankan vein graphite; Graphene; Microwave irradiation; Intercalation

Optimization of Photovoltaic Performance of Electrospun PVdF-HFP Nanofiber Membrane Based Dye Sensitized Solar Cells with Membrane Thickness

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Electrospinning is a versatile and efficient method to fabricate polymeric nanofibers with attractive properties such as the large surface area to volume ratio, better pore interconnectivity, and superior mechanical performances, which can be extended to applications in Dye Sensitized Solar Cells (DSSCs). Hence, to overcome the problem of poor long-term stability of conventional liquid electrolyte based DSSCs, the use of electrospun polymer nanofiber membrane-based gel electrolytes is a possible option. The DSSCs with polymer nanofiber-based gel electrolyte, made by trapping a solution electrolyte within a three-dimensional matrix made of polymer nanofibers exhibit almost liquid-like ionic conductivities while offering better mechanical and chemical stability than conventional liquid electrolyte based DSSCs. In electrospinning, there are various processing parameters, which significantly affect the characteristics of fiber membrane. In this work, a systematic study was performed to analyze the influence of membrane thickness on the photovoltaic performance of the DSSCs, which was assumed to be proportional to electrospinning time. Poly (vinylidene fluoride-co-hexafluoropropylene) (PVdF-HFP) nanofiber membrane was fabricated using the electrospinning method and in order to vary the membrane thickness of the nanofiber mat, electrospinning time was varied. Scanning Electron Microscopic images have shown that the PVdF-HFP membrane consists of porous, thin nanofibers with an average fiber diameter of 80-100 nm. The host polymer membrane was soaked in the solution electrolyte made with iodine (I₂), potassium iodide (KI), and tetrapropyl ammonium iodide (Pr₄NI) dissolved in ethylene carbonate (EC) and propylene carbonate (PC) co-solvent. The short circuit current density (J_{sc}) and light-to-electricity conversion efficiency (η) have shown almost similar variation with the duration of electrospinning. Both parameters have gradually increased to a maximum value and then has decreased with electrospinning time. Maximum efficiency (η) of 5.96% was observed for the DSSC fabricated with optimized nanofiber membrane, corresponding to 4 minutes of electrospinning time. The open circuit voltage (V_{oc}), short circuit current density (J_{sc}) and fill factor were recorded as 693.4 mV, 14.6 mA cm⁻², and 58.86% respectively at an incident light intensity of 1000 W m⁻² with a 1.5 AM filter whereas the conventional liquid electrolyte cell showed an efficiency (η) of 6.56%.

Keywords: Dye sensitized solar cells; PVdF-HFP co-polymer; Nanofiber gel polymer electrolyte; Electrospinning

Development of a Silicone Dielectric Polymer for Actuators

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Virtual 3D environments (Virtual Reality) are created inside computers to deliver thermal, vibrational, and force feelings. Haptics technology brings this virtual world to end-users by haptics goggles and gloves. Tactile displays have been developed to deliver sensations in haptics gloves. In this regard, actuators act as movers in tactile displays stimulating sensations to skin receptors inside the fingertips. Dielectric polymer-based actuators are prominent in the world due to lightness, lower energy loss, and simplicity leading to wearable haptics gloves. Acrylic and silicone are the major types of dielectric polymers used for actuators. Silicone dielectric polymers have excellent properties such as faster response (3 s), efficiency, lower mechanical loss, and thermal stability comparing to acrylic. But silicones unable to achieve greater electro-strains (>10%) as it's in acrylic-based actuators. This research work focused on enhancing the electro-strain property of silicone dielectric polymer by blending polyaniline particles. The electro-strain property of dielectric polymers depends on both dielectric constant and elastic modulus. Increased dielectric constant and decreased elastic modulus improve the electro-strain of actuators. Polyaniline has positive and negative charges itself which can be utilized to improve the dielectric constant of silicone polymer. Also, dispersed particles can change the elastic modulus of the matrix material. In the procedure, polyaniline and Dow corning silicone (DC 3481) were mixed in 0.0wt%, 0.5wt%, 1.0wt%, 1.5wt%, and 2wt% compositions and stirred for six hours. Next, thin films (thickness-125 μm) were prepared using the Doctor blade technique on PVC (Polyvinylchloride) sheets. Crosslinking process was carried out for 24 hours. In characterization, 2wt% Dow corning silicone (DC 3481) and polyaniline polymer blend showed the 41.76% increment in dielectric constant, and elastic modulus was decreased by 68.71% compared to pure Dow corning silicone (DC 3481). This composition achieved the best matching electromechanical properties in dielectric constant and elastic modulus to apply in actuators. The developed polymer is recommended for haptics gloves to deliver enhanced force and vibration. Moreover, the Doctor blade technique can be introduced to fabricate thin films in actuators which is simple and cost-effective.

Keywords: Virtual reality (VR); Actuators; Dielectric constant; Elastic modulus

Fabrication of Biodegradable Composite Packaging Film from Banana Fibers

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Plastic Polymers are the most popular petroleum-based material used in food packaging, due to their low cost and functional advantages. As a result of improper waste management, these materials take considerable time to decompose. After harvesting crops, both banana pseudo- stems and leaves are disposed of as landfills and this leads to increase environmental pollution. Biodegradable packagings made up of natural fibers and other environmentally friendly materials are being used to reduce this issue. These materials are eco-friendly and decompose rapidly in ambient conditions. The purpose of this study was to prepare a biodegradable composite film for food packaging using alkali and bleached banana pseudo-stem fibers, polyvinyl alcohol (PVA) and titanium dioxide (TiO₂). Composite films were prepared using the solution casting method. In brief, NaOH was used as a pretreatment chemical and NaOCl/ CH₃COOH were used in the bleaching process where incorporating the latter step produced pure cellulose with respect to the alkali pretreatment. The compositional effect on the structure and properties of the resulting films were investigated and synthesized films were characterized using Fourier Transform Infrared Spectroscopy (FT-IR) and Scanning Electron Microscopy (SEM). FT-IR showed more prominent peaks for bleached cellulosic fibers indicating pure cellulosic fibers. Furthermore, SEM analysis showed a smooth surface for bleached composite film and a rough lignin-based surface for the pretreated composite film. Due to the photocatalytic effect of TiO₂ an enhanced antibacterial resistivity was observed in the composite films. Biodegradability test showed biodegradation upon three days at ambient soil condition whereas Water Vapor Permeability (WVP) test and water solubility tests showed, lowest water solubility and WVP at 25% fiber loading. The highest tensile strength of 42.9 N/mm² was observed for PVA+bleached fiber (25%) +TiO₂ film with effect from the increase in fibre-matrix adhesion. Furthermore, it was observed that incorporating bleached fibers resulted in an increased tensile strength from 4% to 6%. Banana pseudostem fibers in combination with PVA and TiO₂ demonstrated to be a potential biodegradable composite packaging film with enhanced antibacterial resistance.

Keywords: Composite; Banana fibers; Pseudostem; Packaging; PVA; TiO₂

Development of a Novel Composite Tile using Meetiya-goda Kaolinite Reinforced with Polylactic Acid (PLA)

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Sri Lanka has high quality Kaolinite deposit in Meetiya-goda that govern by the Lanka Ceramic PLC and refined kaolinite has provided to the local ceramic industries. Kaolinite, is a layered silicate clay mineral composed with low shrink–swell capacity and cation-exchange capacity. Mostly ceramic tile production is suffering with cracking, low strength, high weight and less waterproof capacity. Hence, ceramic tile industry has been updating with product advancement gradually since last decades. Specially, the evolution of tile body formulations and technological behavior of clay composite materials have taken in to attention. This trend has taken step forward with introducing novel composites by mixing polymer materials with raw materials. Polylactic Acid (PLA) is a blend composite having low stiffness, high tensile strength and high gas permeability. Therefore, the present study is focused on develop a composite material by mixing PLA and kaolin in order to obtain low weight, high strength and waterproof ceramic tiles. Initially Kaolin samples were collected from Meetiya-goda Kaolinite deposit and all the samples were tested for moisture content & were subjected to physical purification by mixing with distilled water and obtained a milky color clay solution. After that dried clay samples were powdered and 125 micron size fraction was obtained by mechanical sieving. Then while PLA was heating to its melting temperature (170⁰C), kaolinite was added time to time (ratio in 50:50) into PLA container and mixed using a heat stirrer in 170⁰C for 30 min to develop a slurry which then set up in a mould. Then the prepared novel composite tile sample was tested on water absorption, compressive strength & crystal structure was tested by using the X-Ray diffraction (XRD).As an overall result the novel tile sample shows almost 0% water absorption with time and also it is very light in weight with a considerable amount of strength. This novel tile can be developed with low temperature (170⁰C). Therefore, the product is cost effective. Future of this research can be directed to enhance more properties based on what material used to reinforce the kaolinite (Ex: Glass fiber, Silica, graphite) and we can use this reinforced kaolinite as a raw material to develop a novel cement (plaster) to apply in building constructions.

Keywords: Kaolinite; PLA; Novel reinforced tile; Water absorption

Application of Thermally Reduced Graphene Oxide-based Counter Electrode for Dye-sensitized Solar Cells: A Comparative Study on Sintering Temperature

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A counter electrode (CE) fabricated with thermally reduced graphene oxide synthesized from Sri Lankan graphite is proposed for promising Platinum-free dye sensitized solar cells (DSSC). As it is well known, Sri Lankan natural graphite has become more attractive and demanding in the world due to its high purity and high crystallinity. In a DSSC, a thin film of Platinum (Pt) is generally used as the catalytic material on the CE due to its high conductivity and superior electro-catalytic activity. However, there is a considerable attention to replace Pt based CEs due to their high cost and limited supply. Recently, extensive research has been performed on using carbon materials for the CEs due to their low cost, high conductivity and good catalytic activity. In this study, reduced graphene oxide (RGO) was synthesized and deposited on FTO conducting glass substrate by spray method. To investigate the effect of sintering temperature of the CE on the performance of DSSCs, a series of RGO based CEs were prepared with different sintering temperatures from 100 °C to 300 °C by increasing the temperature by 50 °C intervals. Results confirmed that the DSSCs prepared with sintered CEs exhibit a better photovoltaic performance compared to the DSSCs made with un-sintered CEs essentially due to the enhanced adhesion to the FTO glass substrate in the sintered composite material. DSSCs with CEs sintered at 250 °C have exhibited the highest efficiency of 4.52 % compared to the DSSC with un-sintered CEs (efficiency=1.35 %). This low cost RGO CE exhibits good stability and acceptable efficiency compared to Pt CE (7.82 %) in DSSCs operating under similar conditions. Synthesized RGO sheets were characterized using scanning electron microscopy, Raman spectroscopy and X-ray diffraction. The electro-catalytic activity of RGO CE was determined by cyclic voltammetry. Results suggested that this CE can be one of the alternatives to the Pt CEs in DSSCs with further modifications.

Keywords: Dye sensitized solar cells; Counter electrode; Reduced graphene oxide; Sintering temperature

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Investigating the Potential of Clay Brick Waste to Be Used as a Raw Material for Rice Husk Ash-Based Bricks

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Rice husk ash (RHA) and clay are well-known pozzolan materials that can be incorporated to tailor the properties of commercial bricks in the construction industry. Clay brick waste (CBW) is a clay product that is largely generated during mass-scale demolition activities. Although several works reported the use of RHA for developing bricks with improved physical properties, no work investigated how CBW influence the performance of RHA-based bricks. Accordingly, this work investigated how brick waste can be incorporated into RHA-based cement brick and how its properties such as compressive strength, water absorbency and morphology are influenced. For this, untreated RHA (particle size: 63-500 μm), CBW, OPC cement and water were used, and several bricks with dimensions 7 \times 5 \times 3 cm were developed by using different volume mixing ratios. The optimum mixing ratio among constituents was determined based on the brick's porosity, surface finish and de-moulding capability. Results indicate that the optimum volume mixing ratio is 2:3:6:1 (cement: CBW: RHA: water). The RHA content should be less than 13% w/w to ensure de-moulding. Having BCBW content of more than 44% w/w is acceptable for a better product, but too high contents around 64% w/w are not desirable as it discourages the removal of the brick for the mould. The brick with the optimum mixing ratio shows a water absorbance of 51% w/w and compressive strength of 3.61 MPa (28 days). Without RHA, the brick maintains the same compressive strength while reducing the water absorbance down to 20%. Compared to bricks reported in the literature using RHA/clay, RHA/lime/cement, RHA/aggregates, the proposed brick has significantly high water absorbency, and the compressive strength is around the reported values. Considering its properties, and the presence of heavy-metal-adsorptive RHA, the brick can be proposed for construction areas where wastewater channels are involved.

Keywords: Rice husk ash; RHA; Clay brick waste; Compressive strength; Water absorbance; Optimum mixing ratio

Removal and Recovery of Phosphate using Sorption from Wastewater: Effect of Process Parameters and Modeling

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Wastewater contains P (Phosphorus) from human excreta, household detergents and some industrial and trade effluents in the form of orthophosphates, organic compounds and polyphosphates. Out of these, phosphate is the most available form of P. Thus, the need for the removal of excess phosphate is a necessity. Since P is a nutrient, release of wastewater containing excess P could lead to create problems of eutrophication. Apart from that, P is a finite resource, therefore, recovery of P from wastewater is also of interest. Sorption has been given importance in this regard mainly by using Activated Carbon (AC). However, use of kinetics and adsorption isotherm models to describe this P sorption process on to AC is limited in the literature. Therefore, this study is sought at describing adsorption kinetics and equilibrium adsorption isotherms of P on to AC and the desorption process to enhance the recovery of phosphate. Different reaction parameter impacts on the adsorption process were tested. Experiments were conducted with synthetic solutions having an initial P concentration of 25 ppm prepared by using KH_2PO_4 . Results of the kinetic study done in triplicate showed that the phosphate removal reached its maximum value (38.37%) after four hours and thirty minutes. The Elovich model fit well with the kinetic study experimental data explaining that the rate of adsorption of P on to AC gets decreased exponentially as the amount of adsorbed P on to AC increases. Equilibrium isotherm study results suggested that this adsorption process could be well explained by the Langmuir model with the maximum adsorption capacity of $-0.5488 \text{ mg g}^{-1}$. The results also revealed that the pH of the solution significantly influences the adsorption process as P removal efficiency is considerably decreased from lower pH to higher pH. Desorption study w results showed that the phosphate adsorbed by AC could be successfully desorbed using 1 M NaOH solution up to 84.17% after 1.6 hrs.

Keywords: Phosphorus; Adsorption; Elovich model; Langmuir model; Desorption

Preparation and Optimization of Banana Fiber Reinforced Natural Rubber Composites

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Agro-industrial waste has become a major environmental issue in most parts of the world. Banana trees are one of the major underutilized agro by-products generated, especially in Sri Lanka. Natural fiber reinforced bio-degradable composites are good alternatives for composites produced with conventional materials. Banana fibers are cheaper, environmentally friendly, renewable and biodegradable. This work was aimed to evaluate the feasibility of utilizing fiber extracted from banana stem with natural rubber to develop a composite with enhanced mechanical properties, especially for flooring products. In this study, banana fibers were extracted and characterized using Fourier-transform Infrared (FTIR) spectroscopy. The surface of the banana fibers was modified using NaOH and Na₂SO₃. The surface modification was confirmed by FTIR spectroscopy. Natural rubber-based composites were prepared with different levels of banana fiber loadings with other compounding chemicals. Physico-mechanical properties of the composites such as hardness, compression set, abrasion volume loss, tensile properties and tear strength were evaluated. These properties of the composites were compared with those of the composite prepared according to the same formulation, but without banana fiber (i.e. control). Compared to the Control, novel banana fibre-filled natural rubber composites show improved mechanical properties such as lower compression set, higher abrasion resistance and higher hardness. It can be concluded that, within the limited scope of the experiments carried out in this investigation, this banana fibre-filled natural rubber composites could be utilized as a flooring material.

Keywords: Banana fiber; Natural rubber; Composite; Reinforcement

Utilization of Sugarcane Bagasse Ash as a Partial Replacement of Fine Aggregate in Grade 45 Concrete

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Nowadays, many investigations focus on ways of utilizing industrial or agricultural wastes as a replacement for the construction industry. In addition to the financial benefits in this regard, such materials may also lead to sustainable products and a pollution-free environment. Sugarcane bagasse ash is one such siliceous and aluminous waste generated in the sugar refining industry apart from ethanol. In this study, fine aggregates in a concrete mixture were partially replaced by untreated sugarcane bagasse ash under different weight percentages: 0%, 10%, 20% and 30%. The untreated bagasse ash was also used as another raw material in the concrete mix apart from other raw materials: fine aggregates, coarse aggregates, cement and water. The compressive strength measured at 28 days was considered to determine the optimum ash content for the concrete mix. In this optimum range, the highest value range for compressive strength is found. Accordingly, the optimum ash content should be between 0% - 10%, if sugarcane bagasse is used as a partial replacement to fine aggregates. However, when added in addition to the existing materials (without partial replacement), the outcomes for the compressive strength have not found to be favourable. The compressive strength is comparatively low in this case compared to the full replacement scenario. This study thus concludes that high strength concrete can be made by utilizing sugarcane bagasse ash as a partial replacement of fine aggregate.

Keywords: Compressive strength; Sugarcane bagasse ash; Sugarcane bagasse; Agricultural waste

The Effect of Bis-(3-triethoxysilylpropyl)-Tetrasulfane and Polyethylene Glycol on the Properties of Natural Rubber/ Mica Composites

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The bis-(3-triethoxysilylpropyl)-tetrasulfane (Si69) is widely applied as a coupling agent to rubber-filler interactions in silica filled rubber composites. In this study, the effect of bis-(3-triethoxysilylpropyl)-tetrasulfane (Si69) and polyethylene glycol (PEG) on the properties of natural rubber (NR)/mica composites has been studied. The mica loading and the total weight of Si69/PEG were kept constant at 30 phr and 2 phr, respectively. A composite free from Si69/PEG (SP00) was used as the control, while ratios of the above chemicals (Si69: PEG) were varied as 1:0, 0:1 and 1:1 in the other composites. These three systems were denoted SP10, SP01 and SP11, respectively. Curing characteristics, physico-mechanical properties and thermal degradation of NR/mica composites were investigated. The maximum cure time (T_{c90}) and scorch time (T_{S2}) were exhibited in the SP10 compound. However, introduction of PEG into the system with Si69 in SP11 composite yield a reduction in T_{c90} and T_{S2} , which were comparable with the control (SP00). Maximum tensile strength and elongation at break were observed in Si69 treated NR/mica composite (SP10). This could be attributed to the improved rubber-filler interactions caused by incorporation of higher amounts of Si69 (2 phr). Further, the composite treated with both Si69 and PEG (SP11) with 1 phr each, has shown the second highest tensile strength among candidate composites. However, the enhanced moduli values at 100%, 300% and 500% elongation indicated better rubber-filler interactions in SP11 composite than SP10. The same reason may have resulted the highest hardness and resilience values in SP11 composite. The thermogravimetric analysis indicated that the application of Si69 and/or PEG have no significant impact on the thermal degradability of NR/mica composites. It was also found that SP01 exhibited the highest swelling ratio among all samples. Therefore, overall results indicated that PEG/Si69 treated system (SP11) could be employed more effectively than individual use of Si69 and PEG to optimize the cure characteristics, while improving the physico-mechanical properties of NR/mica composites.

Keywords: Mica; Natural rubber composites; Polyethylene glycol; Coupling agent; Rubber-filler interactions

Comparative Study of Catalytic Reduction of Methylene Blue by Green Synthesized Copper Nanoparticles Using *Syzygium cumini* Leaves Extract

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Green synthesis using plant extracts is considered as an efficient, eco-friendly and inexpensive approach in metal nanoparticle synthesis. Copper nanoparticles are well known as catalysts in many organic reactions. The present study focuses on the green synthesis of heat and sunlight-induced copper nanoparticles using *Syzygium cumini* leaves aqueous extract as the source of reducing and capping agents. Synthesized nanoparticles were used to investigate and compare the catalytic effectiveness in the reduction reaction of Methylene Blue. The leaves extract was prepared by treating the leaves with distilled water at 50 °C for 1 hour. Copper nanoparticles were synthesized by mixing a known copper sulphate solution with leaves extract at a volume ratio of 5:3 followed by either heating (4 hours at 50 °C) or irradiating the mixture to sunlight for 4 hours. The synthesis of copper nanoparticles was initially recognized by the colour change of the extract solutions from pale yellow to dark brown. The formation of heat and sunlight derived copper nanoparticles were confirmed by UV-Visible peak maxima at 335 nm and 333 nm, respectively. Peak positions of Fourier transform infrared spectra of synthesized copper nanoparticles have revealed the activity of biomolecules as reducing and capping agents. Catalytic activities of synthesized copper nanoparticles were investigated using the reduction reaction of aqueous Methylene blue to Leucomethylene blue in the presence of excess NaBH₄ as a model reaction. The reaction progress was monitored by UV-Visible spectrophotometry at room temperature. The apparent rate constants of the reaction in the presence of heat and sunlight derived copper nanoparticle catalysts were 51.1×10⁻³ min⁻¹ and 32.6×10⁻³ min⁻¹ respectively. The apparent rate constant of the reaction in the absence of copper nanoparticle catalyst was 8.1×10⁻³ min⁻¹. The study confirms the catalytic activity of *Syzygium cumini* leaves derived copper nanoparticles while heat-induced copper nanoparticles showed 56% greater catalytic activity compared to sunlight-induced copper nanoparticles. Further characterization of nanoparticles and optimization of the biosynthesis parameters are needed to be performed.

Keywords: Green synthesis; Dye degradation; Sunlight irradiation; Sustainability

Green Synthesis of Zn Nanoparticle (ZnO NPs) Using Palmyrah Resource and Evaluation of Its Antimicrobial Property

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Borassus flabellifer is a tree found in the tropical belt of Sri Lanka and almost all parts of the tree can be used for various purposes like food, medicine, and others. Mostly, the leaf has been used to make handicraft items and is popularly known for this only but other than this, there is a potential for the leaf being used for various purposes. Only very few studies were conducted to evidence the medicinal importance of palmyrah leaf. The aim of this work is associated with plant-mediated nanoparticle synthesis through developing low-cost, eco-friendly processing using palmyrah leaf extract and zinc sulphate and sodium hydroxide as precursor solution. The artificial synthesis of ZnO is assisted by chemical processing and leaving several hazardous effects on the world. The nanoparticles synthesized were characterized using X-ray diffraction analysis and the antibacterial activity was evaluated by the agar well diffusion method. The X-ray diffraction (XRD) spectrometer was used to determine the crystalline size of nanoparticles synthesized as 20 ± 6 nm at the wavelength of 517 nm. Antimicrobial activity for two different concentrations of ZnO nanoparticles (50 and 100 mg/ml) was studied for *Escherichia coli*. A significant inhibition activity was observed for the tested two concentrations and the maximum activity (18 mm) was observed from the highest concentration. An attempt is employed for the synthesis of ZnO nanoparticles using leaf extract of *Borassus flabellifer* in an environmentally friendly manner. In this green nano-particle synthesis process, palmyrah leaf extract has functioned as a reducing and capping agent. Green aspects of ZnO nanoparticle synthesis could be recommended as an alternative to high thermal chemical processing. Further characterization for associated phytochemical compounds and any toxic factor will assist to incorporate this nanoparticle for developing any value-added product from palmyrah in the future.

Keywords: *Borassus flabellifer*; ZnO nanoparticle; XRD analysis; Antibacterial activity



Enhanced Photovoltaic Properties of Cadmium Sulfide Quantum Dot Sensitized TiO₂ Solar Cells with Novel SnO₂ Based Counter Electrode

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Quantum dot sensitized solar cells (QDSSCs) have gained increased attention due to the unique properties of the semiconductor quantum dots (QDs), as light captivating materials. QDs facilitates multiple exciton generation, tunable bandgaps, high absorption coefficient, and low power consumption. Many studies have been carried out towards producing affordable QDSSCs with high power conversion efficiencies, utilizing these properties. As a critical component of QDSSCs, counter electrodes hold significant importance among these studies. Platinum (Pt), a widely used counter electrode with QDSSCs, is being disfavored due to high cost, diminishing material supply, and reduced catalytic activity, when used with polysulfide electrolyte which is the most common electrolyte for QDSSCs, due to surface, adsorbed sulphur. Therefore, substantial investigations have been carried out in searching for an alternative, affordable and effective counter electrode in these devices. Among the suitable materials, tin oxide (SnO₂), a wide bandgap semiconductor, has become a promising candidate for counter electrode due to its high chemical stability, high electron mobility, low cost and environmentally friendly nature. In this study, counter electrodes were fabricated by depositing SnO₂ films on fluorine-doped tin oxide (FTO) glass substrates by using a simple spray pyrolysis technique. These counter electrodes were characterized by scanning electron microscopic and Raman techniques. Photovoltaic properties of CdS quantum dots sensitized TiO₂ solar cells with polysulfide electrolyte were tested by using this novel counter electrode. QDSSCs fabricated with optimized SnO₂ counter electrode showed 1.47% power conversion efficiency under the illumination of 100 mW cm⁻², whereas the devices fabricated with conventional Pt coated counter electrodes showed 1.08% under the same conditions. Therefore, about 36% enhancement in power conversion efficiency could be obtained by employing this novel low-cost counter electrode in these QDSSCs.

Keywords: Counter electrode; SnO₂; CdS; Quantum dot sensitized solar cell

Effect of 4-tertbutyl pyridine and guanidinium thiocyanate Co-Additives on Performance of Dye-Sensitized Solar Cells Fabricated with Non-Volatile Liquid Electrolyte

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Dye-sensitized solar cells (DSSCs) are emerging as potential candidates to substitute for expensive silicon solar cells because of reasonably high efficiency, easy fabrication method, lower production cost and transparency. Electrolyte modifications of DSSC are an easy way to enhance the photovoltaic performance. The conventional liquid electrolyte system is composed of iodide/triiodide single salt in the volatile, acetonitrile solvent. In this work, the non-volatile ethylene carbonate (EC) and propylene carbonate (PC) were used with tetrapropyl ammonium iodide (Pr₄NI) salt to prepare the reference electrolyte. The effect of the co-additives 4-tert butylpyridine (TBP) and Guanidinium thiocyanate (GuSCN) on the photovoltaic performance of DSSCs was also studied. The addition of TBP as an additive into the iodide electrolyte system increased the photovoltage (V_{OC}) by 13.8%, but it reduced the photocurrent density (J_{SC}) by 7.2%. However, the J_{SC} was increased by about 8.7% by the addition of GuSCN as the additive. The addition of the combination of TBP and GuSCN binary additives in the optimized ratio of 65:35 enhanced the cell efficiency from 5.63% to 6.83%. The overall efficiency enhancement has been explained by the shifting of the conduction energy band edge of TiO₂ due to the adsorption of species from the two co-additives by TiO₂ leading to the enhancement of both, the photocurrent density as well as the photovoltage. TBP improves the V_{OC} by a negative shift of the band-edge and also prevents the electron recombination to I₃⁻ due to the blocking effect on the dye-absent active site of the TiO₂ surface. The addition of GuSCN to TBP-added electrolyte restored the J_{SC} by the positive shift of the band-edge. The net effect is to increase the overall performance of DSSCs due to the synergistic effect of the two co-additives.

Keywords: Photovoltaic effect; Co-additives; Band-edge shift; Non-volatile; V_{OC} improver

Development of a High Abrasion Resistance Shoe Sole Incorporating Four Different Silica Grades

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Silica used as active reinforcing filler to improve high abrasion resistance in Rubber. In this study, the effect of four different silica grades (silica MP BET 161-190, silica powder newsil micro peral, silica 355GR and silica BET higher grade) on the abrasion resistance and other properties of the shoe sole have been studied. In this study type of silica grades was changed while keeping all the other ingredients and their amounts constant. The abrasion resistance was determined using DIN 53516 test method and the hardness, specific gravity, tensile strength and elongation at break were determined by following the respective ISO and ASTM standards. The results of the study showed that all four silica grades incorporated shoe soles have achieved acceptable abrasion resistance values. Achieved abrasion resistance value for shoe sole is maximum 350mm³. However, silica MP BET 161-190 has 289 mm³ which is also a quite higher abrasion resistance with a minimum loss of rubber in abrasion compared to other three silica grades. When considering the effect of silica grade on the physical properties of rubber compound, both silica MP BET 161-190 and 355GR grades showed acceptable values for all tested hardness, specific gravity, tensile strength and elongation at break of silica MP BET 161-190 grade incorporate sample were 48 IRHD, 1.088,17 MPa and 676% respectively. While silica 355GR incorporated sample were 51 IRHD, 17.1MPa and 631% respectively. However, both silica powder newsil micro peral and silica BET higher grade incorporated samples showed poor performance for the tested physical properties. Therefore, it can be concluded that, silica MP BET 161-190 is better performing as an active reinforcing filler with the highest abrasion resistance and a minimum loss of rubber in abrasion compared to other three silica grades.

Keywords: Abrasion resistance; Physical properties; Shoe sole; Silica grades

Effect of Fiber Size on Properties of Oil Palm Fiber Waste Filled Natural Rubber Composites

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The twenty-first century has witnessed remarkable achievements in the rubber industry regarding green technology through the development of natural fiber based rubber composites. A wide variety of natural fibers extracted from coconut, palmyra and banana has been used as fillers in the development of natural rubber (NR) based green composites, most importantly to reduce environmental pollution caused by hazardous powdered fillers and to enhance reinforcement. Oil palm fiber (OPF) is hard, tough and has the potential to reinforce the rubber matrix. Mesocarp part of OPF, which generates as a waste material of palm oil processing mills was used as a filler in this study. The objective was to investigate the effect of size of OPF on cure, physico-mechanical, water absorption and ageing properties of NR composites. A chemical treatment was conducted to reduce fiber size and to improve physico-mechanical properties. Chemical processing with sodium hydroxide, bleaching with sodium chlorate and oxalic acid were conducted to remove residual oil and reduce fiber size. A series of NR composites were prepared with 2 phr OPF by varying its size from 250 μm to below 50 μm . The NR composite prepared without OPF, but with 2 phr of carbon black was considered as the control. Although an increase in properties was expected with the reduction of fiber size, no significant increase was observed. Nevertheless, results showed the highest values for the NR composite prepared with OPF in the size range 125-175 μm in regard to modulus at 300% elongation, tensile strength, hardness, resilience and an average value for water absorption. This revealed even dispersion of OPF in the rubber matrix of the above composite and the results were in agreement with crosslink density indicated by the delta cure value. There was no decrease in tensile modulus and strength after ageing, which indicates high retention of these properties. Overall, results revealed that carbon black in NR composites could be replaced with OPF to manufacture rubber products requiring hardness ranging from 29-36 Shore A.

Keywords: Oil palm fiber; Natural fillers; Natural rubber; Cure characteristics; Physico-mechanical properties

A Comparative Study on Degradability of NBR and NR Latex Gloves

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Natural rubber (NR) and Nitrile rubber (NBR) gloves are two main types of latex gloves used in the personal protective equipment market. In the face of an abrupt increase in the demand and usage of these gloves due to the present Covid-19 pandemic, degradation of these gloves after usage may create an environmental threat. Therefore, a study was conducted to compare the degradable behavior of these products. Both glove types were treated under thermal and hydrothermal, and UV radiation environments. Untreated samples were used as the control. Under thermal, hydrothermal and photo-oxidative treatments, an increase of the swelling index of untreated NR gloves (65.2%) increased by 38.23%, 14.69% and 7.17%, respectively while NBR gloves showed a percentage swelling index increment of 14.52%, 15.56% and 12.12% with compared to the percentage of the swelling index of the untreated sample (28.77%) in the same order of treatments. The average tensile strength of NR was decreased from 16.89 to 15.67, 11.19, and 15.63 MPa while for NBR it decreased from 28.06 to 24.35, 23.93 and 20.56 MPa after the thermal, hydrothermal and UV exposure, respectively. Hydrothermally treated NR gloves showed new peaks suspected as hydroxyl groups and carbon-carbon triple bonds. Spectra of thermally and hydrothermally treated NBR showed identical loss of the peak responsible for the cyanide group. TGA analysis showed that the initial decomposition temperature of NR has reduced from 365.42 °C to 364.95 °C, 360.63 °C and 365.27 °C, respectively after the thermal, hydrothermal and UV treatments. NBR gloves also showed the same trend except for hydrothermal treatment where an increase in initial decomposition temperature was recorded. Overall, hydrothermal treatment was the best degradation method for NR gloves among candidates while exposure to UV radiation exhibited the highest degradation potential for NBR gloves. It was also found that removal of cyanide group when NBR gloves were subjected to hydrothermal degradation.

Keywords: Fourier transform infrared spectroscopy; Natural rubber; Nitrile Butadiene rubber; Thermo gravimetric analysis; Ultraviolet

Effect of Residual Diammonium Hydrogen Phosphate Content on Properties of Natural Rubber Centrifuged Latex

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Natural rubber particle, a polyisoprene core is surrounded by a shell of non-rubber components, proteins and phospholipids. Natural PO_4^{3-} are added to ammonia preserved latex due to the hydrolysis of phospholipid layer around the rubber particle. Although this process contributes to the stability of the latex this could produce a waste sludge; a precipitate of magnesium with phosphate. In centrifuged latex (CL) manufacturing process PO_4^{3-} are added as diammonium hydrogen phosphate (DAHP) before centrifugation in order to remove residual Mg^{2+} present in field latex to the level of 80-100 ppm. In most cases, added DAHP will leave excess PO_4^{3-} in latex as most manufacturers added it without estimating the remaining Mg^{2+} present in latex. It results in a high amount of PO_4^{3-} in latex as a considerable amount of PO_4^{3-} are released from the natural process of hydrolysis with storage time. This study aimed to determine the variation of residual PO_4^{3-} content of CL with storage time and its ultimate effect on latex property development. A series of centrifuged latex samples were prepared by adding 0 g (control sample), 3 g, 6 g, 9 g, 12 g, and 15 g of 15% DAHP. Changes of the latex characteristics such as mechanical (MST) and chemical stability time (CST), PO_4^{3-} and Mg^{2+} concentration, viscosity were determined with time. All the testing were carried out according to ISO procedures. High ammonia preserved CL showed a considerable amount of natural PO_4^{3-} of about 300-200 ppm with storage time. The PO_4^{3-} content of latex is not a stable amount and showed several fluctuations with time due to several chemical reactions within the latex sample. The excess amount of PO_4^{3-} in the latex leads to a decrease in viscosity and stability of latex due to colloidal destabilization. The control sample showed the highest MST (315 seconds) and CST (97 seconds) with storage time than other samples revealing that there is no need for the addition of DAHP if the Mg^{2+} content of field latex is below 100 ppm in manufacturing CL.

Keywords: Latex; Diammonium; Phosphate; Magnesium; Destabilization; Colloidal

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