Faculty of Science
University of Ruhuna

RISTCON 2022

RISTCON 2022

Empowering Research in a Digitally Advancing Society

Proceedings of 9th Ruhuna International Science & Technology Conference January 19, 2022

Abstracts and Plenary Lectures

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Editorial Note

A high number of abstracts in diverse disciplines under science and technology was received for RISTCON-2022. We thank all the authors for responding eagerly to our call for abstracts. Initially, we screened all submissions for novelty and plagiarism. Then, each abstract (and the extended abstract) was sent to two experts in the relevant field in-line with a double-bind review process. In cases where the decisions by the two reviewers were remarkably different, the abstract/extended abstract was sent to a third reviewer. The editorial board took the final decision by considering the decisions and comments made by the reviewers. We believe that this unbiased review process has ensured a high quality and standard in the publication of proceedings.

The responsibility for the content in each publication remains with the respective authors. No part of this serial publication will be reproduced in any form. When citing the published abstracts, this serial publication can be referred to as 'Proceedings of the 9th Ruhuna International Science and Technology Conference - 2022, Faculty of Science, University of Ruhuna, Matara, Sri Lanka'.

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RISTCON-2022

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Message from the Vice Chancellor, University of Ruhuna

As the Vice Chancellor of University of Ruhuna, it gives me immense pleasure to send this message to the 9th Ruhuna International Science and Technology Conference (RISTCON 2022). This is one of the prominent scientific conferences of the University of Ruhuna. The theme of the RISTCON 2022 is "Empowering research in a digitally advancing society".

The research environment and culture has turned upside down and inside out within the last 20 months of the Covid-19 pandemic. The world is witnessing restrictions in social gatherings with environmental and personal movement controls with physical networking. The rationale and impact of all these would be better known in the years ahead. The scientists all over the world are challenged by these impacts and are forced to find alternative ways of linking, networking, collaborations and even supporting to retain the pre Covid-19 research environment and the culture. Hence the theme is timely and important.

It would be extremely difficult for the entire world of scientists to go back to pre Covid-19 environment way of work and conducting research. That model is likely to fail at least partially if pursued exclusively. In that context, the proposed theme is extremely important to initiate a dialogue over the next few years among the global academia.

After several millennia of evolution, the world has reached an unexpected or surprised milestone. The environment will no longer be the same to tolerate an imbalance of unlimited mobility and non-sustainable interventions or experiments. However, we are also unable turn back to the past completely by throwing away everything in the in modern world.

This is the best time to rethink the role of digitalization to empower research culture and environment in the entire world for future. The way most parts of the world adopted to restrictions in education gives us confidence in this direction. Constructive alignment of social and economic environment with digitalization of research should be an anticipated challenge.

RISTCON 2022 will provide an excellent opportunity for academics, researchers, students and industry personnel to discuss the contemporary trends and innovative research findings in relation to the above theme.

I appreciate the enormous effort of the Dean, Faculty of Science, Chairperson of the RISTCON 2022 and the organizing committee for a digitalized but hybrid mode of conduct of the conference. Doing it for the

second time during the pandemic is an indicator of the capacity building that has taken place within the scientific community of Sri Lanka. I wholeheartedly wish the 9th Ruhuna International Science and Technology Conference (RITSCON) 2022 a great success.

I look forward to witnessing a fruitful conference.

Senior Professor Sujeewa Amarasena
Vice Chancellor
University of Ruhuna

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

It is a great pleasure to convey this message as the Dean of the Faculty of Science, University of Ruhuna, for the 9th Ruhuna International Science and Technology Conference (RISTCON-2022). RISTCON has been an important event of the Faculty of Science of the University of Ruhuna in providing an appropriate platform for discussing findings of researchers, practitioners and educators from various scientific fields for nearly a decade. I am glad to know that RISTCON-2022 has received around 168 submissions, which are suitable for review process. Around 125 of them have been accepted as oral presentations or poster presentations after a rigorous double-blind reviewing process. I greatly appreciate the efforts of all the authors who submitted their findings to RISTCON-2022, and their willingness to share their findings among the researchers in the respective fields and the participants of the conference.

Almost everyone around the world has been suffering from the Covid-19 pandemic for around two years, and the scientists are endeavouring to discover a cure for this lethal virus to overcome the suffering, fear and death this pandemic situation brought us. It is a mandatory requirement for all of the people who shoulder responsibilities in teaching, research work, policy-making and governance, as well as normal citizens to make an effort towards enhancing and developing the socio-economic status of the societies around the world, irrespective of the difficulties they face due to a pandemic like Covid-19 or other unfavourable conditions. The current pandemic situation which negatively affected the education system of our country for more than a year, will degrade the socio-economic status of our people in the long run, unless relevant authorities come up with alternative methods for upgrading our education system to a better position than that was in existence before this global pandemic situation.

The academics in our country have been making every effort to introduce and develop new methods for teaching, learning and assessment activities, with the limited resources and facilities available for the staff and students while ensuring that the standard of our education system is not downgraded. Their attempt will make sure that a considerable proportion of our population will be able to attend and graduate from schools and universities, and other educational and training institutions, and our country will have a sufficient number of educated people who are intelligent enough to ensure that the

country's development is not affected by the current and future obstacles. This will ultimately lead to steady and significant growth of the socio-economic level of our society.

The RISTCON-2022 has been organized with the theme of "Empowering Research in a Digitally Advancing Society" to provide a premier multidisciplinary forum for leading academics, researchers and research students to present and discuss their innovations, concerns, practical challenges encountered and the solutions adopted in their fields under the current context of our country. I wish that the conferences like RISTCON will be a platform for our researchers to share their scientific knowledge and new findings with a special focus towards the development of the country in every aspect to overcome the current struggling situation around the world.

Organizing a conference is a difficult and very responsible task, especially under the current pandemic situation. Therefore, I would like to convey the gratitude of the Faculty of Science of the University of Ruhuna to Dr. B. G. Sampath Aruna Pradeep, the Chairperson of the Organizing Committee of RISTCON-2022 and his team for their creative, effective and untiring efforts for making this hybrid mode conference a reality.
I hope that all the presenters and participants would have productive and fruitful discussions during the conference and enjoy the humanity and the kindness of our community of the Faculty of Science, University of Ruhuna, even though it is conducted through the online mode.

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

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Message from the Chairperson – RISTCON 2022

It is a great pleasure for me to provide a message as the Chairperson of the Organizing Committee of the 9th Ruhuna International Science and Technology Conference (RISTCON 2022) which is scheduled to be held on 19th of January 2022 on the theme of "Empowering Research in a Digitally Advancing Society". It was held for nine consecutive years under the guidance and supervision of the Dean of the Faculty of Science and the academic staff of the Faculty of Science. In the first place, I welcome all invitees, authors of abstracts, academic staff of the Faculty of Science, sponsors and all distinguished guests and participants who join us at RISTCON 2022. This year, as we organize the event as a virtual-based conference, it is possible for us to bring together the researchers, academics and professionals from all over the world into a single platform. RISTCON 2022 is designed to share the findings of multi-disciplinary research efforts in the fields of Science and Technology.

It provides a stage for discussing the recent developments, discoveries and innovations in a wide variety of topics in Science, Engineering, Agriculture, Medicine, Health Sciences, Fisheries and Aquatics, Natural Sciences and other disciplines. 168 research communications were received this year from local and international scholars. Through the double-blind reviews conducted by national and international experts in multiple disciplines, about 125 research abstracts were accepted to be presented at the conference. The selected abstracts which were scrutinized by a seven-member Editorial Board for their novelty, plagiarism and language were to be published in the proceedings of RISTCON 2022.

I extend my profound gratitude to our Vice Chancellor, Senior Professor Sujeewa Amarasena, Deputy Vice Chancellor, Professor E.P.S Chandana and Dean of the Faculty of Science, Professor P.A. Jayantha for their encouragement and consistent guidance provided for making this event a success. Further, I wish to express my gratitude to all reviewers for taking time for reviewing. It is my pleasure to acknowledge my gratitude to the Keynote Speaker, Professor Saman Halgamuge and the Plenary Speakers, Professor. J. P. Verma and Dr. K. K. J. R. Dinesh for accepting our invitations for sharing their knowledge and opinions with us.

As you know that an event like this could not happen overnight. It requires proper planning and hardworking. I have been fortunate enough to have a

motivated group to work with me. Therefore, I express my deepest appreciation to the members of the Advisory Board, Editorial Board and Organizing Committee for their hard work and dedication. My special thanks go to the sponsors, Bank of Ceylon, FSPI Project and Nippon Paints Company for their generous financial support. I would like to extend my gratitude to all the members of the Faculty of Science who tremendously supported for this event to be a success.

Have a fruitful day!

Dr. B. G. Sampath A Pradeep
Chairperson - RISTCON 2022
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Keynote Speech
Can 21st century artificial inteligence (AI) conquer the challenges in a brave new post pandemic world?

Professor Saman K. Halgamuge, FIEEE
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University of Melbourne, Australia.

The first question we need to ask is, how the new post pandemic world would look like? Would we behave fairer to each other given that we may have future "common enemies" like viruses to protect us from? Would we offer more kindness to vulnerable communities in our society than before? Would we treat the planet and the environment we live in with more care than before? Would we be more meritocratic than never before because we need to get the smartest children in the world to become the top leaders and scientists in the world to protect us from the "common enemy". They are the most difficult questions AI may not be able to solve. But on certain aspects AI can make a better contribution than before.

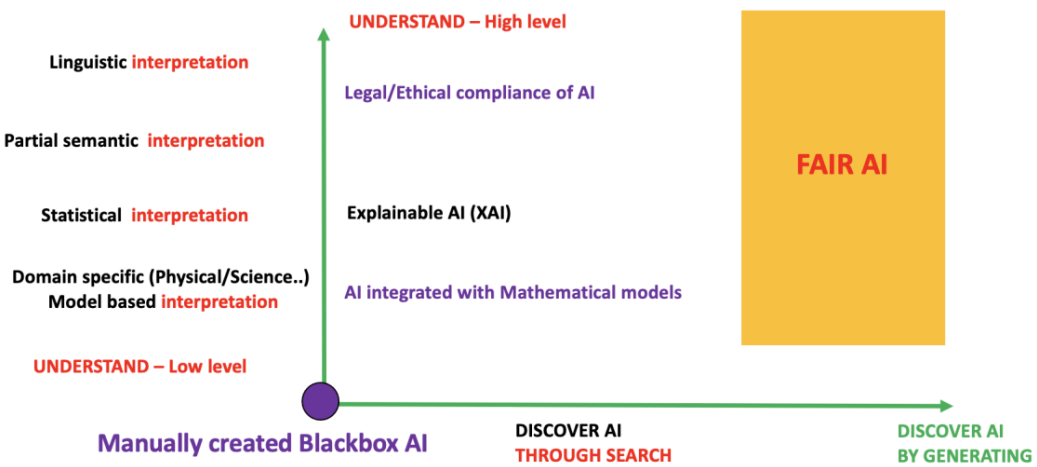

Figure 1: Fair, Accessible, Interpretable and Reproducible (FAIR) AI [1]

Popular models of AI, in particular machine learning based models have three significant deficiencies: they are mostly manually designed using the experience of AI-experts; they lack human interpretability, i.e., users do not understand the AI architectures either semantically/linguistically or mathematically/scientifically; and they are unable to dynamically change

when new data are acquired. Addressing these deficiencies would provide answers to some of the valid questions about traceability, accountability and the ability to integrate existing knowledge (scientific or linguistically articulated human experience) into the AI model. To overcome some of these deficiencies, I proposed **Fair, Accessible, Interpretable and Reproducible (FAIR) AI – a new generation** AI illustrated in Figure 1 [1]**.** This keynote addresses these deficiencies and FAIR AI in the context of several major global problems in the post pandemic world using new research conducted in AI with continuous and life-long learning capability [2]. The "common enemy" may sometimes act as a "good friend" of human health too and this new AI can be used to explore how they (microbial organisms) will continue to change the world and its inhabitants [3].

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Organic agriculture-pro and cons in agriculture production in Asia

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Due to green revolution and industrialization, the use of chemical fertilizers, pesticides and hybrids varieties which have increased productivity to provide food and fibers to increasing population. These excessive and imbalance application of chemical and pesticides causes many environmental pollution and soil degradation. Soil microbial flora and fauna has been recorded reduction in number and its diversity so that all biogeochemical cycle hampered and caused loss of soil fertility and health. Many human diseases (cancer, skin, neurological disorder, stomach pain, heart attack etc.) are increasing due to pesticide application as well as micronutrient deficiency in food. Therefore, organic farming practices (biofertilizers, vermi-compost, biopesticides, FYM, INM, IPM, crop rotation, green manuring, mixed cultivation etc.) are very important for sustainable agricultural productivity in worldwide. But, increasing population, shrinking land area, decreasing farm land and mindset of farmers is major the limitation and challenges of organic agriculture productivity. During this COVID-19 era, organic food and nutrient rich fortified vegetable and fruits demand is increasing and many farmers are growing organic vegetable in kitchen garden, vertical farming and terrace gardening . In India, Sikkim state has been certified as organic state and state government is strict and not allow the chemical and pesticide applications in crop productivity. The demand of organic food in Asia is increasing 15 to 20% every year over the last decade (IFOAM, 2009). The organic products (e.g., rice, fresh produce, sugar, aromatic herbs and medicinal plants, and imported products-seasonal fresh produce, baby food, breakfast cereals, beverages and dairy products) used in Asia and more demand require. The import of processed organic food from the major retail markets are Australia, New Zealand, Japan, Singapore, Taiwan Province of China, Hong Kong and the Republic of Korea. Asian countries are initiating organic market in Philippines, Thailand, India, China and Malaysia but the cost of organic food products are five time more expensive than conventional due to their low productivity, shortage and high import costs. In the US, EU, Australia and Japan have strict organic certification laws for high quality

organic production. While, Asian countries (China, India, Israel, Thailand and Taiwan) have own official organic standards and rules, but have not yet been legislated into laws which is strict to give penalty for the violators. Other Asian countries such as Indonesia, Malaysia, the Philippines, and Singapore do not have any organic standards yet (IFOAM 2003). Positive and negative factors (e.g., certification system, un-awareness, expensive and less productivity) are affecting the organic production and marketing in Asia. Organic farming is really need of present and future generation which environment friendly and long term sustainability for happy and healthy human being of the worlds and conserve the nature.

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Modern energy landscape

Dr. Ranga Dinesh Kahanda Koralage

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The world is at a critical crossroads where urgent issues in energy security and climate change are competing and converging. People are rightly concerned, with the latest evidence showing that if we fail to limit global warming to 1.5°C above pre-industrial levels, the floods and fires we have seen around the world in recent years will get more frequent, crops will be more likely to fail, and sea levels will rise driving mass migration as millions are forced from their homes. Above 1.5°C we risk reaching climatic tipping points like the melting of arctic permafrost – releasing millennia of stored greenhouse gases – meaning we could lose control of our climate for good.
Global warming and climate change is an energy problem. The world needs another industrial revolution to tackle this issue in which our use of energy in the twenty-first century must be sustainable. Energy efficiency and conservation, as well as decarbonising our energy sources, are essential to this revolution. The actual path we follow will depend on how efficiently and effectively we use existing and new sources of energy. Many important and challenging research areas have the potential to significantly affect modern energy landscape. Renewable energy sources such as solar, wind and water-based energy generation, bio-energy, hydrogen economy, and energy storage are a few examples of the alternatives that could lead to a sustainable and secure energy future for the world.

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In vitro induced mutagenesis in the calli derived from Black-gold Snake plant; *Sansevieria trifasciata* var. *Laurentii compacta*

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Sansevieria trifasciata is widely used as an ornamental due to diverse color combinations and variegation patterns. To cope up with the growing demand, it is commercially important to develop promising varieties with novel phenotypes. Therefore, current study was conducted to develop a mutagenesis protocol using selected mutagens and to study the effect of mutagens. Moreover, the combination of Plant Growth Regulators on the shoot and root regeneration of *Sansevieria trifasciata* var. *Laurentii compacta* was optimized. Three months old calli grown in MS+0.4 mg/l 2,4-D were exposed to selected physical and chemical mutagens; UV radiation for different time intervals (60, 120,180, 240, 300, 360, 480s), gamma radiation for different doses (17, 20, 25, 30, 35, 40, 45, 50Gy) and Ethyl Methanesulfonate (EMS) for different concentrations (0.2%, 0.4%, 0.6%, 0.8%, 1.0%, 1.5% v/v). Afterward, calli were cultured in MS media supplemented with different PGR combinations for shoot and root generation. For data analysis, both Kruskal Wallis and Dunn's tests were carried out by using a statistical software R 3.6.3. The highest shoot regeneration (56.25%) was observed from UV treatment of 300s. With the increase of gamma dose from 17Gy to 50Gy, regeneration percentage gradually declined from 67.71% to 0%. Also, EMS of 0.8% v/v showed the highest shoot regeneration (66.47%). The media of MS+2.0 mg/l BAP+1.0 mg/l NAA+2.0 mg/l Kinetin and MS+3.00 mg/l IAA showed the maximum response in shoots regeneration (70.36%) and root induction (2.17±0.27) respectively. Moreover, further field trials and screening techniques are necessary for developing novel phenotypic variants.

Keywords: Mutagenesis, UV radiation, Gamma radiation, EMS, Plant growth regulators

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Effect of rate and split application of fertilizer on growth and yield performances of *Brassica oleracea* var. *botrytis* under IoT-based protected house in low-country wet zone of Sri Lanka

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An experiment was conducted to investigate the effect of rate and split fertilization on the growth and yield of cauliflower (*Brassica oleracea* var. botrytis) grown under IoT-based protected house conditions in Sri Lanka. Cauliflower variety White Flash (F1 hybrid) had grown using cocopeat potting media. Three different rates (1.0 g/plant, 1.5 g/plant and 2 g/plant) and three splits (once per day, twice a day and three times a day) of Albert's fertilizer mixture was tested on growth and yield performance of *Brassica oleracea* var. botrytis. The experimental design was two-factor factorial completely randomized design with nine treatment combinations and four replicates. Treatments were applied daily. Optimum temperature (25-30℃) and relative humidity (65-70%) were controlled using IoT platform. The interaction effect of rate and split of fertilizer on growth and yield parameters of cauliflower were significant. Among growth and yield parameters plant height (25.4 cm), number of leaves (29.88/plant), leaf area (318.2 cm^2), curd diameter (13.85 cm), fresh weight of curd (498.45 g) and fresh weight of plant without curd (1329.05 g) were the highest when fertilizer was applied as 1.5 g/plant/day as 3 splits. The lowest values of all these parameters were found in 1.0 g/plant/day as single dose. This study proves that 1.5 g along with 3 split application of Albert's solution enhance the growth and yield performances of cauliflower with compared to existing famers' practice of 2 g along with 1 split grown under protected house conditions.

Keywords: Cauliflower, Growth, IoT-based protected house, Rate and split of fertilization, Yield

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Selection of carrier matrix for bacteria-mediated bioremediation in aquatic environments

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Water pollution and the outbreak of algal blooms are emerging environmental issues in many parts of the world. There is a growing concern on the application of bacteria-mediated bioremediation and bio control strategies to restore water quality and control algal blooms. However, in this context, selecting a suitable carrier matrix for the delivery of selected bacterial inocula is the most important and challenging step. Therefore, this study aimed to find a suitable carrier matrix to deliver bacterial inocula into the natural aquatic environment. Sodium alginate and four locally available low cost materials (sugarcane bagasse, rice husk, rice straw, and corn husk) were selected as potential carriers and treated with an alkaline solution to disintegrate the lignocellulosic cell wall structure. A selected model bacteria, *Escherichia coli* was immobilized into matrices at 1 x 10^8 cells/mL density. Scanning electron microscopic images confirmed enhanced bacterial immobilization in carrier matrices following alkaline pre-treatment. Bacterial growth in nutrient agar medium proved their viability after immobilization. In all carrier matrices bacterial viability remained high (10^7 CFU/g) at the end of seven weeks. The effect of carrier materials on the physicochemical properties of water was monitored in every other week for seven weeks. Dechlorinated tap water was used as the control. The measured water quality parameters; chemical oxygen demand (COD), dissolved oxygen (DO), pH, total dissolved solids (TDS), turbidity, conductivity, salinity and nitrate-N showed time-dependent reduction in water quality in treatments and control. However, Tukey's pairwise comparison revealed absence of a significant difference ($P < 0.05$) in COD, DO, pH, nitrate-N and turbidity in the treatment with sodium alginate compared to the control indicating that there is no negative impact of the application of sodium alginate on the water quality of receiving aquatic environment. Therefore, this research highlights the potential use of sodium alginate as a carrier matrix to deliver bacterial inocula into natural aquatic environments in the application of bacteria-mediated bio control strategies.

Keywords: Bacterial carrier, Bioremediation, Sodium alginate, Water quality

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Red mold rice water extracts to inhibit adipogenesis in vitro

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Monascus-fermented products are being used as food and medicine for over thousands of years. Due to the water solubility, adipogenesis inhibitors from *Monascus*-fermented products can be used in food or nutraceutical industry. This study was conducted to investigate the anti-adipogenic effects of the water extracts of *Monascus pilosus* NBRC4507 fermented red mold rice (RMR) using 3T3-L1 cells. RMR was prepared by cultivating *M. pilosus* NBRC4507 in steamed rice for 7, 10, 14, 17 and 21 days at 30 °C. The water extracts of RMR were concentrated and the resultant concentrate was freeze dried and dissolved in phosphate buffer. RMR water extracts (0.5, 0.75 and 1.0 mg/mL) were prepared using each cultivated samples at 30 °C in differentiation medium. RMR extracts on lipid accumulation inhibition in 3T3L-1 cells was measured using Oil-red O staining method. The lipid accumulation suppression by 1.0 mg/mL RMR extract fermented with M. pilosus NBRC4507 for 14 days was significantly higher than that of 5 µM lovastatin ($p < 0.01$). Further, water soluble tetrazolium salts (WST-1) assay confirmed zero cytotoxic effect on 3T3L-1 cells. Thin layer chromatography confirmed water extracts were free from Lovastatin and Citrinin. RMR fermented for 14 days at 30 °C is a potential source to inhibit adipogenesis in vitro.

Keywords: *Monascus pilosus,* Red mold rice, Adipogenesis, 3T3L-1 cell, Lovastatin

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Standardization of dehydration techniques for preservation of selected ornamental foliage

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In the present era of eco-consciousness, use of natural products have become the premier choice for interior decoration. Dry foliage can be used as filler element and give bold effect in floral arrangements. Dehydration techniques are exploited for dehydrating promising color and shape of flowers and foliage for commercial utilization. However, dehydration techniques of foliage have not been fully exploited in Sri Lanka. Therefore, the present experiment was conducted with an objective of studying the efficacy of different dehydration techniques on preservation of selected ornamental foliage species viz. *Thuja standishi, Chlorophytum comosum, Asparagus setaceus, Araucaria luxurians, Nephrolepis exaltata*. As dehydration treatments; air drying, press drying, embedded in sand and silica at room temperature, hot air oven drying embedded with sand and silica, microwave oven drying embedded with sand and silica and freeze drying were studied. The experiment was arranged in two factorials completely randomized design with three replicates. Quantitative parameters such as moisture loss percentage, drying time, drying rate, reduced in diameter was analyzed were analyzed using Minitab 17 statistical software. Qualitative parameters including color, shape, brittleness, overall acceptability were measured visually. The results have indicated *T.standishi* and *A.luxurians* showed best results when dehydrated using freeze dryer for 48 hours with moisture loss of 60.1% and 65.3% respectively. *N.exaltata* reported the most promising results under hot air oven drying embedded in silica at 45ºC for 24 hours with higher moisture loss percentage (92.8 %) as well as retention of better shape and preferable color. *A.setaceus* manifested notable brittleness under microwave oven drying, embedded in silica with higher drying rate (33.7 water/g/hours). *C.comosum* is not preferable for dehydration, since it lost its the color and shapes under all methods of dehydration. Among all the tested treatments, freeze drying gave best results with foliage shape, size, color, structure than other dehydration techniques. Therefore, the present study paved a way for finding the most suitable dehydration technique for selected ornamental foliage for their everlasting value.

Keywords: Dehydration techniques, Ornamental foliage, Preservation

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Optimization of polyphenol extraction from *Hibiscus rosa-sinensis* flowers

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Edible flowers of *Hibiscus rosa-sinensis* have been identified with various phenolic compounds which are capable of combatting oxidative stress. However, different extraction parameters greatly influence the quantity as well as the composition of bioactive compounds extracted from them. Thus, effective extraction of phenolic compounds is important to efficiently utilize these flowers. The present study aims to make use of central composite design, to investigate the effects of extraction parameters on the three response variables; total phenolic content, total anthocyanin content and antioxidant activity. Four independent variables including solid:liquid ratio, ethanol concentration, temperature and time were studied for the simultaneous optimization to maximize the response variables. Solid-liquid extraction technique was used for the extraction process. A two level four factor central composite design, with 31 experimental runs were performed and mathematical models were generated. The ability of the models to predict the studied responses is reflected by p values for lack of fit ($p > 0.05$). The optimum extraction parameters generated were 24.0 % ethanol, 1:40 solid to liquid ratio, extraction temperature 44 °C and time 41 minutes. The experimental values obtained for the response variables under the generated optimum conditions confirmed the validity of the proposed second order polynomial model. The results demonstrated the application of feasible process parameters for the extraction of phenolics from *Hibiscus rosa-sinensis* flowers and effective utilization of these flowers in food as well as pharmaceutical industry.

Keywords: *Hibiscus rosa-sinensis,* Optimization, Phenolics, Response surface method

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Powder X-ray diffraction (PXRD) analysis of usnic acid in five selected lichen species from Sri Lanka

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Cancer remains a global health problem despite the continuous development of anticancer therapies. The discovery of anticancer drugs from diverse natural sources has recently gained a focus. Lichens are a widespread symbiotic association between fungal and photosynthetic partners, and they are known to produce a diverse array of secondary metabolites with promising anticancer effects. Usnic acid (UA), a dibenzofuran derivative, is a key secondary metabolite found only in lichens and has shown anticarcinogenic effects on a variety of human cancer cell types. This study was conducted to investigate the presence of UA in five selected lichen species, which has previously been detected by thin layer chromatography (TLC), using a powder X-ray diffraction data analysis (PXRD) approach. Lichen samples representing *Lepraria* sp., *Physcia* sp., *Lecanora* sp., *Parmotrema* sp. and *Graphis* sp. were collected from Peradeniya, Sri Lanka, and crude acetone extracts for PXRD analysis were prepared following a standard protocol. In the diffractograms of *Lepraria*, *Physcia*, *Lecanora* and *Parmotrema*, peaks were observed at 10.54°, 10.34°, 10.4° and 12.84° of 2θ position, respectively, which could be slightly overlapped with one of the main peaks of UA (10.24° or 12.73°). However, a similar correspondence was not observed for the peak pattern of *Graphis* sp. The current study confirmed the findings of our previous TLC detections of UA in *Lepraria*, *Physcia*, *Lecanora*, and *Parmotrema* spp. Further investigations are underway to confirm the presence of UA in lichens and to determine their effect on different human cancer cell lines for elucidating their therapeutic anticancer potential.

Keywords: Anticancer compounds, Lichen secondary metabolites, PXRD, Usnic acid

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Synthesis and characterization of nano Co_3O_4- B co-doped *g-CN* heterojunction for photocatalytic degradation of textile dye wastewater under sunlight

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Photocatalysis is the best method for organic dye removal process due to non-toxicity of the final products. Hetero-junction photocatalysis has become a hot topic in removal of organic pollutants from the wastewater under sunlight. In this study the photocatalytic activity of the boron doped graphitic carbon nitride (BCN) and tricobalt tetroxide (Co_3O_4) was used to produce visible light active Co_3O_4/BCN heterojunction photocatalyst. Graphitic carbon (g-C_3N_4) and B co- doped BCN with 0.5-10 (w/w) % was synthesized according to literature. 5% BCN has the lowest band gap energy of 2.64 eV. Different weight percentages Co_3O_4 (10-75 (w/w) %) was used to synthesize hetero-junctions catalyst. The 50 (w/w) % Co_3O_4-BCN showed the best band gap energy for the photocatalysis (2.34 eV, 530.0 nm). The photocatalysts were characterized by using FT– IR spectroscopy (809, 1237, 1317, 1407, 1555, 1631, 3000-3500 cm^{-1} for g-C_3N_4 and 656 cm^{-1} for Co_3O_4). Reactive black 5 dye (RB5) 50 ppm solution was used for the catalysis. The best photocatalyst dosage 0.3 g of g-C_3N_4 was found from 0.1- 0.4 g and 0.4 g of 50% (w/w) Co_3O_4-BCN from 0.1- 0.4 g was the best dosage at pH=4. Under sunlight, g-C_3N_4 was found the best photocatalyst. RB5 dye degradation reached 100% in 100 minutes under sunlight irradiation. Degradation efficiency was enhanced with the pH = 4 up to 100 % efficiency within 80 minutes.

Keywords: Hetero-junction photocatalyst, Organic pollutants, Band gap

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Biodegradability and plasticizing effect of sorbitol and citric acid on cassava starch edible films

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This work explores the development of cassava starch-based biofilms using solvent casting process for food packaging applications. Cassava starch has shown low moisture content (13.09%), ash content (0.43%), water solubility (1.49%), swelling capacity (2.02 g/g), and gelatinization temperature (70.17 ℃). A series of cassava starch biofilms with varying concentrations of sorbitol 10, 20, 30, 40 and 50 (%wt.) and 5, 10 and 15 (%wt.) citric acid (CA) was produced. All the tested formulations resulted in biofilms of 0.20 to 0.23 mm thickness with good appearance and were easily removable from the plates without bubbles or cracks. The effect of CA and sorbitol on the biofilms was analysed using ANOVA and Tukey's post hoc tests at a confidence level of 95% ($P < 0.05$). 10 percent CA was positively affected for the 30% sorbitol formulated biofilms on the characteristics such as moisture content (10.99%), swelling capacity (2.45 g/g) and water solubility (21.75%). A partial crosslinking between CA and cassava starch in biofilms matrix was found by FTIR spectra. X-ray diffraction analysis displayed a crystalline character with increasing in sorbitol and CA contents. Water vapor permeability properties of all the biofilms were adequate, ranging from 2.77 to 4.82 $\times 10^{-12}$ g/ms Pa. In vitro tested biofilms biodegraded within 15 days. Filmogenic formulation containing 30% sorbitol and 10% CA incorporated cassava starch had acceptable properties of transparency, renewability, biodegradability, and absence of characteristic odour or color. Morphological aspects of the films were also characterized. In conclusion, cassava starch could be used to tailor biodegradable edible films with enhanced properties and future fruit coating applications.

Keywords: Cassava starch, Sorbitol, Citric acid, Edible coating, Plasticizer

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Electrocoagulation for chromium removal in simulated water: response surface methodology

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Wen the global community moves towards a sustainable environmental development concept, providing safe drinking water to the community is a challenge. Cr(VI) is a priority pollutant, released to natural water bodies through industrial processes could pose deleterious health effects on humans and other aquatic organisms. Therefore, the effluents should be treated in such a way to keep the concentration of Cr(VI) below the maximum contaminant level (<0.1 mg/L) and to secure health and wellbeing. Electrocoagulation (EC) is a promising technique for remediation of water and wastewater. A laboratory scale EC batch reactor consisting of two Al electrodes as both anode and cathode arranged in a mono-polar configuration with a distance of 10 mm was employed in this study. Response surface methodology (RSM) statistical approach was used to identify the optimal Cr(VI) removal in simulated water containing 5 mg/L Cr(VI), 150 mg/L Ca^{2+}, 50 mg/L Mg^{2+} and 5 mg/L F^- ions. The initial conductivity and pH were found to be 900 µS cm^{-1} and 6.0 respectively. Under optimized conditions based on RSM analysis, optimal removal efficiency of chromium (100%) was achieved in this reactor at the expense of 2.92 kW h/m^3 electrical energy at initial pH 6.0.

Keywords: Aluminium electrodes, Chromium removal, Electrocoagulation, Response surface methodology

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Characterization of microplastics in selected commercial marine fishes in Sri Lanka

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Coastal and offshore fisheries in Sri Lanka are mainly dependent on wild fish stocks, which may have been contaminated with microplastics (MPs) that have a potential risk to transfer subsequently to consumers. However, studies on MPs in commercial fish species are limited, and therefore, we estimated the MPs abundance and composition in three species, i.e., *Amblygaster sirm* (n = 30 from Dondra), *Selar crumenophthalmus* (n = 70 from Dondra and Kudawella) and *Thunnus albacares* (n = 70 from the Indian ocean and the Arabian Sea). MPs were extracted from the gastrointestinal tract by acid digestion and observed under Olympus™ DP21 photomicroscope. All fish samples (100%) were found to be contaminated with microplastics coloured in red, orange, black and blue. Major MPs morphotypes observed in *A. sirm* and *S. crumenophthalmus* were microspheres and fragments, whereas fragments and fibers were the commonest in *T. albacares*. No significant difference (p>0.05) of MPs abundance per individual was identified between *A. sirm* (54.2 ± 33.0) and *S. crumenophthalmus* (56.4 ± 33.0). In contrast, MPs abundance per individual in *S. crumenophthalmus* in Dondra (56.4 ± 33.0) and Kudawella (65.7 ± 89.0) were significantly different (p<0.05). The highest MPs abundance of *T. albacares* was observed in the Arabian Sea (59.3 ± 79.7 of MPs per 2.5g), followed by the Southern Indian Ocean (19.4 ± 15.2 MPs per 2.5g) and Bay of Bengal (18.1 ± 11.5 MPs per 2.5g). Our findings indicate MPs contamination in marine food fish species *A. sirm*, *S. crumenophthalmus, T. albacares* and emphasize the importance of regulation and control of MPs to ensure food safety.

Keywords: *Amblygaster sirm,* Microplastics contamination, *Sellar crumenophthalmus, Thunnus albacares*

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Gold complexes of a bulky bipyridine ligand

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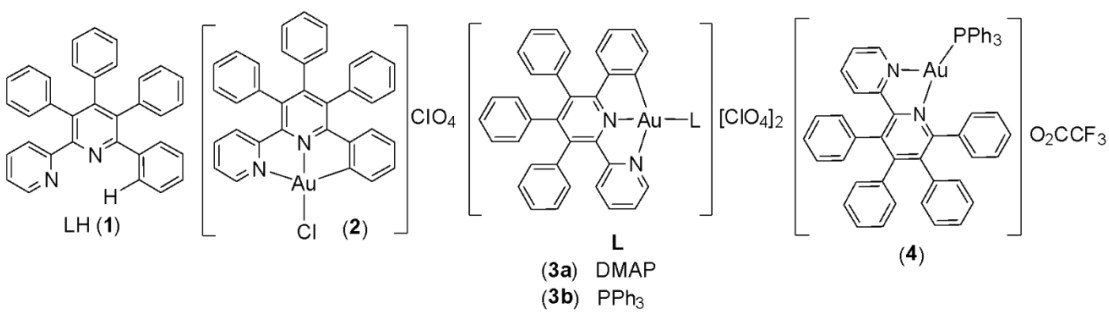
Since good old days, gold has been a precious metal possessed by rich people and now it is used in nanoscience and nanotechnology as nanoparticles and self-assembled monolayers. In addition to its attractive monetary value, highly active cationic gold(I) catalysts have found applications in organic synthesis as well. Recently, it has attracted growing attention due to luminescent properties of Au(I)/Au(III) complexes, *e.g.*, Au(I)-phosphine complex $[Au_2(dppm)_2](BF_4)_2$, that exhibits strong and long-lived yellow phosphorescence. Cyclometallated Au(III)-pyridine complexes have shown interesting photophysical properties. Thus, it is of interest to devise synthetic routes to gold complexes of this bulky bipyridyl ligand (LH, **1**). Treatment of (**1**) with $HAuCl_4 \cdot xH_2O$ in the presence of $AgClO_4$ afforded the cyclometallated square-planar Au(III) complex $[LAuCl]ClO_4$ (**2**) containing an anionic terdentate (NNC) ligand. All complexes were characterized by a combination of IR, Mass and NMR spectroscopy. Substitution of chloride ligand of (**2**) with neutral ligands, 4dimetylamino pyridine (DMAP) and PPh_3 afforded $[LAu(DMAP)][ClO_4]_2$ (**3a**) and $[LAu(PPh_3)][ClO_4]_2$ (**3b**), respectively. The X-ray crystal structures of (**2**) and (**3a**) were determined. $[(LH)Au(PPh_3)]O_2CCF_3$ (**4**) was prepared by treating $[AuCl(PPh_3)]$ with (**1**) in the presence of AgO_2CCF_3.



Keywords: Au(I) and Au(III) complexes, Bipyridyl ligand, Cyclometallation, NNC complexes

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Silica extraction and chemical analysis of rice husk in Sri Lanka

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Rice husk is an abundant agricultural waste in Sri Lanka. However, waste rice husk are being utilized as a source for raw material to manufacture value-added products and materials such as construction materials, filters, tableware, cardboards, etc in many other countries. As the first step toward initializing the development of rice husk-based products in Sri Lanka, this preliminary study was carried out to characterize the chemical constituents of local rice husk and to extract silica. Rice husk samples were obtained from Kurunegala, Galle, Hambanthota districts and they belonged to a few different rice varieties. Previously reported analytical procedures from the literature were employed to obtain the chemical compositions of each sample. Average value obtained for moisture, total cellulose, lignin, and silica contents were 10.80%, 48.12%, 22.30% and 15.20%, respectively. Results agreed with the literature values, however, certain statistical variations in moisture, cellulose, and silica contents between the rice varieties were observed. White color silica powder was extracted from pyrolyzed (at 600 ^{0}C) rice husk after solubilizing it in an alkaline solution and precipitating in an acidic medium. FTIR analysis confirmed the high purity in silica obtained without any organic impurities. Therefore, the silica obtained from local rice husk can be utilized to develop commercially viable silica-based products.

Keywords: Rice husk, Lignin, Cellulose, Silica, Silica extraction

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Antidiabetic mechanisms of the hexane extract of an Ayurvedic polyherbal mixture in diabetic rats: A reflection on enzyme activities of antioxidant and carbohydrate metabolism pathways

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Antidiabetic mechanisms of an Ayurvedic polyherbal mixture composed of dried fruit rinds of *Garcinia queasita* Pierre, leaves of *Murraya koenigii* L. Spreng., seeds of *Piper nigrum* L. and cloves of *Allium sativum* L. are scientifically untapped. In the present evaluation, the effect of the hexane extract of the mixture on the enzyme activities of the antioxidant and carbohydrate metabolic pathways was evaluated in streptozotocin-induced (65 mg/kg, ip) diabetic Wistar rats. The rats were randomly assigned to four groups (n=6/each group); healthy, untreated diabetic, diabetic rats treated with the hexane extract and glibenclamide. The hexane extract (25 mg (powder)/kg) and glibenclamide (0.5 mg/kg) were given once a day orally for 30 days. On the 30th day, the liver was excised on sacrificed rats to prepare liver homogenate that was used to determine the antioxidant and carbohydrate metabolism enzyme activities. The results showed that total antioxidant status, catalase and glutathione peroxidase activities were increased by 41% (p=0.04), 264% (p=0.01) and 34% (p=0.10), respectively, in the liver of the hexane extract treated rats with respect to the diabetic control rats. The hexane extract treatment improved the activities of the hexokinase (0.68 ±0.01 nmol $min^{-1}mL^{-1}$) and 6-phosphofructokinase enzymes (0.73 ±0.04 nmol $min^{-1}mL^{-1}$) in diabetic rats compared to diabetic control rats (0.25 ±0.01; 0.06 ±0.01 nmol $min^{-1}mL^{-1}$), however, a significant improvement was observed only for the hexokinase activity ($p<0.05$).

Keywords: Diabetes mellitus, Polyherbal mixture, Hexane extract, Antioxidant potential, Glycolysis

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Phytochemical profile and *In vitro* sun protective activity of *Wrightia antidysenterica, Ipomoea pescaprae* and *Ipomoea aquatica* flower extracts

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W. antidysenterica, I. pescaprae, and *I. aquatica* are known as important medicinal plants in Sri Lanka and are widely utilized in traditional medicine. Flowers are used in the preparation of medicines for the treatment of numerous diseases. Despite the fact that there is no adequate scientific literature available on these plants, this study was aimed at investigating the phytochemical profile, antioxidant properties, and sun protection Factor (SPF) of methanolic extracts of flowers. Phytochemical profiles were determined using the standard methods in the literature. Quantification of phytochemicals was done using gravimetric and spectrophotometric methods. The 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and Ferric Reducing Antioxidant Power (FRAP) assays were performed to determine their antioxidant activities. Photoprotective activities were determined using a UV spectroscopic technique. Phytochemical screening showed the presence of alkaloids, flavonoids, tannins, phenols, diterpenes, terpenoids, and saponins as main classes, whereas quantification gave alkaloids, saponins, and tannin content ranged from 1.09-2.16%, 6.18-10.82 (w/w%), and 59.52-84.55 mg TAE/g, respectively. The total phenolic content (85.3-144.75 mg GAE/g), total flavonoid content (101.9-219.87 mg QE/g), FRAP value (475.2-675 mol Fe2+/g), and DPPH scavenging capacity (158.0-326.25 g/mL) were all present in significant amounts in the extracts.*I. aquatica* and *I. pescaprae* showed the highest SPF (23.4±0.012), while W. antidysenterica showed SPF 20.29±0.016 at 1 mgmL-1. The reference agent (OLIO-SUN ERA) also had higher SPF (23.03±0.028). Thus, *W.antidysenterica*, *I. pescaprae*, and *I. aquatica* flower extracts have adequate antioxidant and photoprotective activities. Therefore, it is concluded that flower extracts can be considered to develop photoprotective formulations in different combinations and proportions.

Keywords: Sun protection factor (SPF), Mansur equation, Sun Screen, Methanol, I. aquatic, DPPH scavenging capacity

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Effect of cyanolytic bacterium, *Pseudomonas fluorescens* BG-E on the photosynthesis of *Pseudanabaena lonchoids*: An attempt to understand cyanolytic mechanism

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Cyanolytic bacteria inhabited in freshwaters play a major role in controlling cyanobacterial blooms. Disruption of photosynthesis processes, synthesis, and maintenance of photosynthetic pigments in cyanobacteria leading to death is one of the major strategies utilized by cyanolytic bacteria in controlling cyanobacterial blooms. However, the mechanisms by which cyanolytic bacteria disrupt photosynthesis and its' efficiency are species-specific. Therefore, the objective of the study was to explore the effect of *Pseudomonas fluorescens* BG-E (MZ007859) on the photosynthetic pigments of *Pseudanabaena lonchoids* (MW288940) during the cyanolytic process as an attempt to understand cyanolytic mechanism. In the experimental setup, 15% (v/v) of the total volume of bacterial cell-free supernatant was inoculated into *P. lonchoids* grown in BG11 liquid medium at a cell density of 0.020 (OD_{730}) and incubated at 26 ℃. Photosynthetic pigments (chlorophyll *a* and carotenoids) and phycobiliproteins contents (phycocyanin and allophycocyanin) were analyzed at 0, 2, 5, 8, and 10 days after incubation. Results indicated time-dependent significant ($p < 0.05$) reductions in all the analyzed pigments of *P. lonchoids* following 2 days of incubation compared to the controls. The % inhibition of chlorophyll *a*, carotenoids, phycocyanin, and allophycocyanin contents were 72, 71, 83, and 86% respectively after 10 days. The chlorophyll stability index (CSI) also showed a time-dependent reduction. It had reduced to 28% after 10 days. These findings infer that the secreted metabolite/s of bacteria in the cell-free supernatant might have reduced or impaired photosynthetic and accessory pigments as an efficient cyanolytic mechanism to disrupt photosynthesis leading to declining the population growth of *P. lonchoids*.

Keywords: Bacterial cell-free supernatant, Chlorophyll stability index, Photosynthetic pigments, Phycobiliproteins

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Analysis of secondary metabolites present in endophytic fungi from selected invasive plants as potent antioxidants and antibacterial agents

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Prosopis juliflora, *Acacia auriculiformis*, and *Annona glabra* are three of the well-established invasive plants in Sri Lanka. Symbiotic relationships of endophytic fungi with these plants may produce secondary metabolites with high medicinal values. Thus, this study was aimed at the identification of endophytic fungi and extracting secondary metabolites of fungi, with biological importance. Plant roots were collected from the Southern province and isolation of endophytic fungi was performed using standard procedures. Twelve endophytic fungi were isolated and identified. Five species (*Penicillium* sp1, *Penicillium* sp2, *Aspergillus* sp1, *Aspergillus* sp2, and *Aspergillus* sp3) were selected for further analysis. Qualitative phytochemical analysis of ethyl acetate crude extracts (scale up by batch culturing) of fungi showed the presence of alkaloids, phenols, tannins, terpenes, flavonoids, saponins, and sterols in all extracts. Quantitative analysis of total flavonoids and total phenolic content was also performed following standard protocols. The antioxidant capacity of extracts was investigated using DPPH and FRAP assay with ascorbic acid and $FeSO_4.7H_2O$ as the standards respectively. According to the DPPH assay, the lowest IC_{50} value was given by *Aspergillus* sp3 (59.85±1.05) ppm and the highest FRAP value was observed for *Aspergillus* sp3 (1382.94±1.74) µ mol Fe^{2+}/g. *In-vitro* antibacterial studies (negative controls: Ethyl acetate and DMSO) were conducted using agar well diffusion assay and all the extracts showed inhibitory activity against *S. aureus*, *Enterococcus* sp, *Bacillus* sp, *Proteus* sp, and *E. coli*, where *Penicillium* sp2 showed the highest inhibitory activity against all the selected bacterial strains, with the highest value of (30.0 ±0.8) mm against *S. aureus*. In conclusion, it is confirmed, that the selected invasive plants are habitats for a number of endophytic fungi, and can be used as an important source of secondary metabolites with high antioxidant capacity and high antibacterial activity.

Keywords: Invasive plants, Endophytic fungi, Secondary metabolites

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Efficiency enhanced greener approach for bromination of activated aromatic compounds

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Bromination reactions are important in organic synthesis because the generated organobromides can be used as building blocks in a variety of syntheses due to their versatility. The use of the toxic and highly reactive molecular bromine (Br_2) makes these brominations difficult and dangerous. Other synthesis processes involve toxic modified brominating reagents like N-bromosuccinimide (NBS) or expensive bromine carrying agents. Most of them are still hazardous due to liberated bromine. A new *in-situ* bromination of activated aromatic compounds which is quick, cheap, safe, effective and greener method was studied by using solid $KBrO_3$ and aqueous NaBr in glacial acetic acid in 45 minutes at room temperature. Vanillin, 2-Nitroaniline, 4-Niroaniline, 4-Aminobenzoic acid (A1-A4) were subjected to the bromination in triplicates and higher average yield of brominated products 78.67%, 89.79%, 88.68% and 73.24% obtained respectively. Furthermore, this insitu bromination process was enhanced by adding 10%(w/w) amount of silica gel and increased average yields obtained for 5-Bromo-4-hydroxy-3-methoxy-benzaldehyde (88.02%), 4-Bromo-2-nitroaniline (93.45%), 2-Bromo-4-nitroaniline (93.14%) and 2-Bromo-4-aminobenzoic acid (85.21%) at the same reaction conditions.

Keywords: In-situ Bromination, Organobromides, N-bromosuccinimide activated aromatic compounds, Silica gel

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The synthesis and evaluation of methyl eugenol from *Cinnamomum zeylanicum* leaf oil as the *Bactrocera dorsalis* attractant: A value addition

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Eugenol is the major bioactive constituent of cinnamon leaf essential oil (CLO). Among the various types of cinnamon, *Cinnamomum zeylanicum* has been found to contain 70-90% of eugenol. In this study, CLO was extracted from *Cinnamomum zeylanicum* leaves by hydrodistillation method. The extracted oil was analyzed using gas chromatography (GC) and found to contain 90% of eugenol as the major constituent. The eugenol present in the extracted oil was converted to methyl eugenol (ME) by the reaction of eugenolate generated using NaOH with dimethyl sulfate (DMS) as the alkylating agent (eugenol: DMS = 1: 1). The crude ME was analyzed using GC and 93% ME was observed. The functional group conversion was confirmed by using IR spectroscopy. The oil enriched with ME was used for a bioassay against the oriental fruit fly, *Bactrocera dorsalis*, as a sex pheromone to attract male fruit flies by using a trap changing the concentration of ME from 100 – 100,000 ppm. It was observed that the number of fruit flies attracted to the trap increased at higher concentrations of ME. However, the optimum concentration to be used in the field effectively against fruit flies was found to be 1000 ppm of ME. This result shows that ME can be used in agricultural fields as an eco-friendly pest control method against fruit flies and it leads to a value addition to CLO.

Keywords: Methyl eugenol, Eugenol, *Bactrocera dorsalis*, *Cinnamomum zeylanicum*

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Computational study of SARS-CoV-2 M^{pro} inhibition by phytochemicals in five traditional medicinal plants

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Developing antiviral drugs against the current crisis of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is of high priority among scientific communities. The main viral protease enzyme (M^{pro}) is a key target of COVID-19 drugs, as the inhibition of which could halt disease progression. In search for potential inhibitors, phytochemicals from Sri Lankan traditional medicinal plants are an invaluable source of drug leads. Therefore, this study utilized molecular docking based virtual screening to evaluate the inhibition of SARS-CoV-2 M^{pro} by phytochemicals in five medicinal plants that formulate the traditional herbal preparation of 'paspanguwa'. A total of 15 phytochemicals were assessed for their pharmacokinetic properties *in-silico*, upon which, 9 favorable compounds were identified and were docked against the target using Autodock Vina engine in PyRx software. Evaluation of docking scores revealed three compounds, diosgenin, kaempferol and ecdysterone, as promising hits against M^{pro}. These three compounds exhibit low toxicity as well as high bioavailability. Upon binding to the enzyme, they formed favorable interactions with key residues in the active site. Hence, the results of this study indicated that diosgenin, kaempferol and ecdysterone could act as potential inhibitors of SARS-CoV-2 M^{pro}. These findings may provide new insights for developing antiviral therapeutics against SARS-CoV-2.

Keywords: SARS-CoV-2 M^{pro}, COVID-19, Traditional medicine, Phytochemicals

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Utilization of tire pyrolytic char as a potential adsorbent for the removal of methylene blue

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The objective of this study was to investigate the feasibility of using tire pyrolytic char (TPC) as a potential adsorbent of coloured species present in wastewater. The removal of methylene blue dye (MB) from an aqueous solution by TPC was studied as the initial step. Low-quality TPC is discarded as solid wastes in many tire pyrolysis plants, and its disposal is problematic. TPC was demineralized by dilute solutions of acids and bases and the demineralized tire char (DTC) was characterized by elemental analysis, thermogravimetric analysis (TGA), X-ray diffraction (XRD) and scanning electron microscopy (SEM) to determine the chemical, thermal and surface characteristics. SEM analysis of DTC showed that the adsorbent has a rough texture with a porous surface. According to XRD analysis, DTC indicated a minimum amount of wurtzite and sphalerite crystal phases. The effect of process parameters such as adsorbent dosage, contact time, pH and temperature on the adsorption of MB by DTC was investigated by using a 20 ppm MB solution. It revealed that 0.30 g of DTC can reduce 99 % MB concentration of this 50 mL of 20 ppm solution by stirring for 20 minutes at 40 °C and pH 6. The equilibrium adsorption was the best fit with Langmuir isotherm model indicating monolayer adsorption with a maximum adsorption capacity of 46.51 mg/g for non-activated DTC. It is a promising result for the activation of DTC by using a suitable activating method which may show higher adsorption properties comparative to the commercial activated carbon black. Reactivation of used DTC by heating at 500 °C for 1 hour in a nitrogen-filled muffle furnace shows the same activity for the removal of MB for more than six cycles.

Keywords: Tire pyrolytic char, Demineralization, Methylene blue, Reactivation

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Mg-Doped ZnO nano particles for photodegradation of methylene blue and chlorophenol

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Commercial dyes, methylene blue (MB), 4-chlorophenol (4CP) and 2-chlorophenol (2CP) can form mutations in the human body by consumption of contaminated water from industrial waste. As a solution for this environmental issue, the degradation process of MB, 4CP and 2CP in synthetic waste water was studied using the photocatalyst, Mg doped ZnO nanoparticles (NPs), under natural sunlight irradiation. NPs were synthesized by co-precipitation method with and without polyethylene glycol as the stabilizer. Mixture of $ZnCl_2$ and $MgCl_2$ solutions and NaOH were used to synthesize series of $Zn_{1-x}Mg_xO$ NPs with the values of x = 0.000, 0.025, 0.050, 0.100 and 0.150. Broad characteristic absorption bands in UV-vis spectra at 365 and 378 nm were detected for ZnO and Mg doped ZnO NPs respectively. The photocatalytic activity of NPs was evaluated using UV Spectroscopy and the best degradation Efficiency (DE) of 3.7 ppm MB was found as 96.7% in 16 min irradiation at 664 nm with x = 0.025, $Zn_{1-x}Mg_xO$ catalyst with the stabilizer. However, undoped ZnO resulted in 27.1% DE. Enhancement of DE may be attributed to the incorporation of Mg into ZnO structure, which leads to the modification of band gap and hence, increase of the fermi level. Exceeding the critical concentration of the dopant lowered the DE by increasing the band gap known as Burstein Moss effect. With the same experimental conditions and the catalyst, 4CP and 2CP exhibited 97.7 and 79.8% DE respectively, for 100 min. The effect of pH of the medium on DE of CPs was found with the optimum pH of 8.0. The results show a feasibility to utilize the Mg doped ZnO NPs, $Zn_{1-x}Mg_xO$ with x= 0.025 as a resource of photodegradation for organic substances such as MB, 4CP and 2CP in wastewater treatment.

Keywords: Photodegradation, Methylene Blue, Cholorophenol, Mg doped ZnO

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Performance of surface modified pyrolytic carbon black in rubber compounding

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Waste tyres pyrolysis (WT- pyrolysis) process provides a sustainable solution for waste tyre recycling. Value addition to pyrolytic tyre char (PT-char) is particularly essential because it will reduce enormous inventories of wasted PT-char, generate income, and enhance WT-pyrolysis sustainability while still being environmentally friendly. This study was aimed at modifying the surface properties of unusable PT-char to be amalgamated in a rubber compound. PT-char was obtained from a WT-pyrolysis plant, sieved, demineralized using diluted HCl and or Citric acid followed by diluted NaOH. The purified samples were then heated with different ratios of 92-octane at 220-250 °C until the self-ignition of octane occurred. The heat produced by the self-ignition triggered the activation of the surface of PT-char as well as it initiated localized explosions which resulted in breaking up the large PT-char particles. The modified pyrolytic char (PT-char $_M$) was characterized by XRD, Elemental Analyses, and SEM. SEM images of PT-char $_M$ samples and commercial carbon black (CB–N660) samples clearly demonstrate the uniform distribution of nano-size (~50 nm) particles. Modified samples were blended with various additives according to ACS 1 formula to prepare rubber compounds and their cure characteristics and mechanical properties were evaluated and compared with CB–N660 and recycled carbon black. The physico - mechanical properties of the PT-char $_M$ samples were greater than the unmodified samples but little lower than the commercial carbon black. Most interestingly, almost all PT-char $_M$ samples showed better physico - mechanical properties compared to recycled carbon black which suggests that the current PT-char modification protocol might be a promising route to replace recycled carbon black in industry

Keywords: Pyrolytic carbon char, Pyrolysis, Demineralization, Waste tyre

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Purification and application of pyrolytic carbon char in paint formulations

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In waste tyre pyrolysis process, the generation of pyrolytic char (PT-char), a byproduct, is problematic as it has a minimum market value due to the presence of many impurities. In order to improve the market value of the PT-char, economical and efficient purification method was introduced in this study. PT-char samples were sieved, magnetically separated, and purified with dilute acids and/or bases or combination of both. Raw sample (sample A) and three more purified samples (Sample B –washed once with acid, Sample C – washed twice with acid and Sample D – washed twice with acid followed by washed once with a base) were prepared and characterized by TGA, Elemental analysis, SEM/EDX and XRD. The results obtained for the samples were compared with those of commercially available carbon black: N330. Carbon wt% of raw pyrolytic char was ~78% and it was increased to ~84%, ~86%, and ~89% in samples B, C, and D respectively. XRD peaks appeared for ZnO and ZnS impurities were completely disappeared in C & D samples. All four samples, A to D, were then incorporated in paint formulations and investigated their suitability as pigments in paints. Samples C & D were easy to process in grinding to be added in paints. Opacity, color strength, Gloss @60 of the paint developed form sample C was comparable to the standard paint formulated using commercial Ravan black. Sample C & D had better tint tone properties when they were blended with Ravan black 98:8.5 ratio. In conclusion, pyrolytic char is suitable as a black color pigment in paints when it is washed with diluted HCl and NaOH.

Keywords: Pyrolysis, Waste tires, Pyrolytic char, Purification, Paint

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Aggregated adult-recruit spatial pattern of *Shorea* species explained by dispersal limitation process

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Aggregated spatial patterns are commonly observed in tropical rainforests and studying mechanisms related to them advances the understanding of species coexistence in plant communities. Bivariate spatial patterns of recruits relative to conspecific adults of six *Shorea* species, *Shorea affinis*, *S. congestiflora*, *S. cordifolia*, *S. disticha*, *S. megistophylla*, *S. worthingtonii*, which is one of the dominant genera in the lowland rainforest, Sri Lanka were studied using the data from four censuses (1996, 2001, 2006 and 2011) of a 25-ha Sinharaja Forest Dynamic Plot. Dispersal limitation, i.e., adults serve as cluster centers of recruits was assumed during the analysis. Since adults are aggregated, the univariate simple and double cluster Thomas processes were fitted to the adults' pattern, and the most parsimonious model was selected based on the minimum AIC value. To evaluate whether the adult-recruit spatial pattern can be explained by dispersal limitation, we fitted the bivariate Thomas process with known parents. Based on the univariate analysis of adults, the univariate double cluster process was selected for all species. Among the six species, the bivariate adult-recruit pattern of *S. congestiflora*, *S. disticha*, and *S. megistophylla* could be explained well by dispersal limitation at 1-50m scale. However, for the other three species, a goodness-of-fit test indicated a significant departure between the observed pattern and the fitted model at a 5% significance level, and graphical representations of the simulation envelope test suggested additional small-scale clustering between 1-5m. Our results convey that aggregated adult-recruit patterns at the species level revealed different insights into the dispersal limitation process.

Keywords: Aggregated, Adult-recruit bivariate spatial pattern, Dispersal limitation, Univariate double cluster process

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Phenotypic plasticity in orange and black color-patches in wild guppy (*Poecilia reticulata* Peters) linked to habitat characteristics

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The colors of male guppies vary in hue, chroma, reflectivity, and the number, size, and position of color spots. Although conspicuous visual cues play a major role in sexual selection, they may also pose a risk of predation for the guppies. Whether the fish is conspicuous to predators or not may depend on ambient habitat conditions, and hence, it is hypothesized that the color of guppies may show phenotypic color plasticity linked to their habitat features. The objective of the present study was to demonstrate whether male wild guppies show phenotypic plasticity in orange and black color patches. Guppies were sampled from three locations (two urban water-logged ditches L1, L2 and one natural stream L3, approx. 150 km apart) (n= 60 each) with apparently different physical habitat characteristics. Imaging-based method was used to collect data on number of orange and black color patches on left side of male guppies, and the relative size of those color patches. Hypothesis of phenotypic variation among locations was tested by non-parametric tests using R-software. Male guppies from the stream (L3) had a significantly higher number of black patches ($p<0.05$, Kruskal Wallis test) and the lowest area of orange patches (mean 0.06 ± 0.02) than those in the other two locations (L1: mean 0.10 ±0.03, L2: mean 0.08 ± 0.03) indicating that male guppies at L3 were relatively less conspicuous. Highest relative area of orange color patches was found in guppies at L1 (mean 0.10 ± 0.03) followed by L2 (mean 0.08 ± 0.03), suggesting that more male conspicuousness is present in those habitats which are polluted ditches with much darker ambient coloration. The study concludes that there is a significant phenotypic variation in color patches in male guppies in different habitats with varying ambient physical features. More geographic samples and data on cohabiting predatory species and guppy abundance are needed to confirm the adaptive value of color variation connected to predation risk and sexual selection.

Keywords: Guppy coloration, Intraspecific variation, Predation risk, Sexual selection

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Relationship between reservoir morphometry and chitin yield of giant freshwater prawn (*Macrobrachium rosenbergii*) collected from different reservoirs in Sri Lanka

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Chitin, the second most available carbohydrate in nature next to cellulose is a modified polysaccharide that contains nitrogen. Chitin is a primary compound in exoskeletons of *Macrobrachium rosenbergii*, one of the major freshwater crustaceans in culture-based fisheries and fish processing industry in Sri Lanka. Present study ascertains the variation in chitin yield amongst *M. rosenbergii* cultured in different reservoirs and, the relationship of the chitin yield with the area (hectares) and shoreline length (km) of the reservoir. Reservoir morphometric parameters were collected, and chitin was isolated from *M. rosenbergii* shells (n=300) collected from different perennial reservoirs (n=25) located in Anuradhapura, Puttalam, Hambantota and Monaragala districts of Sri Lanka. Three steps (pre-conditioning, demineralization, and deproteinization) were followed in extracting chitin from the shells. Simple linear regression for the two morphometric parameters of the reservoirs and chitin yield were ascertained as, Chitin (%)= 15.96+1.98E-3*Reservoir area, and Chitin (%)=15.8+0.08*Shoreline length. The area of the studied reservoirs varied from 50 to 1781 ha, while shoreline length of the studied reservoirs varied from 2.77 to 30.34 km. Chitin yield of the male *M. rosenbergii* varied from 11.63 ± 7.54 to 23.16 ± 6.16, and that of the female varied from 10.65 ± 1.76 to 21.88 ± 2.47. Pearson correlation indicated that there was a significant relationship between chitin yield and area of the reservoir (r=0.182, p=0.002), and between chitin yield and shoreline length of the reservoir (r=0.130, p=0.025). Present findings elucidate that the morphometry of the perennial reservoirs affect the chitin yield extracted from *M. rosenbergii* shells.

Keywords: Exoskeleton, Culture-based fisheries, Perennial reservoirs, Area, Shoreline

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Colour enhancement of ornamental black carp using dried squid-ink powder

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Black carps have a high demand due to their unique black colour. Local breeders, however, experience a dull brown-black colour in black carps, giving them a low market value. Aim of the present study was to increase the melanin pigments in black carp skin incorporating squid ink (*Loligo* spp) powder into fish diets. Diet A was prepared with commonly used fish feed ingredients (100%), whereas Diet B and Diet C had the same ingredients (99.9867% and 99.9733%, respectively) and made into 100% by adding dried squid-ink powder 0.0133% and 0.0267% respectively. Black carps (mean weight 0.25 g; mean length 22.20 mm) were stocked in glass tanks in triplicates per treatment and fed 10% of body weight with the respective diets for 50 days. At the end of the experiment, black colour of fish-skin was measured at 475 nm by using UV-Vis spectrophotometry, and by analysis of photographs using Image-J software. Image analysis and spectrophotometry data revealed significant differences ($p<0.05$, ANOVA) in mean percentage pixel count per unit area for skin black colour (52.39% ± 2.62) and mean skin-melanin concentration (3.159 mg/g ± 0.114) for the Diet C. Respective values for the same analyses for the Diet A were 33.65% ± 5.23, and 1.268 mg/g ± 0.071, whereas those for the Diet B were 43.47% ± 4.38 and 2.357 mg/g ± 0.325. Mean survival was 58.3%, 66.7% and 38.9% respectively in fish fed with Diet A, Diet B and Diet C. The study reveals that adding a minute amount of squid ink in fish feed could significantly increase the black colour of black carps, but the survival rate is reduced when higher amount of melanin is added to the diets.

Keywords: Melanin in ornamental carps, Pigments in fish feed, Squid-ink

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Identification of suitable sites for freshwater aquaculture in the flood-prone areas of the Nilwala river basin, using land-use patterns and soil quality

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Flood-prone areas (FPA) are land areas susceptible to being inundated by water and, preparation of FPA maps are important in disaster management and planning further development activities. The present study ascertains the areas suitable for aquaculture in flood-prone areas of the Nilwala River basin, using land-use patterns and soil quality. Five GIS maps of the most flooded District Secretariat (DS) divisions of Matara district, viz, Thihagoda, Malimbada, Athuraliya, Matara, and Kamburupitiya were developed. Relative abundance of sand, clay, and silt and the pH and electrical conductivity (EC) were measured. Basic soil textural classes were ascertained in 20 selected locations having high aquaculture potential. Developed GIS maps indicate that potential areas for aquaculture were highest in the Matara DS division (9.64 km^2) followed by Thihagoda (6.25 km^2), Athuraliya (2.13 km^2), Malimbada (2.08 km^2), and Kamburupitiya (1.53 km^2) DS divisions, having a cumulative value of 21.63 km^2, accounting for 22% of FPA in five DS divisions. Abandoned paddy fields (10.52 km^2) accounted for the highest aquaculture potential areas followed by marshlands (7.38 km^2), rivers and canals (2.6 km^2), and minor reservoirs (0.59 km^2). Soil quality analysis in twelve sampling locations indicates the optimal distribution of sand, clay, and silts which consisted of silt clay loam and clay loam soil textural classes that are suitable for aquaculture fishpond contraction. The recorded low EC values (<800 $\mu S\ cm^{-1}$) and higher pH values (>7.5) indicate that almost all studied locations are suitable for freshwater fish and prawn culture. Present findings unfold the suitable sites for freshwater aquaculture development in FPA of the Nilwala river basin.

Keywords: Aquaculture, Flood-prone, Nilwala river basin, Soil quality

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Antioxidant potency in seeds of selected *Vigna unguiculata* varieties of Sri Lanka

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Recently, more attention has been paid towards promotion of nutraceuticals to ensure wellbeing of humankind. *Vigna unguiculata* (cowpea) is a legume crop cultivated in rural areas of Sri Lanka, and the objective of the current study was to compare the antioxidant potency of different cowpea varieties grown in Sri Lanka. Seed samples of four local varieties, i.e. Waruni, Dahawala, MICP 01 and Bomaby were collected from Field Crops Research and Development Institute of Sri Lanka and aqueous extracts were prepared by maceration. The antioxidant potency of seed samples were evaluated by DPPH radical scavenging assay (DPPH), ferric reducing antioxidant power assay (FRAP) and the nitric oxide scavenging assay (NO) using standard methods. In addition, the total phenolic (TPC) and total flavonoid content (TFC) were estimated. The highest DPPH radical scavenging activity was exhibited by MICP 01 variety (32.62 ± 0.42%), while maximum NO scavenging activity was shown by the Dahawala variety (0.689 ± 0.013 mg of gallic acid/g of extract). Dahawala (1.204 ± 0.008 mg of ascorbic acid/g of the extract) and Waruni (1.182 ± 0.019 mg of ascorbic acid/g of the extract) varieties demonstrated comparatively higher FRAP. Dahawala (0.499 ± 0.012 mg of quercetin/g of extract) seed sample indicated a significantly ($p<0.05$) higher TFC compared to other samples. Waruni (1.768 ± 0.015 mg of gallic acid/g of extract) and MICP 01 (1.628 ± 0.005 mg of gallic acid/g of extract) varieties showed the highest TPC. The current study revealed that the seeds of different local varieties of *V. unguiculata* exert different levels of antioxidant potency by the action of various secondary metabolites.

Keywords: Antioxidant, Legumes, *Vigna unguiculata*

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Temporal variation of flower visitors of *Calotropis gigantea* (L.) in Southern Province of Sri Lanka

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Sri Lanka is rich with highly diverse medicinal plants. Among them, *Calotropis gigantea* is a native plant having Ayurvedic value. It is however invasive in countries like Australia and the USA. Information on flower visitors associated with the *Calotropis* plant and their temporal variation becomes important for experimental purposes and to conserve them in their native range, and to eradicate the plant when invasive in an introduced range. The present study investigated flower visitors associated with *C. gigantea* in 11 sites of three districts in the Southern Province of Sri Lanka, i.e., Matara (03), Hambantota (04) and Galle (04). Monthly sampling was done from August 2015 to August 2016 from 6.00 am to 6.00 pm. Monthly rainfall data relevant to the study period was obtained from the Sri Lankan Meteorology Department. *Danaus chrysippus* (L.), *Xylocopa caerulea* (Fabricius), *Xylocopa fenestrate* (Fabricius) and *Apis cerana* (Fabricius) were the flower visitors of the plant. The most frequent species were *Xylocopa* spp. Their frequency of visits varied significantly among 11 sites ($F = 8.18$, $p<0.001$) having the highest frequency in Matara sites and the lowest in Hambantota. *Apis cerana* was uncommon in all districts while *D. chrysippus* was more frequent in Matara district. The highest mean flower visitor abundance was recorded from Matara district while the lowest was in Hambantota district where it may be due to higher temperature, wind velocity and solar radiation intensity. Monthly rainfall however had no influence on their visiting frequencies ($r=-0.082$, $p= 0.352$). Flower visitors were high in March to May while it was low in August in all districts. Abundance of *C. gigantea* fruits had a positive correlation with the abundance of *D. chrysippus* ($r=0.094$, $p<0.001$) and *Xylocopa* spp. ($r=0.160$, $p<0.001$) indicating they might play a significant role in *Calotropis* pollination.

Keywords: *Calotropis gigantea,* Medicinal plant, Flower visitors, *Xylocopa spp.*

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Determining the toxicity of papaya (*Carica papaya*) leaf extract on zebrafish (*Danio rerio*) embryos

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Herbal drugs becoming popular in medicine as well as in other fields including aquaculture. Papaya (*Carica papaya*) has proven antibacterial, anti-inflammatory and anti-tumor properties. However, the toxicity of papaya leaf extract needs to be tested to determine the teratogenic effects. Zebrafish (*Danio rerio*) embryo toxicity testing is one of the standard methods used in toxicological assays. Hence, present study investigated the acute toxicity effect of wild type papaya leaf extract on Zebrafish embryos. Zebrafish embryos (16 cell stage) were exposed to four different concentrations of aqueous papaya leaf extracts as 200, 150, 100 and 50 mg/ml (36 embryos per treatment). Distilled water was used as negative control while tetracycline (2 mg/ml) suspension was used as positive control. Lethality rate was recorded at 24, 48, 72 and 96 hours based on four apical observations of lethality i.e, coagulation of fertilized egg, lack of somite formation, lack of detachment of the tail and lack of heartbeat. The results indicated that median lethal concentration (LC_{50}) of papaya leaf extract after 96 hours was around 257 mg/ml which was higher than the tested concentrations. It was observed an increasing trend of mortality rate along with the concentrations. However, the results confirmed that papaya leaf extract below 100 mg/ml has low toxicity effect on zebrafish embryo compared to the tetracycline suspension.

Keywords: Herbal antibiotics, Papaya leaf extract, Toxicity, Zebrafish embryo

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Molecular identification of selected species of family Carangidae in Sri Lanka: An initiation for establishment of barcoding library

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Economically important fish groups in family Carangidae have been identified as potential candidates for aquaculture. The phenotypic similarity of many species may lead to misidentification of species. The objectives of this study were to use partial sequence of mitochondrial Cytochrome c Oxidase I (COI) gene (650bp), also known as the DNA barcoding gene region to confirm the species status of selected carangid fishes and to initiate the first Sri Lankan Barcode Library for native Carangid species. Eight fish species, namely, *Caranx ignobilis*, *Caranx heberi*, *Caranx sexfasciatus*, *Gnathanodon speciosus*, *Carangoides hedlandensis*, *Carangoides malabaricus*, *Selaroides leptolepis* and *Selar crumenophthalmus* were collected from fish landing sites. Three samples from each species were amplified for the DNA barcoding gene region and sequences were submitted to both databases, the National Center for Biotechnology Information (NCBI) and Barcode of Life Database (BOLD) to initiate the formation of library. The mean length of the generated sequences was 655bp. Calculated using the P-distance model, the pairwise distances within species ranged from 0 to 1.4% and between species ranged from 6.1 to 17.1%. The resulted distance levels were consistent with the reported values for marine fish species and revealed that DNA barcoding gene region was successful in discriminating the selected fish species. The species phenotypically identified in the current study as *Carangoides malabaricus* showed only 88.2% similarity (11.8% divergence) with *Carangoides coeruleopinnatus* under NCBI Blastn option. Further studies are recommended for confirmation of its species status and to identify remaining Carangid species in Sri Lanka using DNA barcoding data.

Keywords: Barcoding library, Carangidae, Cytochrome c Oxidase I, Pairwise P-distance.

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In vitro antioxidant activity, total phenolic and flavonoid contents of different solvent extracts of *Ficus racemosa* (Attikka) bark

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Ficus racemosa (Attikka) is widely used in Sri Lankan traditional medicine system for treatment of various diseases. The objective of the present study was to evaluate in vitro antioxidant activity of different solvent extracts obtained from the bark of *Ficus racemosa* grown in Sri Lanka. Two different crude extracts namely, 70% aqueous acetone and 80% aqueous methanol extracts were prepared by steeping method and subjected to quantitative analysis. The total phenolic and flavonoid contents were evaluated by Folin-Ciocalteu assay and aluminium chloride colorimetric method respectively. *In vitro* radical scavenging activity and antioxidant activity of the extracts were evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay and ferric-reducing antioxidant power (FRAP) assay. The results for the total phenolic contents were 5195.354 ± 132.942 (70% aqueous acetone) and 4414.158 ± 117.363 (80% aqueous methanol) mg Gallic acid equivalent/100 g dry weight (DW) of bark. Results of the total flavonoid contents were 8611.538 ± 87.521 (70% aqueous acetone) and 7592.864 ± 74.782 (80% aqueous methanol) mg Catechin equivalents /100 g DW of bark. The results of DPPH assay showed significantly high value (20.152 ± 0.646 mmol Trolox equivalents/100 g DW of bark) for 70% aqueous acetone extract compared to the value (18.562 ± 0.328 mmol Trolox equivalents/100 g DW of bark) obtained for the 80% aqueous methanol extract. Antioxidant activity by FRAP assay was 32.837 ± 1.557 (70% aqueous acetone) and 28.483 ± 0.395 (80% aqueous methanol) mmol Fe (II) equivalents/100 g DW of the bark. It is concluded that 70% aqueous acetone extract obtained from *F. racemosa* bark has significantly high values of total phenolic, flavonoid contents, antioxidant activity. Further studies should be carried out to isolate active compounds.

Keywords*:* Antioxidant activity, Flavonoids, *Ficus racemosa*, Phenolics

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Genotypic identification of *Orientia tsutsugamushi* strains causing scrub typhus disease in southern Sri Lanka

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Scrub typhus (ST) is a febrile illness in human caused by intracellular bacterium *Orientia tsutsugamushi* (OT). OT is transmitted to humans via a chigger bite leaving an eschar at the bite site. High genotypic diversity of OT is a major obstacle in developing diagnostics and vaccines. Little is known regarding OT genotypes in Sri Lanka (SL). Present study determined the OT genotypes in Southern Province, SL. A total of 13 eschars, 4 peripheral blood cell samples (PBCs) and 5 blood clots (BCs) were collected from 22 clinically suspected ST patients between 2018 and 2020. Specimens were stored in RNA*later* at -80 ^{o}C prior to analysis and DNA was extracted with DNeasy Blood and Tissue DNA extraction kit (Qiagen). Partial *tsa56* gene locus (483bp) was amplified by nested Polymerase Chain Reaction (PCR), and sequenced. A phylogenetic tree was constructed using maximum likelihood method in MEGAX10.1 (nucleotide substitution; Tamura nei model, 1000 Bootstrap Trials). OT genotypes of Karp related (54.5 %), Kato (18.2%), Taiwan Gilliam variant clade of Gilliam/Kawasaki (22.7%) and TA763 (4.5%) were identified. This is the first to report TA763 genotype in SL showing 0.009 nucleic acid divergence from prototype TA763. Residue conservation analysis showed amino acid substitutions Q168P, N170D in variable domain (VD)II, V218A in VDIII and Q223R at spacer VDIII are conserved within the Karp strains of this study. Substitutions K236R, F238L at spacer VDIII are also notable in TA763 detected in SL. These domains have been shown to elicit immune responses via CD4 T-cell receptor epitopes.

Keywords: Scrub typhus, *Orientia tsutsugamushi*, TA763, Sri Lanka

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Linoleic acid levels in patient peripheral blood cells may serve as a biomarker of acute scrub typhus

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Scrub typhus (ST) is an acute febrile illness in human caused by obligate intracellular Gram-negative bacterium *Orientia tsutsugamushi* (OT). OT exploits white blood cells during infection. Previous studies in mouse models showed that OT infection alter host lipid metabolism. Therefore, current study was focused to investigate the changes in the fatty acid profile in peripheral blood cells (PBC) from acute ST patients in response to OT infection to determine its potential to serve as a disease biomarker. OT infection was confirmed by diagnostic PCR (n= 17). Venous blood (2.5 mL) was collected into EDTA tubes from each subject with informed consent, PBC were separated, and cellular fatty acids were extracted. Fatty acid methyl esters (FAMEs) were prepared and analyzed by a gas chromatograph equipped with column Rtx^{R}-WAX and flame ionization detector. Mean percentage area for each signal was calculated as a percentage of total fatty acids, and peaks were identified against authentic FAME standards. The (*9Z,12Z*)-octadeca-9,12-dienoic acid (linoleic acid) content in PCR positive subjects (n= 17) is significantly higher ($p<0.05$) than the levels detected in PCR negative subjects with febrile illness (n= 17) and the healthy subjects (n= 17). Logistic regression analysis of percentage linoleic acid content in PBC is predictive of ST infection (odds ratio, 3.19; 95% CI 1.35 – 7.56; $p< 0.05$) with an area under the receiver operating characteristic curve (AUC) of 0.82. The sensitivity and specificity of ST infection is 0.82 and 0.87 respectively at 1.98 % linoleic acid content suggesting its potential to serve as a biomarker of ST.

Keywords: Biomarkers, Linoleic acid, *Orientia tsutsugamushi*, Scrub typhus

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Aqueous extract of *Catharanthus roseus* L. loaded alginate nanoparticles: Characterization and assessment of α-glucosidase and α-amylase inhibitory potential

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Low solubility and degradation under unfavorable conditions limit the bioactivities of herbal extracts. This study aimed to characterize the aqueous extract of *Catharanthus roseus* L. (Family: Apocynaceae) encapsulated alginate nanoformulation (CEA) and assess α-amylase and α-glucosidase inhibitory potential. Aqueous extract of *C. roseus* was prepared using ultrasonication followed by refluxing. Nanoformulation was done using the ionic gelation method. Extract concentration was optimized via encapsulation efficiency (EE), loading capacity (LC), particle size analysis and zeta potential analysis. The α-glucosidase and α-amylase inhibitory potential of free extract and CEA were evaluated. The optimum concentration for encapsulation was selected as 1 mg/ml with the highest EE of 62.0 ± 1.5% and LC of 1.1%. Microscopic examination showed the lowest particle size of 158.2 nm and acceptable zeta potential of (-) 22.00 mV at 1 mg/ml. The α-amylase inhibition assay showed that the free extract (10.3 ± 2.1 mg/ml) and CEA (6.0 ± 0.7 mg/ml) exhibited 50% α-amylase inhibition activity at the mentioned concentrations. The α-glucosidase IC_{50} values for the free extract and CEA were found to be 23.0 ± 0.7 mg/ml and 9.3 ± 1.6 mg/ml respectively. IC_{50} values of α-amylase and α-glucosidase for acarbose were 0.004 ± 0.000 mg/ml and 1.8 ± 0.6 mg/ml respectively. The free extract and CEA have shown a significant difference comparable to that of reference compound acarbose. The results concluded that CEA had a higher inhibition on α-glucosidase and α-amylase enzymes. Further studies are warranted to determine the stability of nanoformulation.

Keywords*:* Alginate, Antidiabetic activity, *Catharanthus roseus* L.

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Assessment of glucose-lowering activity of *Cassia auriculata* L. extracts encapsulated nanoliposomes

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Glucose-lowering activity of *Cassia auriculata* L. (Ranawara, Family: Fabaceae) flowers is scientifically proven. However, it has limited use as therapeutic agents due to drawbacks including reduced absorption and stability. This study aimed at optimization and screening of *C. auriculata* encapsulated nanoliposomes using high-fat diet fed, streptozotocin induced diabetic Wistar rat model. *C. auriculata* flowers were extracted using water, ethanol and aqueous ethanol 70% v/v by ultrasonication (40 ^{0}C, 40 kHz, 30 min). The dried extracts were encapsulated in nanoliposomes. The glucose-lowering activity of optimized nanoliposomes was determined by oral glucose tolerance test (OGTT, 3 g/kg) in diabetic rats. The results were evaluated using the total area under the OGTT curve (TAUC). Optimum encapsulation efficiency and loading capacity of water, ethanol, aqueous ethanol 70% v/v extracts encapsulated nanoliposomes were observed at 3, 6 and 6% w/v loading concentrations respectively. The optimized extracts encapsulated nanoliposomes at the selected doses (45, 60 and 30 mg/kg) showed percentage reduction of TAUC as 13.89 (p= 0.032), 13.25 (p= 0.04) and 1.4 (p= 0.808) respectively compared to diabetic control rats. However, a significant reduction of TAUC (11.63%) (p= 0.05) compared to unencapsulated extract at the respective dose was shown only for water extract encapsulated nanoliposomes (WENL). Particle size and zeta potential of the WENL nanoparticles were 494.53 ± 1.15 nm and -17 ± 2.63 mV. In conclusion, nanoencapsulation improved the glucose-lowering activity of *C. auriculata* water extract. The variation of TAUC among nanoliposomes is associated with the varying polarities of encapsulated secondary metabolites interacting with the nanoliposome system.

Keywords: *Cassia auriculata* L., Diabetes mellitus, Nanoliposomes

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A comparison of partition of unity finite element method and finite volume technique for solving 1-D heat conduction problems

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The scope of this research concerns with the numerical methods used for solving one-dimensional partial differential equations. It is motivated by the need for efficient numerical methods to deal with partial differential equations that are difficult to solve using analytical approaches. Among those numerical methods, the Finite Difference Method (FDM) is the simplest method, and the Finite Volume Method (FVM) is generally expected to provide better conservation properties. Also, the Partition of Unity Finite Element Method (PUFEM) has been identified as an extremely powerful new numerical method which deals with overlapping subdomains. In this study, we examined the PUFEM and FVM to see whether they produced equivalent numerical solutions. We considered two problems namely, a steady-state heat conduction problem and an unsteady state heat conduction problem when Dirichlet boundary conditions are given, for this study. In the Steady state heat transfer problem, we studied the change of the temperature of different points in the spatial domain, and in the unsteady state heat transfer problem, we examined the temperature distribution at a given point x in space and at a given time t. Both of these problems are solved separately using FDM, FVM and PUFEM. We found that the numerical solutions from the FDM are accurate by comparing the exact analytical solutions of one-dimensional steady state heat conduction problem with those from the FDM. The numerical solutions of FVM and FDM were compared to ensure that the FVM numerical solutions were accurate. Then the numerical solutions from PUFEM and FVM were compared, and we observed that the numerical solutions obtained using the two numerical approaches are indistinguishable in one dimension. We found that it is efficient to use PUFEM, which is a meshless method, instead of FVM, which is a mesh-based method, because PUFEM requires less computational time and programming effort.

Keywords: Partition of unity finite element method, Finite volume method, Finite difference method, Steady, Unsteady, Heat conduction

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A study on the daily exchange rate fluctuation in Sri Lanka using stochastic models

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The main objective of this work is to determine the most appropriate model for forecasting the daily exchange rate of the Sri Lanka Rupee (LKR) against the United States Dollar (USD) among the geometric Brownian motion (GBM) and three selected stochastic differential equations (SDEs) used in stochastic analysis of financial markets. As a first step, we obtained the exchange rate data of LKR against USD throughout the day from the http://www.Xrates.com website and studied the behavioral pattern. We observed compact fluctuations in exchange rates for 24 hours on one day and large fluctuations on another day. Thus, we identified three types of fluctuations in the 24-hour exchange rate data, namely, small, intermediate, and large. Then, hourly exchange rates were obtained for these three types of fluctuations, that is, on 2021.04.26 for small, on 2021.03.11 for intermediate, and on 2021.04.05 for large. We calculated the drift and volatility parameters for these three types using corresponding exchange rate values obtained for the small, intermediate, and large, respectively. Finally, the three data sets were predicted separately for the next 24 hours using GBM and the three SDE models. The accuracy of the predictions of the GBM and three SDE models were examined using the Mean Absolute Percentage Error (MAPE) statistic for LKR against USD forecasts under consideration. For each of the four models, the corresponding MAPE value was calculated and found less or almost less than 10% in each of the predictions made and it was observed increasing with the increasing fluctuations. One SDE model gave a better approximation for next day 24-hour exchange rate prediction compared to the other models. The results were obtained by using the R software package (4.0.3 version).

Keywords: Exchange rate, Geometric Brownian motion, Stochastic differential equations, Drift and volatility parameters, Mean Absolute Percentage Error

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An approach towards settling a conjecture on ample numbers

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A positive integer n is said to be *abundant* if $\sigma(n) > n$ and *ample* if $a(n) > n$, where $\sigma(n)$ denotes the sum of positive divisors of n and $a(n)$ denotes the number of recursive divisors of n. In 2005, Iannuci claimed that there exist abundant numbers that are not divisible by the first k primes for all $1 \leq k \leq 7$. The conspicuous parallel properties between abundant and ample numbers have led to the conjecture, *there exist ample numbers that are not divisible by the first k primes for all k*. In 2020, Fink used computational evidence to find the smallest ample number that is not divisible by the first two primes as 3.3×10^{81}. In the present study, we consider a positive integer x that is not divisible by the first k primes for all $k \in \mathbb{N}$ and write $x = q_1^{\alpha_1} q_2^{\alpha_2} \dots q_j^{\alpha_j}$; $q_j = p_{k+j}$, $j \geq 1$ and $0 \leq \alpha_j < \infty$. We try to construct a general formula for $a(x)$ by considering the types of proper divisors m_i of x and formulating the total number of proper divisors $a(M_i) = \sum a(m_i)$, where M_i is the set containing all the proper divisors of type m_i. We show that $a(M_1) = 2\sum_{i=1}^{j}[2^{\alpha_i} - 1]$, where $M_1 = \{q_i^{\alpha_k} : i = 1, 2, \dots, j\ ;\ \alpha_k = 1, 2, \dots, \alpha_i\}$ and $a(M_2) = 3j[j-1]$, where $M_2 = \{q_i q_l : i = 1, 2, \dots, j-1\ ; l = 2, 3, \dots, j\}$ with j being the number of distinct primes in the prime factorization of x. The aforementioned results are used in the ongoing study on settling the conjecture which states such a positive integer x is ample. These ideas can be utilized in finding new possible modular grid sizes and related applications therein.

Keywords: Abundant numbers, Ample numbers, Recursive divisibility

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Approximate analytical solution for the Cauchy fuzzy reaction-diffusion equation via method of directly defining the inverse mapping

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This work employs the Method of Directly Defining the inverse Mapping (MDDiM) to obtain an approximate analytical solution for a fuzzy partial differential equation (FPDE). The FPDEs have attracted a great deal of attention among scientists and engineers, because of its frequent involvement in the modeling of industrialized applications, such as heat and mass transfer, electromagnetic fields, and many others. The numerical and analytical solutions of FPDEs have been investigated by numerous authors using various numerical and analytical methods. The MDDiM was applied to calculate the solution of fuzzy reaction-diffusion equation (FRDE) by considering the first three terms of the series solution. This is the first time someone used the MDDiM to solve FPDEs. Here, we obtained an approximate analytical solution by considering the upper bound and lower bound solutions. The best value of the convergence control parameter was determined by minimizing the square residual error of the MDDiM solution. The results that we obtained here agreed very well with the exact solution of Cauchy FRDE. The main achievement of this study is the demonstration of the successful application of the MDDiM in obtaining an analytical solution of the Cauchy FRDE.

Keywords: Analytical solution, Cauchy fuzzy reaction-diffusion equation, Fuzzy partial differential equation, Method of directly defining the inverse mapping, Series solution

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A hybrid method for solving the model of human immunodeficiency virus infection of CD4+ T cells

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The present study describes the application of a new method called Laplace Padé Differential Transform Method (LPDTM), which combines Differential Transform Method (DTM) with Laplace-Padé approximation for a system of non-linear ordinary differential equations. A dynamic model of HIV-1 (Human Immunodeficiency Virus - type 1) infection of CD4+ T cells is considered. These CD4+ T cells secrete growth and differentiation factors that are required by other cell population in the immune system, and thus these cells are known as helper T cells. LPDTM is used to prove that the post-treatment power series solution updated by Laplace-Padé re-summation method is a useful strategy to extend the convergence range of the approximate solutions. The main advantage of the proposed method is that it is based on a few simple steps, does not generate secular terms, and does not depend on perturbation parameters. Firstly, the solutions of the model consisting of a system of ordinary differential equations are obtained in the form of convergent series using the DTM. Then, a post-processing combining Laplace transform and Padé approximation is applied in order to expand the convergence range of the truncated power series. Finally, a comparative study between the present method, Differential Transform Method and fourth order Runge-Kutta (RK4) method is also carried out to show the high accuracy of the results using numerical solutions and plots.

Keywords: Differential transform method (DTM), Fourth order Runge-Kutta (RK4) method, HIV-1 CD4+ T cells model, Padé approximation

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Predicting dengue fever cases using Time Series Model and Hidden Markov Model in Sri Lanka

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Dengue fever is one of Sri Lanka's most serious health problems, wreaking havoc on the country's social and economic infrastructure. Dengue fever is a mosquito-borne viral disease that has recently risen considerably. A few studies were conducted using time series analysis to investigate the dengue outbreak in Sri Lanka. It does not appear that the models' accuracy can be leveraged to produce more accurate forecasts. The objective of this study is to develop Markov and time series models for forecasting monthly dengue patients in Sri Lanka and identify the most suitable model. The findings of this study are critical for many stakeholders, including the medical community and policymakers, to allocate health resources and create prevention programs. According to the statistical analysis, the highest number of dengue cases were recorded in the western province. The highest number of dengue cases were recorded in July 2017 (41,121) when considering the data from 2010-January to 2021-August. By using the unit root test, the p-values for the Augmented-Dickey-Fuller *test* and Phillips-Perron test were 0.0189 and 0.008 respectively. Since p-values were less than 0.05, the time series was stationary. The number of dengue cases was predicted using the ARMA (1,1) model, which has the lowest AIC value. The Gaussian HMM was developed using Python's GaussianHMM function. Parameter values were obtained by changing the number of hidden states. For concealed states 4, 5, and 6, relevant performance measurements were taken. The most accurate model based on the data was obtained for five hidden states. Mean error, mean absolute error, and mean absolute percentage error of HMM were 6.21, 10.22 and 0.005016 respectively and these values were less than the values obtained from the time series model. As a consequence, the HMM model is more accurate and can be used to predict dengue cases in Sri Lanka.

Keywords: Dengue, Time Series Model, Hidden Markov Model

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A linear programming model to optimize the apparel production process during the Covid-19 pandemic

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Besides the fact that the apparel industry is a major contributor to the Sri Lankan economy, it has been adversely affected by the sudden health regulations imposed by the Government to mitigate the outbreak of the Covid-19. Although the garment factories followed a well-established production process, Covid-19 pandemic forced a re-design of the production line, which is considered to be the backbone of any production plant. Due to the imposed health regulations, the factories were compelled to reduce the employee capacity by at least 50% in order to maintain the social distancing within the plants. This caused the factories to operate on a fewer number of production lines which led to reduction of productivity. As a result, the factories failed to meet the market demand and consequently lost customer satisfaction. Therefore, the objective of this study was to develop a decision-making tool to generate optimal production schedules adhering to the imposed health restrictions. Initially, a literature survey was conducted to lay down the foundation for the study and subsequently, to acquire ground-level information, a series of interviews with the work-study teams in the plants was conducted. Next, a generalized linear programming model was formulated to generate optimal production line schedules to increase the efficiency and profitability of manufacturing plants. Finally, to test the performance of the formulated model, it was applied to a garment factory of a prominent garment chain in Sri Lanka. The optimal production schedule recommended by the model achieves higher productivity gaining, customer satisfaction and the profit.

Keywords: Linear programming model, Covid-19 pandemic, Apparel industry, Production line scheduling

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A binary linear programming model for a case study in university timetabling problem

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In this study, a university timetabling problem is addressed and proposed a two-phase approach for solving the problem. The timetabling problem is a combinatorial, NP-complete optimization problem. Due to its practicability and complexity, timetabling problem is prominent among the researchers and has sound literature equipped with various methodologies and solution techniques. Among the various timetabling problems, addressed in the literature, university course timetabling is more complex due to the sophisticated course structures, a large number of student groups, and many other requirements imposed by the institution. University timetabling problems can be hardly generalized due to the different inherent characteristics of the timetabling problem from institution to institution. And hence, many studies are focused on case studies while extending and generalizing to a certain extend. In this study, the timetabling for semester I of the Faculty of Science, University of Ruhuna, Sri Lanka is selected as a case study. Two-phase approach is proposed to produce the timetable. In the first phase, a binary linear programming model is constructed to determine the feasibility of the number of optional courses to offer at different time slots. Using the genetic algorithm, the constructed model is solved and the optimum number of classes that can be assigned to different timeslots is determined. Once the optimum allocation is determined, the second phase is devoted to find the optimal timetabling treating the preferable constraints as objectives. Genetic algorithm is used to solve the phase two problem and an automated timetable is produced.

Keywords: Optimization, Integer programming, Timetabling

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Mathematical modeling and inverse mapping to find the saturation of carbonate-water in the fingering phenomenon

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The fingering phenomenon occurs during the secondary oil recovery process when the water is injected at a relative speed through the porous media. Water injection (water flooding) is a cheap and very effective method that depends on the oil-water viscosity ratio. Carbon Dioxide is a miscible gas with both oil and water, and it can reduce the viscosity of oil in a process called swelling. That led scientists to study water injection together with CO_2 gas in the oil recovery process to recover important potion of oil. For the first time, in this study we build up a mathematical model to find the saturation of carbonate-water of the fingering phenomenon and, also discussed the effect of the inclination angle of the oil layer. To determine the parameters of this model we used the Method of Directly Defining the inverse Mapping (MDDiM) which is a novel technique to solve nonlinear differential equations. This study proves the saturation of carbonated water is high compared to the previous studies for saturation of water. If the saturation of injected fluid is increasing then it leads to increase oil recovery. Therefore this study reflects the fact that the important portion of oil recovery when the carbonated water injection than the water injection. We obtained second and third-order solutions for carbonate-water saturation for different inclination angles and they are accurate enough with the squared residual errors that were found using Maple 16. We can conclude that carbonate-water saturation increases with the inclination angle and further it is founded that third-order solutions are more accurate compared to the squared residual errors.

Keywords: Carbonate-water saturation, Fingering phenomenon, Incline angle, Method of directly defining the inverse mapping

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An improved public key cryptosystem based on ElGamal algorithm

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Cryptography is a method of storing and transmitting data in a particular form so that only those for whom it is intended can read and process it. It not only protects data from alteration, but also can be used for user authentication. Over the years, the original cryptographic schemes have been altered in order to achieve a higher level of security and efficiency. There are two main cryptosystems, symmetric and asymmetric depending on the key distribution properties. Public key cryptography or asymmetric cryptography is a scheme that uses pair of private keys and public keys. The generation of such key pairs depends on cryptographic algorithms which are based on certain mathematical techniques. ElGamal cryptosystem is an asymmetric cryptographic scheme which was introduced by Taher ElGamal in 1985. This algorithm was developed based on the Diffie-Hellman key exchange protocol. We have proposed a variant of the ElGamal scheme using two random integers instead of using one integer as used in the standard ElGamal cryptographic scheme. Then the new scheme becomes more intricate and challenging to decipher. This scheme is designed under three primary steps of key generation, encryption, and decryption. The key generation and encryption processes are improved due to the addition of one more random integer. The security of the system depends on the discrete logarithm problem which is known to be computationally hard.

Keywords: Discrete logarithm problem, ElGamal cryptosystem, Key generation, Encryption, Decryption

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Estimating the empirical distributions of exchange rates volatility in Sri Lanka

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The exchange rate is the worth of a country's currency compared to another foreign currency. It is important to identify the empirical distribution of the exchange rates, as these rates are indicators of the economy of a country. This study aims to identify the accurate distributions of eight exchange rates (i.e. USD, EURO, GBP, CHF, CAD, AUD, SGD and JPY) against the Sri Lankan Rupees among potential distributions. This is the first study that identifies the empirical distributions of exchange rates in Sri Lanka. According to the findings of previous studies, most of the exchange rates are non-normal due to their volatile behavior. With respect to the statistical properties of the data, all considered exchange rates in this study were skewed and the kurtosis values indicated severe non-normality. Three candidate distributions, namely, the Generalized lambda distribution (GLD), the Skew-normal (SN) and the Normal Inverse Gaussian (NIG) were considered in the study. Formal goodness of fit (GOF) tests and graphical GOF techniques were applied to evaluate the suitability of the fitted distributions. Moreover, the Kullback-Leibler divergence was calculated to find the amount of information loss when the probability distribution function (PDF) approximates the original data. The best-fitted PDF was the GLD with the parameter estimation method of the maximum product of spacings for all the considered exchange rates. The findings of this study will direct the researchers in accurate model fitting incorporating the identified distribution, which would further support the country's international trading, employment, investors and stakeholders in decision-making.

Keywords: Empirical distribution, Exchange rates, Non-normality, Sri Lankan Rupee

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Noise-induced stochastic transition: a novel stochastic chemostat model with flocculation effect

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The continuous culture of microorganisms is extensively used to produce some important commercial products. Hence, the collection of continuously cultured microorganisms is one important topic in the applications of microbial engineering. In this research work, we present a novel stochastic chemostat model with two complementary nutrients and flocculation effect to provide control strategies. At microscopic scale the accumulation of small perturbations in the chemostat could not be neglected. In order to capture the fluctuations caused by environmental heterogeneity, we extend a deterministic model to the case with some stochastic perturbation in the form of white noise and then study the influence of stochastic perturbation on the global dynamics of such model. We obtain some theoretical results including sufficient conditions for the existence of a unique ergodic stationary distribution and persistence of the stochastic model. In biology, the existence of unique stationary distribution of stochastic model means that microorganisms can be collected continuously. Based on usual sensitivity analysis method, some control strategies are discussed. Therefore, in order to achieve continuous collection of microorganisms, it is feasible to adopt the following strategies, (i) increasing the maximum growth rate of microorganisms, or the input concentration or of carbon source or nitrogen source; (ii) reducing the dilution rate, or the flocculation rate, or the input concentration of flocculants; (iii) reducing the intensities of white noise as much as possible. Further numerical simulations using MATLAB2019 were carried out to validate the analytical predictions and those show that the random fluctuation may have positive biological effects.

Keywords: Stochastic chemostat model, Flocculation effect, Stationary distribution, Extinction and persistence, Noise-induced stochastic transition

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Local stability properties of a delayed HIV-I virus dynamic model with saturation infection rate

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This study investigates the local stability properties of a virus dynamic model for HIV-I virus infection including saturation infection rate. The novel feature is that both the absorption effect and the cure rate are incorporated into the model with the intracellular time delay. This study was undertaken to present the local stability and how the basic reproduction number influences the local stability of the model. We included four significant and distinctive aspects in the proposed model compared to the usual HIV-I mathematical models available in the literature. To make the processes more biologically realistic, the saturation infection rate and absorption effect were incorporated into this dynamic model. We included the cure rate because by improving the cure rate, it allows the disease to be controlled more effectively. As the facts surrounding delayed processes are biologically more crucial, intracellular time delay was incorporated into this dynamic model to provide a more extended and specific infection process. In the presence and absence of time delays, the model's characteristic equations were utilized by considering the Jacobian matrix of the model. To evaluate the local stability behaviors of both the infection-free and chronic infection equilibriums, the characteristic equations are analyzed separately. The mathematical analysis using the Routh Hurwitz stability criterion revealed that the basic reproduction number was exclusively accountable for the stability properties of the model when the delays were not present. Furthermore, correlations were established between the basic reproduction number and time delay. The numerical simulations were also illustrated in order to verify the theoretical results, which concluded that the basic reproduction number was directly involved in determining whether the virus in the host persist or die.

Keywords: Absorption effect, Cure rate, HIV infection, Mathematical modelling, Time delay

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Popular repeated significance type of sequential tests for binary responses

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Fixed sample clinical trials involve humans that are accumulated over a considerably large period of time in order to achieve the pre-specified sample size calculated prior to the study. These designs are somewhat impractical as they do not address economical and some ethical issues such as the decisions are made using a greater number of patients. Thus, for the reason being one of economical and ethical, sequential designs come into practice. At interim inspection, sequential designs either stop or continue. These usually have lesser number of patients, leading to saving in cost and time while improving ethical issues. When the response is binary with the interest of clarifying the significant difference between two treatments, the application of the binomial test in sequential framework is merited. This research aims to compare three repeated significant type of sequential tests namely, Pocock, O'Brien-Fleming and Lan & DeMets tests to specify the best sequential design involving binary data. These were compared using type I error, power, mean information and average duration to stopping the trial by using simulation studies developed in software SAS Version 9.4. To ensure the practicability of each design, the three designs were applied to a real-world dataset which comprises information on U.S. diabetics. An envisaged feature of early termination of the trial at early stages successfully appeared allowing the sample size to be reduced. All designs provided type I error rates which are maintained within the acceptable region while keeping high power. An appropriate value was assigned to each design property while introducing a Likert scale and the design that reached the highest total score was selected as the best. Eventually, the Lan and DeMets design is marginally superior to the other designs studied while ensuring all designs are feasible in practice.

Keywords - Sequential designs, Repeated significant type tests, Binary, Type I error, Power

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Influence of environmental factors on catch rates of flotsam associated Indian Scad (Decapterus Russelli) in the Indian Ocean

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The Indian Scad is an important Carangidae fish species caught in ring net, gillnet, and longline fishery. The fishes of the family Carangidae are one of the important fishery resources in Sri Lankan waters as they constitute nearly 34% of the annual marine fish landings of 32956 metric tons pelagic fish landing during 2019. The present study was undertaken to study the relative influence of oceanographic environment factors on their Catch Per Unit Effort (CPUE) in the Indian Ocean. The relationships were examined for the oceanographic environment factors namely, Sea Surface Chlorophyll (SSC), Mixed Layer Depth, Sea Surface Height (SSH), Salinity, Sea Surface Temperature (SST). In addition, two variables indicating the geographical location (Latitude (Lat), Longitude (Lon)) were used as explanatory variables. The data was obtained from the National Aquatic Resources Research and Development Agency (NARA) for three consecutive years 2018-2020. A Generalized Additive Model (GAM) was fitted for describing the relationships between oceanographic factors and CPUE. The relationships between oceanographic factors and the CPUE are mostly expected as non-linear. Once the shape of the relationships between the CPUE and each explanatory was identified, the appropriate functions were used to parameterize these shapes in the GAM model. The CPUE as a function of oceanographic factors were included in the analysis using GAM. The results show that SSC, Lat, and SST have significant impact on Indian Scad catch rate ($p<0.05$) at 0.05 level of significance. The results obtained show that the high CPUE of Indian Scad occurred when SSC about $0.2 mgm^{-3}$. The GAM results show that Lat has influence on Indian Scad catch rates in the region between latitudes 4° N and 6° N. The higher catch rates of Indian Scad were observed from the areas where SST varied between 28.5-30°C.

Keywords: Indian Scad, GAM, CPUE, Oceanographic environment factors

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Use of statistical quality control techniques: a case study on Southern Province medium-scale manufacturing sector in Sri Lanka

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The need for statistical quality control techniques in the competitive business environment has been felt more important than ever. Although the importance is highlighted, most of the medium-scale entrepreneurs are not practicing these techniques sufficiently. The knowledge on which statistical quality control techniques are used in medium-scale manufacturers and the reasons for non-compliances for the statistical quality control techniques in medium-scale manufacturers are lagged behind the market requisites. Thus, the objectives of the study were to identify the statistical quality control techniques use in medium-scale manufactures, discuss the limitations hinder the level of usage of statistical quality control techniques and the possible strategies to meet-up with those limitations experienced by the medium-scale manufacturers. The survey method was used to collect the data through a structured questionnaire from the medium-scale manufacturers in Galle, Matara, and Hambantota districts in the Southern Province, Sri Lanka. A total of 108 manufactures were identified and questionnaires were administered. Descriptive statistical techniques and factor analysis were applied using R language (version 4.0.3). The results of the analysis indicate that most of the quality control techniques used by the medium-scale manufacturers are non-systematic and in a very low level. The acceptance sampling, control charts, and check sheets were identified as common statistical quality control techniques used by the medium-scale manufacturers. Two barriers were extracted from the factor analysis as attitudinal barriers and non-attitudinal barriers which limit the implementation of the statistical quality control system. Sub barriers under each category were also identified. Motivation, process development, retrenchment, and development strategies were extracted as the possible strategies to improve the usage level of statistical quality control techniques to improve the productivity. The study improves the existing knowledge and significance in organizational and macro-level policy making.

Keywords: Descriptive statistical techniques, Entrepreneurs, Factor analysis, Medium scale manufacturers, Statistical quality control techniques

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Assessment of plant growth performances of *Capsicum frutescens L.* (Chili plant) based on analysis of variance and ordinary differential equation model

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In plant growth-based research, significant differences are usually examined with the end result of plant growth parameters, for example, cumulative growth, total leaf area, stem diameter and root length. Under the conditions that the assumptions on parameters are met and when the experiment deals with one or two fixed factors, the analysis of variance (ANOVA) technique is commonly used to check the level of significance. However, if retrospective changes of plant growth parameters are well monitored and examined with a robust statistical test that would pave a new trajectory to reveal novel patterns in plant behavior. The model plant; *Capsicum frutescens L.* (Chili) was subjected to the study and the effects of different soil water levels i.e., 25% Water Holding Capacity (WHC), 50% WHC, 75% WHC and 100% WHC (control) were examined by using cumulative plant height. Plant height against time show the shape of the solutions of Logistic differential equation. As such, Logistic differential equation model was applied to model the model plant growth. According to the results of two methods, ANOVA and an Ordinary Differential Equation (ODE) model, there was a significant effect of water stress on chili plant growth. Also, ODE model helps to estimate plant's height at any treatment level at which data not collected (ex: 60% WHC) and at a time beyond the data collected. Therefore, it is recommended to use ODE over ANOVA whenever possible in plant growth-based researches as ODE results are more informative and reliable.

Keywords: ANOVA, Ordinary differential equation, Water holding capacity, Logistic differential equation

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Identifying the risk factors for COVID-19 mortality in Sri Lanka using mutual information

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COVID-19 is a pandemic that has taken over the whole world. This virus can easily spread from person-to-person similar to the case with Severe Acute Respiratory Syndrome (SARS-CoV). COVID-19 affects people in different ways majority of the infected people will develop mild to moderate symptoms and recover without hospitalization. As of end of September, there were 516,465 cases and 12,906 deaths in Sri Lanka. The aim of this research is to identify the factors associated with the daily deaths due to COVID-19 in Sri Lanka. In the literature, there are many methods to find factors associated with COVID-19 deaths such as adjusted linear model, logistic regression analyses, and generalized additive model, etc. In this study, the Mutual Information (MI) based method was used to find the factors associated with daily death cases due to COVID-19. The MI was calculated using a *k*-nearest neighbors method. Virus reproduction rate, COVID positive rate, daily vaccinations were collected from the websites of health commissions and temperature, precipitation, specific humidity, surface pressure, and wind speed were collected from the Prediction of Worldwide Energy Resources (POWER) from 13 April 2021 to 30 September 2021 (3rd wave) in Sri Lanka. Based on the results, virus reproduction rate, positive rate, daily vaccination, temperature, specific humidity, and wind speed were significant for the deaths of COVID-19. When the results which were obtained from the suggested MI-based method were compared with the well-known Ordinary Least Square (OLS) method, the same significant factors can be obtained for the deaths of COVID-19. Thus, the suggested MI-based method can be used to find the important factors associated with the deaths due to COVID-19 and to support to implement measures to control the deaths of COVID-19.

Keywords: COVID-19, Mutual Information, Meteorogical factors, Significance, Ordinary Least Square

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Time series model to predict the Leptospirosis outbreak in Kalutara district, Sri Lanka

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Leptospirosis is an infectious disease, contracted through animals, it leads to organ damage, specifically kidney damage. Increasing outbreaks have been reported recently from several countries. The disease is endemic in Sri Lanka and Kalutara district is one of the highly endemic area which is known to be overcrowded with agricultural communities. Hence, forecasting Leptospirosis incidence is an essential aspect. The aim of this study was to find a time series model to forecast Leptospirosis cases in the Kalutara district, Sri Lanka. In this study we mainly focused on the number of Leptospirosis cases reported monthly during the period from January 2010 to December 2020. An Auto-Regressive Integrated Moving Average (ARIMA) model was fitted to predict the monthly Leptospirosis cases in Kalutara district. The forecasting accuracy measures, such as Akaike Information Criterion (AIC), Mean Absolute Error (MAE), and Root Mean Square Error (RMSE), were used to explore the best forecasting model based on the lowest measure of accuracy. According to the data, the highest number of Leptospirosis outbreaks (275) were reported in September 2020 and the lowest reported Leptospirosis outbreak (7) occurred in September 2019. Moreover, the average monthly Leptospirosis outbreak was 44. ARIMA (3, 1, 1) was found as the best model to predict the future outbreak of Leptospirosis. At the present time being ARIMA (3, 1, 1) model could applicable for the successful alleviation of Leptospirosis consequently shifting towards socio-economic advancement of the nation.

Keywords: ARIMA, Forecasting, Leptospirosis

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An optimized method for making thin primary mirrors for industrial scale telescopes

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Fabrication of telescope primary mirrors is considered a costly and challenging process due to the optical precessions required in Astronomy. Conventionally, small telescope mirrors have been made from 3-5 cm thick borosilicate glass plates. However, at present, thin primary mirrors (1-2 cm thick) are at a high demand for applications due to their lightweight and cost-effectiveness. Here, preliminary results of the study on an optimized method for making telescope mirrors of 0.2032 m aperture and 1.2192 m focal length, from 12 mm thick thermally-treated soda-lime glass blanks are disclosed. Polarization tests conducted initially had indicated no signs of tension when loaded with a 100 N force. Dial-gauge measurements and Newton interferometer tests unveiled that the blanks retained the flatness after removing the load. Furthermore, the parallelism of the surfaces remained constant. The tests were conducted over two months period to study the behaviour of glass blanks under the load. The initial properties of the glass remained constant, proving the selected material and thickness were sufficient to withstand the force applied during grinding. Thermal analysis of the glass blanks revealed that a temperature shift of 25-100 °C had no effect on the material integrity. The adopted grinding method has shown a reduction of the material usage, a substantial decrease in the overall cost, and the time of the grinding process. The Ronchi test showed that the grinded mirror satisfies the quality requirement in Astronomy observations. The average cost estimate for finalizing the grinding process of a thin parabolic mirror is about 7,000.00 LKR.

Keywords: Thin telescope mirror, Mirror grinding, Industrial-grade, Glass blank, Ronchi test

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An improved technique for distortion removal in Raman spectra using impulse response filter banks

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For accurate analysis and characterization of materials using Raman spectroscopy, it is often necessary to remove signal distortions, including the noise from the spectra, using a filter such as the Savitzky-Golay (SG) spectral filter. However, distortion filtering accuracies are limited for SG filters due to their polynomial-fitting-based distortion removal process and the inherent inability to select required distortion removal frequencies. In contrast to the SG filtering techniques, Impulse Response (IR) based stable digital filtering techniques using Filter Banks (FB) should be more accurate in removing only the unwanted distortions, especially, due to their ability to control the filtering process based on the signal frequency sub-bands. Thus this paper describes a new and more efficient Impulse Response Filter Bank (IRFB) band-pass filtering technique to remove the distortions in Raman spectral signals using two-band filter banks. The distortion removal performances for the proposed IRFB and typical SG techniques were compared experimentally by estimating the output Signal to Noise Ratios (SNRs) for different input signal SNR levels. Clean Raman spectral data signals were obtained from an appropriate Raman spectral database and were contaminated with noise and background distortions. The contaminated signals were input into the IRFB filtering technique-based distortion removal system. The proposed IRFB filtering technique showed a significantly improved distortion removal performance when compared with the SG technique. Compared to the SG filter, the average improvement of the output signal SNR of the IRFB filter was 3.1 dB. The newly proposed IRFB filtering is an efficient, yet simpler technique, to simultaneously remove different Raman spectral distortions.

Keywords: Distortion, Raman spectra, Impulse response, Filter banks.

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A preliminary study on the use of formant analysis of Sinhala vowel sounds for distinguishing caller's age

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Automatic caller identification has become a challenging research problem due to its wide variety of applications. This study used formant analysis of Sinhala vowel sounds to identify caller's age, mainly ranging from16 to 27 years. Participants were separated into male and female classifications so that each age range, 16 – 18, 19 – 20, 21 – 22, and 23 – 27, comprised of 15 males and 15 females from a sample of 360 individuals. A smartphone, OppoF9, was used for voice recordings, and the required biometric information was collected via a Google form. The discourse material was comprised of two Sinhala vowels ("ඇ", "ඇා"). Formants 1 and Formant 2 of voice pieces were graphically dissected using Praat software. SPSS and Minitab softwares were used for statistical analysis. The age was distinguished by applying the statistical tools of Pearson's Correlation and ANOVA test on the identified formants. The study result reveals that the Formant-1 of vowel "ඇ" is highly clustered for male individuals aged 17 and 19. Formant-2 of vowel "ඇ" is highly clustered for females of age 26. Formant-1 of vowel "ඇ" is clusters among male age groups of 16-18, 19-20, 21-22, and 23-27 and female age groups of 16-18, 19-21, and 22-27. This study was successful in separating certain age groups of males and females.

Keywords: Sinhala vowel, Formant, Age of 16-27, Gender

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Modelling temperature distribution analysis in a data center using computational fluid dynamics

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Data centers contain electronic equipment for telecommunications and storage purposes. So, temperature maintenance is an important thing to avoid unnecessary breakdowns. This paper introduces the computational fluid dynamics (CFD) analysis of the temperature distribution in the data center with 16 types of different layouts. "Future Facilities-6sigma Room 15 CFD" simulation software was used to design the graphical user interfaces and analyze the temperature dissipation effect.

The effects of different types of data center parameters on temperature distribution and flow field have been studied. Parameters and optimization techniques are used to find the best possible layout of the cooling method with single air-cooling unit and dual-air cooling unit conditions. The simulation results predict high temperature areas in the data center within the IT equipment racks and provide detailed 3D analysis of the movement of the temperature distribution. The results also provide a performance analysis of the computer room air conditioning, which includes detailed rack-to-rack inlet and outlet temperatures and 3D heat maps of the data center. The developed software can evaluate the airflow rate and heat load to optimize and design new or existing data centers to the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) standard. Finally, the lowest air-cooling unit (ACU) return temperature observed on double ACU is that the cold aisle intermediate data center is equipped with ACUs on the adjacent wall side is 21.67°C, and the lowest temperature observed on the single ACU condition is that the cold aisle intermediate data center is equipped with an ACU on the front wall side is 25.29°C.

Keywords: Computational fluid dynamics, Data center, Future facilities, Temperature distribution

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Experimental investigation of compressive strength of lathe waste fiber concrete

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Industries are expanding at a faster rate due to the rapid growth of the population result in a surge of trash without proper management. Lathe steel scrap is a major waste material generated during different industry operations such as drilling, cutting, and boring carried out by lathe machines. Lack of sound waste management practices for lathe waste has created enormous environmental issues such as soil and ground water contamination. These industrial waste fibres can successfully be utilized for making high-strength low-cost Fiber Reinforced Concrete (FRC) after exploring their suitability. FRC is a composite material comprised of hydraulic cement, coarse aggregate, sand, water and randomly distributed short discrete fibers. In this research work, a variable weight fraction of fiber (i.e., ratio of weight of fiber to weight of concrete) of 0.5%, 1.0%, 1.5% and 2.0% is incorporated into M25 concrete grade and variations in compressive strength were investigated. According to the results, the specimen containing 1% of lathe waste fibres offered the maximum compressive strength of 52.2 MPa. It was a 33.3% increase compared with the plain concrete sample (34.8 MPa). In the second part, the variable weight fraction of cement was reduced from the 1 % lathe waste contained specimens up to 20% at a gap of 5% (i.e., 5%, 10%, 15%, 20%) and compressive strength was examined. According to the results, compressive strength values were beyond the plain concrete even after a 15% reduction of cement. After reducing the 15% of cement, the cost of concrete was reduced by 13% compared to the cost of the plain concrete mixture. In conclusion, the compressive strength of the concrete can be enhanced by incorporating lathe waste scrap while reducing the cost as well as the environmental burden.

Keywords: Lathe waste scrap, Compressive strength, Fiber reinforced concrete, Waste management

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An improved machine learning approach for drug combination-based drug repositioning

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Introducing a new drug to the market is time-consuming and costly. Therefore, reuse of existing drugs or drug combinations as therapeutics for diseases is identified to be much efficient and useful. This concept is known as drug repositioning/repurposing. The known drug combinations used for therapeutic effects are smaller than the total number of possible drug combinations. Hence, drug repositioning data for drug combinations naturally consists of a majority of unlabeled samples. Therefore, identifying reliable positives and reliable negatives is vital for a reliable binary classification model. With the assumption that unlabeled data is composed of both unidentified positive and negative samples, the set of unlabeled data has to be separated into positives and negatives by a reliable technique. In this study, the significance of employing Positive Unlabeled Learning (PUL) for drug combination repositioning is assessed. We integrated Drug-Target, Drug-disease, Drug-Structure, Drug-Expression and Drug-Module similarities using the Jaccard coefficient to construct the heterogeneous drug-drug similarity matrix. The proposed PUL approach has two tiers: i) determining reliable negatives by clustering the dataset, composed of known positives and unlabeled samples employing a Deep Learning-based Self Organizing Map and ii) determining reliable drug combination repositioning candidates by binary classification employing a Support Vector Machine classifier. The performance of the proposed PUL model was assessed with the frequently used Random Approach that randomly selects negatives from unlabeled samples. Significantly, there is an improvement in the Precision, Recall and F-measure by 16.14%, 18.26%, and 17.46%, respectively, for the proposed PUL approach compared to the Random Approach.We aim to publish the clinical significance of this study and analyze possible adverse drug reactions in the future.

Keywords: Drug repositioning, Deep-learning, Positive Unlabeled Learning (PUL), Support Vector Machine

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Word embedding-based sinhala news documents classification

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News articles are increasing daily, and a huge number of text documents are added to the Internet. Manual classification of these documents has become an impossible task. In Sinhala news document classification, TF-IDF has been used more often as a word representation, but word embedding has rarely been used. We compared the performance of Word2Vec, FastText and Doc2vec with frequently used Term Frequency Inverse Document Frequency (TF-IDF) as word representations for Sinhala news documents classification and applied machine learning approaches for the best word embedding model identified. We also experimented with each representation by removing stop words and investigated the feasibility of using Convolutional Neural Networks (CNN) as well.

Sinhala being a low resource language, it is challenging to prepare a corpus that is comparable with other resource-rich languages. We collected Sinhala news documents from different news websites and used them to create word embedding models, training and testing data. Models were created using *skip* gram method and assigned a 300-dimension vector for each word in the document. For CNN, embedding of each word in the first 100 words was taken for each document. In Word2Vec and FastText embedding models, we used a 300-dimension vector for each document by considering all the words in the document. Our experimental results show that FastText performs better than other representation methods and SVM with the *rbf* kernel always gives the highest accuracy. According to our experiments, the CNN model also showed prominent results but could not surpass the SVM model.

Keywords: Classification, Word embedding, FastText; Sinhala documents

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Adopting blockchain technology to prevent the flow of counterfeit pharmaceuticals in Sri Lanka: A conceptual model

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Controlling the adverse effects of counterfeit pharmaceuticals requires ensuring the transparency of pharmaceutical supply chain. Blockchain technology has been widely recognized by supply chain researchers as an emerging technology for improving the transparency and security of supply chain. Although there is a surge of attention to blockchain technology in the supply chain domain, there is not much empirical evidence on the use of blockchain technology to support decision-making in the pharmaceutical supply chain. The purpose of this paper is to present a conceptual model that was developed to investigate the challenges of adopting blockchain technology to control the pharmaceutical supply chain while combating counterfeit pharmaceutical flow. The conceptual framework of the study is developed by conducting a thorough literature review and structured interviews. To validate the conceptual model, sample data is obtained from supply chain practitioners, pharmaceutical manufacturers, MSD and NMRA. Structural equation modelling approach is used to test the proposed conceptual model, and PLS-SEM is utilized to determine the validity of the proposed model. The suggested conceptual model, which is based on a thorough examination of the literature, encompasses the interrelationships between eight influential factors, including 1) Relative advantage 2) Upper management support 3) Cost, 4) Human Resource 5) Complexity, 6) Compatibility 7) Architecture and 8) Upper Management Support. The study further shows that the upper management support moderates the relationship between the intention of adopting blockchain technology and its complexity. Consequently, the model would enable practitioners to get useful insights for adopting blockchain technology in the Sri Lankan pharmaceutical supply chain.

Keywords: Blockchain adoption, Drug counterfeiting, Pharmaceutical supply chain

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An automated defect identification and marking system for sail manufacturing industry using image processing technique

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Quality control is an essential and inevitable part of the production process. Defect detection in the sale-making tape is one of the most critical quality control measures in sail manufacturing. This study is based on a sale-making company in Sri Lanka which uses a manual defect detection method. It is mainly based on a visually inspecting work done by the machine operator while controlling the whole sail-making tape producing process. A large amount of tape is wasted this way, and it is the main drawback of this system. This study explored the development of an automated defect identification and marking system which detects the spots (defects) in the white sail making tape. By automatically marking the correct spot, tape wastage is reduced. This automated defect identification and marking system consists of a web camera that captures the images to identify the small spots in sailmaking tapes, and defect marking pens which automatically mark the defects on the correct region. When the web camera detects a spot (defect) in sail-making tape, the marking pen receives an actuation signal through the raspberry pi module. The programme runs using a python script. Performance of the defect identification and marking machine was evaluated using a substitute paper marked with similar defects. These defects were artificially made throughout the paper covering right, left and center areas. All defects were detected and marked with a success rate of over 90%. The results show a considerable improvement in terms of precision and speed when compared to the existing system. Proposed system achieved the main objective of minimizing tape wastage caused by current defect and marking method.

Keywords: Sail-making tape, Web camera, Black spot, Raspberry pi, Image processing

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Comparative analysis of traditional load balancing algorithms in software-defined networks

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Load Balancing is one of the efficiency measures of a network that are popular in data centers for efficient traffic management of huge data. Various load balancing algorithms are known to perform better in specific network architectures. Software-Defined Network (SDN) is a new paradigm in which the data plane and the control plane are decoupled while they are coupled together in the traditional networks. Path finding and Path selection are two major phases of any load balancing algorithm. Path finding refers to the algorithms that find paths between sender and receiver. A modified version of Dijkstra's algorithm called Multipath Dijkstra is applied to find multiple paths between source and destination. If it finds a path that is shorter than the current set, it discards them and uses the new path as the shortest path. In this phase the selection of path depends on the different criteria set by multiple path selection algorithms. This work implemented three different load balancing algorithms and evaluation is based on the network bandwidth obtained. Least-busy-path, Simple-round-robin and Weighted-round-robin algorithms are chosen and their performances are tested on bandwidth when there is high traffic flow and low traffic in the network. The results showed that the weighted round-robin algorithms outperform in data transferring than other two algorithms whenever there are a high load or a low load in the network.

Keywords: Load balancing, SDN, Least busy path, Dijkstra's algorithm, Weighted round robin

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An optimized computational water quality prediction model

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Water is one of the most critical necessities for living beings. In the past, it was possible to consume water directly from water sources, but nowadays, it is impossible to do so as water quality has deteriorated at an alarming rate. Therefore, water quality testing and purification processes before consumption have become essential today. When these tests are performed in a laboratory, they can be expensive and time-consuming. Various researchers have researched in order to predict water quality using different machine learning algorithms and found that these tests are unique to each water source. Therefore, this research has used Support Vector Machine, Decision Tree and K-nearest Neighbor algorithms, for the model development. As this research objective is independent of the algorithm used no comparison of algorithms was conducted. However, the research objective of this study is to minimize the time consumption and the total expenditure for the water quality laboratory testing process. In order to achieve that, a model would be developed to predict the water quality effectively by selecting the most suitable subset of parameters from the available parameters, based on the historical data on measuring water quality. For this study, data from fifteen parameters related to physical and chemical requirements from various locations on the Nilwala River during the last ten years were obtained from a verified source. The wrapper-based feature selection technology was employed to identify the most suitable subset of parameters out of fifteen test parameters: pH., turbidity, Color, EC, Total hardness, TDS, and Total iron.

Keywords: Water quality prediction, Feature selection, Machine learning

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Effect of light intensity in indoor cultivation of sweet basil (*Ocimum basilicum* L.)

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The present study investigated the effects of different light intensities on the growth and the morphological characteristics of sweet basil *(Ocimum basilicum),* a medicinal herb used in the flavoring and pharmaceutical industries. The experiment was carried out in a completely randomized design with three replicates: including thirty plants in each replicate, under normal greenhouse conditions. Plants were cultivated at different light intensities using 50, 150 and 250 $\mu molm^{-2}s^{-1}$ photosynthetic photon flux density (PPFD) levels. The PPFD level was maintained by adjusting the distance to the top of the plants relative to the light source. Light treatments were introduced after one week of germination. A photoperiod of 10h was used for the treatments. Control group plants were grown under greenhouse conditions with average light intensity $68\mu molm^{-2}s^{-1}$, daily mean temperature at 27°C and 60% relative humidity. Plant height, internode length, leaf area, and fresh green mass were measured. All data were statistically analyzed using One way ANOVA and Tukey multiple comparison tests ($P<0.05$). Statistical analysis showed that the growth and morphological responses were significantly different among different light intensities. Plants cultivated at $250\mu molm^{-2}s^{-1}$ intensity treatment showed the highest plant height (46.9cm), internode length (11.4cm), leaf area ($72.6cm^2$), and fresh green mass (119.7g). Control group plants showed the lowest plant height (22.2cm), internode length (5.1cm), leaf area ($9.1cm^2$), and fresh green mass (38.1g). The results demonstrate that high light intensity levels are suitable for enhancing the growth and morphogenesis of sweet basil compared to lower light intensity levels. Thus, the application of high-intensity artificial light sources will promote the cultivation of sweet basil. Future studies on this line of research will warrant improving productivity.

Keywords: Light intensity, Morphology, *Ocimum basilicum*, Photosynthetic photon flux density

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Optimization of *in vitro* micropropagation protocol for *Aloe variegata*: An ornamental succulent

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Aloe variegata is distinctive ornamental succulent plant which is commercially important both in local and export markets. Poor regeneration with abnormal organs and hyperhydricity are the associated problems in *in vitro* propagation of this plant. The present study was attempted to develop an efficient and reproducible micropropagation protocol by optimizing the culture medium conditions. The effect of different combinations of Plant Growth Regulators (PGRs) concentrations on *in vitro* shoot regeneration was evaluated using side-shoots as explants. Explants were pretreated by using 0.2% (w/v) fungicide (Captan) followed by 0.1% (w/v) antibiotic (Doxycycline) solution. Surface sterilization was done with series of concentration of Clorox (85%-25%) mixed with Tween-20 and sterilized explants were established on the hormone-free Murashige and Skoog (MS) medium. Shoot multiplication was tested on MS media augmented with various combination of 6-Benzylaminopurine (BAP), Tiadiazuron (TDZ) and Indole-3-acetic-acid (IAA) concentrations, having 12 replicates for each treatment level. Data analysis was performed using statistical software R 3.6.3 for calculating both Kruskal Wallis test and Dunn's test. The highest number of shoots (44.83 ± 3.60) per explant were recorded on MS medium fortified with 2.5 mg/L BAP, 0.3 mg/L TDZ and 0.3 mg/L IAA ($p<0.05$) while the maximum number of roots (6.2 ± 0.34) per shoots were obtained when adventitious shoots were inoculated on MS medium fortified with 0.2 mg/L IBA ($p<0.05$). The developed protocol is efficient since a successful plant regeneration could be obtained within 16 weeks. The optimal PGR combination for enhanced shoots and roots development in *A. variegata* was optimized.

Keywords: *Aloe variegata,* Optimization, Plant growth regulators, Side-shoot explants

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Comparison of yield and quality of oil in Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume) among different agro-ecological zones

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Growth parameters, content and composition of oil in Ceylon Cinnamon in five different agro-ecological zones, IL1a, IL1b, WL1a, WL2a, and DL5 were compared. Statistically predefined number of seed propagated cinnamon samples were collected from agro-ecological zones covering three districts, Galle, Matara, and Hambanthota. The oil extraction was carried out by hydrodistillation technique and the oil contents and the composition were determined by using the gas chromatography–mass spectrometry (GC.MS). One-way ANOVA at 0.05 significance level was used in the statistical analysis to find the effects of the variation of ecology on the quality and quantity of cinnamon bark and leaf oil. The length, girth, weight of a stick, dry leaf yield and dry bark yield per stem were significantly higher ($p<0.05$) in DL5 zone compared to other zones. Both leaf and bark oil content in IL1b zone is significantly different compared with other zones. The major components in the bark oil were cinnamaldehyde and cinnamyl acetate (total cinnamaldehyde) while in the leaf oil, it was eugenol or benzyl benzoate. There was no significant difference in cinnamaldehyde content in bark oil among five zones while there was a slight variation in cinnamyl acetate content though sum of these two did not show significant difference among five zones. The population analysis of leaf oil contents showed that 92.5% and 7.5% of total population as eugenol type and benzyl benzoate type, respectively. The lowest mean value of eugenol in leaf oil (68.7%) was reported in DL5 while the highest (81.0%) was reported in IL1a leaving other three zones insignificant.

Keywords: Cinnamon, Agro-ecological zone, Growth parameter, Oil content, Oil composition

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Development of a ready to drink cinnamon-based beverage using bee honey as a natural sweetener

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Pure cinnamon reputedly represents 65-70% of global Cinnamon production despite less export competitiveness due to poor value addition. This research aims to develop a value-added ready-to-drink cinnamon-based beverage using bee honey as a natural sweetener. Accordingly, value added cinnamon beverage was developed using different ratios of lemon, honey, black tea, sugar and ginger. Initial recipe was developed using trial and error method, and sensory evaluation. Thereafter, the selected recipe was further developed using two different sensory evaluations performed by 30 semi trained sensory panelists with five-point hedonic scale. All the ingredients except for bee honey were initially mixed, and the mix was thermally treated at 65 °C for 20 minutes. Thereafter, bee honey was added once the mixture was cooled for about 37 °C, and the final product was filled into pre-sterilized glass bottles, and was subjected to nutritional and shelf-life analysis. As per the results of the sensory analysis, the cinnamon beverage produced using 75% of cinnamon (v/v), 10% of lemon (v/v), 10% of honey (v/v) and 5% of flavoring agents (v/v). Black tea, ginger and sugar were used as flavoring agents. Product characteristics were tested and analyzed. The final product was found to be contain 15.8 Brix value at 33.2 °C, 3.4 pH and 0.844 (% by mass) titratable acidity. The developed product can be stored for six months under ambient temperature conditions in glass bottles. As per the obtained results, cinnamon can be effectively used in production of value-added beverage using bee honey as a sweetener.

Keywords*:* Bee honey, Cinnamon drink, Value additions

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Impact of extension services on productivity of Betel Leaf (*Piper betel* L.) farmers in Kurunegala district in Sri Lanka

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Betel is a minor export crop that has contributed to foreign exchange earnings in Sri Lanka during the past few decades apart from the notable domestic consumption. Although betel cultivation was popular among smallholder farmers in the Kurunegala district, many have left the cultivation due to production and marketing constraints. Despite the involvement of government and private sector organizations in research, extension and marketing functions related to other minor export crops, a huge gap exists in the delivery of extension services related to betel leaf production. This research therefore intended to assess the impact of extension services on betel production while addressing the constraints. A survey was carried out from 2019.04.01 to 2019.10.01 to gather primary data from 120 farmers. Betel Farmers registered in Kuliyapitiya West, Narammala, and Pannala Agrarian Service Departments were randomly selected for the study. A Key Informant Interview was conducted with the 8 extension officers to capture information regarding extension interventions. According to Likert scale analysis, poor attention paid by government extension services is a constraint identified by 82.5% betel farmers while 69.1% is not satisfied with the extension services. Many farmers (63.8%) stick to traditional methods of cultivation and a positive correlation was observed between the cultivation methods and betel production. Whilst the role of extension, is to disseminate new knowledge and information to improve farm production, this study as its conclusion, emphasizes the need for an efficient extension service to cater to the needs of the betel farmers.

Keywords: Agricultural extension, Impact, Betel production, Farmers, Constraints

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Homegardens in Ampara district: A promising way to improve the food security of rural poor

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Rapid increase in population and urbanization coupled with climate change has major consequences for global food production and food security. Thus, Sri Lanka is no exception. The livelihoods of the rural poor in Ampara district had been affected by local war, tsunami and now by the COVID_19 pandemic. Homegardens were found to be one of the strategies to improve the socio-economic needs of the poor. This study was conducted, focusing on the contribution of homegardens towards improved food security and livelihoods of rural poor in Ampara district. Based on the number of homegardens, two divisional secretariat divisions were selected. And among them, hundred homegardeners were selected using the proportionate sampling. Primary data were gathered through personal interviews using the pretested questionnaire. The status of food insecurity was measured using the Coping Strategies Index (CSI) which was constructed based on the locally applicable coping behaviours. Results of the study revealed that out of the hundred surveyed families, only nine families were female-headed households, and the rest were male-headed households. From the sample, 11% had the education level up to tertiary level, while 59% had education level up to secondary level. Further, the study indicated that relying on less preferred and less expensive foods was common in most (89%) of the households followed by borrowing food or relying on help from a friend or relative (86%). It was interesting to note that none of the households sends their family members to beg. Further, a majority (59%) of the homegardeners were in moderate food-secure condition. Only 17% of the homegardeners were in food secure condition and the rest were in food-insecure condition. Results of the present study provide insight into the contribution of homegardens to food security during the pandemic situation. In the wake of soaring food prices, increased emphasis has to be given on promoting the homegardens for enhancing food security and livelihoods of poor.

Keywords: Food security, Coping behaviours, Coping strategies index, Homegardens

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Optimization of some fermentation conditions and composition of the fermentation medium for bio-ethanol production from poultry and cattle feed by yeast fermentation

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The study aimed to increase the bioethanol production by optimizing the fermentation conditions from poultry and cattle feed. Submerged fermentation was carried out in the presence of Baker's yeast (*Saccharomyces cerevisiae*). The fermentation medium contained 50 g glucose, 2.5 g yeast extract, 1.15 g peptone, 0.25 g $(NH_4)_2HPO_4$ and 0.025 g $MgSO_4$ L^{-1} and inoculated (250 mL fermentation medium / 10 mL inoculum) with activated Baker's yeast. When glucose of the fermentation medium was replaced with 50 gL^{-1} of different types of commercially available poultry feeds such as layer grower, chick feed, layer feed, cattle feed, rice bran, sesame oil seed cake and coconut oil seed cake separately, cattle feed (mean 0.4% v/v) and rice bran (mean 0.3% v/v) showed highest bioethanol activity compared to other carbon sources at 48 h of fermentation at 100 rpm. Glucose containing medium (control) produced a mean bioethanol percentage 3.2 (v/v) at 48 h of fermentation at 100 rpm. Cattle feed and rice bran were selected for further analysis. The optimized medium composition, 50g cattle feed, 4.5 g yeast extract, 2.0g peptone, 0.25g $(NH_4)_2HPO_4$ and 0.025g $MgSO_4$ L^{-1} improved the mean percentage of ethanol yield from 0.4 to 0.7 (v/v). The optimized medium of which composition was 50g rice bran, 4.5g yeast extract, 2.75g peptone, 0.25g $(NH_4)_2HPO_4$ and 0.025g $MgSO_4$ L^{-1} improved the bioethanol production from the mean of 0.3 to 0.7 (v/v). When the optimized fermentation medium was incubated at different rotation speeds at room temperature separately, the mean bioethanol yield increased to 0.86% (v/v) at 150 rpm in both media. This study shows that cattle feed and rice bran are potential sources for bioethanol production and optimization of yeast extract, peptone, and rotation speed slightly increased the bioethanol production.

Keywords: Bioethanol, Oilseed cakes, Poultry feed, Cattle feed, Rice bran

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Comparative physicochemical analysis of seeds of selected medicinal plants used in traditional medicine

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Medicinal plants are the sources of many important drugs in the world's pharmaceuticals. The present study attempts to evaluate the proximate estimation of physicochemical properties of seeds of *Syzygium cumini* L. Skeels, *Brassica alba* L. Rabenh, *Trigonella foenum-graecum* L. and *Nigella sativa* L. Proximate nutrient and total caloric content of the seeds were estimated according to the standard protocols recommended by the Association of Analytical Chemists (AOAC) and bomb calorimeter method respectively. The pH in 1% w/v (1g; 100 ml) of water-soluble portions of seed powder and essential chemical elements were determined by the standard simple glass electrode pH meter and flame photometric method respectively. According to the results, the highest and the lowest ash contents were found in *Syzygium* sp. (16.19%) and *Nigella* sp. (3.86%) respectively. The moisture content ranged between 11.44% (*Syzygium sp.*) and 2.64% (*Nigella sp.)*. The fat content varied from 7.30% (*Syzygium* sp.) to 25.28% (*Nigella sp.*). The caloric content was significantly higher in *Nigella* sp. (595.56 kcal/100g) and the lowest amount was found *Syzygium sp.* (314.7 kcal/100g). All the seeds showed approximately same pH values and ranged between 5.42 (*Nigella sp.*) and 5.60 (*Syzygium sp.*). *Syzygium* sp. has a higher percentage of all the tested chemical elements such as Barium (1.743%), Sodium (0.831%), Calcium (1.203%) and Potassium (0.632%) than other plant seeds. The present study concludes the chances of discovering significant physicochemical properties in seeds of *Syzygium cumini L.* is the highest and it can be used as a potential source in the traditional system of medicine.

Keywords: Physicochemical, *Syzygium cumini*, *Trigonella foenum-graecum*, *Brassica alba*

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A comparison of cultural characters and pathogenicity of *Colletotrichum* spp. causing Colletotrichum leaf disease (CLD) of rubber in Sri Lanka

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Colletotrichum spp. are widespread fungal genus containing severe plant pathogens of economically important crops including natural rubber (*Hevea brasilliensis*). *Colletotrichum gloeosporioides* and *Colletotrichum acutatum* have been identified as the major pathogenic species of CLD in rubber in Sri Lanka. As the causative agent has changed from time to time, comparison of morphology and pathogenicity is important to understand new pathogen population. Ten *Colletotrichum* cultures were isolated from symptomatic rubber leaves from Kalutara district while previously identified *Colletotrichum gloeosporioides* was collected from the department culture collection. Cultural characters and reproductive characters or conidia were observed after 10 days of incubation. Conidia concentrations were detected using a haemocytometer. Pathogenicity test was performed using 10^5 conidia/ml suspension on detached rubber leaves and Disease Index (DI) was calculated. All the colonies were approximately similar with slight colour changes. Conidia were aseptate with one cell, green colour, smooth-walled and granular. The conidia of *C. gloeosporioides* were oblong with obtuse ends and were generally shorter and broader. A minority of the conidia of *C. gloeosporioides* were obovate with 1.01 x 10^7 conidia/ml concentration. All other isolates produced cylindrical, both ends rounded with the concentration between 3 x 10^4- 2.09 x 10^7 conidia/ml. In pathogenicity test, lesions were produced at all inoculation points but the size and type of lesions produced by each isolate were different. K29 can be considered as a severe pathogen as it has the highest DI value (2.44) than *C. gloeosporioides.* Hence, it can be concluded that special consideration is needed to control K 29.

Keywords: *Colletotrichum* spp., Colletotrichum leaf disease, Natural rubber,

C. gloeosporioides

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Can restoration efforts improve soils in degraded grasslands at the Knuckles Conservation Forest, Sri Lanka?

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Most of the abandoned tea plantations in the Knuckles Conservation Forest (KCF) were converted into grasslands due to many biotic and abiotic stresses. The conversion of natural forests to grasslands causes drastic changes to the soil biota which result in less biodiverse and low productive soils. In this study, we investigated whether the establishment of native plants islands in the grassland with the presence of *G. sepium* as a shade plant and also with the application of Biofilmed Biofertilizer (BFBF) affect the fungal: bacterial ratio of degraded lands at KCF. Inside the three different islands (2 m^2, 4 m^2,8 m^2) four native plants (*M. indica, B. ceylanica, S. cochinchinensis, E. bracteata*) were randomly established using treatments, namely with *G. sepium* (+G) as shade plant and the application of BFBF (+B). This resulted in four treatments {(+G+B), (-G+B), (+G-B) and (-G-B)}. Fungal: bacterial ratio was determined in the soil collected from different island sizes and the nearby grassland before initiation of the field experiment and after two years from the four different treatments in the three different tree island sizes. The soil samples were analyzed for fungi and bacteria in the region of 4,000-400 cm^{-1} at a resolution of 4 cm^{-1} using FTIR. Two-way ANOVA and Tukey's HSD in Minitab 17.1.0.0 were used to analyse the data. The fungal to bacterial ratio was significantly higher ($p<0.05$) in the grassland than in the different island sizes. Nutrients released from the thick mulch of dead leaves might be a reason for the recorded improvement in fungal to bacterial ratio. However, the presence of *G. sepium* as the nurse plant and the application of BFBF (+G+B) in the different island sizes had the second-largest fungal to bacterial ratio which was significantly ($p<0.05$) higher than the initial ratios in the bare land and the other three treatments {(-G+B), (+G-B) and (-G-B)}. The recorded significantly lower fungal to bacterial ratio in bare land compared to the treatments might be due to the removal of all the organic litter in the land preparation of selected sites. The highest relative growth rate and survival were observed with the application of treatment of (+G+B) in the islands. Therefore, the fungal to bacterial ratio has been increased due to improvement of the above ground vegetation of the native plants with the application of (+G+B). We conclude that established native tree species in the tree islands with the treatment of (+G+B) enhances the fungal: bacterial ratio and leads to restore the degraded soil at the KCF.

Keywords: Fungal: bacterial, Restoration, Native plants

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Mass production and determination of shelf-life of two *Trichoderma* sp. in compost formulation

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Trichoderma isolates have emerged as biological control agents which have been found effective against *Rigidoporus microporus* which is the cause of white root disease in rubber trees. Compost has been used to formulate biocontrol agent multiplied by liquid fermentation. A formulated product for agricultural applications should have abundant viable propagules with good shelf life. An attempt was taken to test the shelf life of compost-based formulation of *Trichoderma* isolates prepared by liquid fermentation. Soil samples were collected from rubber growing soils to isolate the most abundant and visually-different soil fungi. Out of isolated fungi, ten *Trichoderma* isolates were selected based on morphology to be tested for the antagonistic ability against *R. microporus*. Two fungal isolates which showed the highest inhibition towards *R. microporus* were identified. *Trichoderma* were inoculated into potato-glucose broth for mass production. After 2 weeks, *Trichoderma* inoculated broth was added into compost. Colony forming units (CFU) of *Trichoderma* inoculated compost were estimated by dilution plate method to test the shelf life. Popolation effects were statistically analyzed using Duncan's multiple range test, at a probability level of 0.05. According to results, *T. koningii* and *T. harzianum* showed the highest inhibition. In broth, maximum growth of *Trichoderma* showed after 2 weeks. Initially, CFU count in compost formulation was 7.740 $\log_{10}$ $CFUg^{-1}$ which fell to 7.079 $\log_{10}$ $CFUg^{-1}$ at 14 weeks. After 18 weeks, formulation retained a population of more than 5 $\log_{10}$ $CFUg^{-1}$. Within six weeks, an increment of $CFUg^{-1}$ was observed as the nutrient content of compost medium was high and fungi willingly grew. There was a gradual decline in population due to the production of extra-cellular enzymes. The population of *T. harzianum* was significantly higher than that of *T. koningii* ($p < 0.05$). The formulation retained good numbers of viable propagules for more than 20 weeks of storage.

Keywords: *Trichoderma sp.*, Compost formulation, Shelf life
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Welfare issues in intensive broiler production on the perception reflected by different social strata: A case study in Matara district

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Meeting the societal aspirations about animal welfare is essential to prioritize the welfare issues. The objective of this study was to identify and prioritize welfare issues of broiler production as perceived by broiler farmers, academics and general public. Administrating a questionnaire, information was collected (n=50; stratified random sampling for each category). Fifty welfare issues were classified under 5 domains; feed/water (FW), housing condition/stocking density (HCSD), natural behaviour/animal health (NBH), suffering/stress (SUS) and transportation. Respondents were requested to rank the importance of each issue to improve broiler welfare on a 5-point Likert Scale. Descriptive statistics were used. Irrespective of the social category, most important welfare domain was FW (87.3 % ± 0) followed by NBH (86.7 % ± 0), HCSD (85.8 % ± 0), SUS (85.2 % ± 0) and transportation (82.5 % ± 0). The most important issues identified were disease controlling, cleanliness of water and the amount of feed consumed. The top three important welfare domains for the general public were FW (83.7 %), NBH (82.7 %) and SUS (81.4 %). The highest concern for welfare was recorded by the academics (88.44 %) while that of the consumers was the lowest (81.44 %). The highest (88.4 %) and the lowest (83.18%) priorities were marked by above degree level respondents, followed by those studied up to A/L and O/L. Overall, the perception of poultry welfare is higher (87.34%) among the 30-50 years aged category. It is concluded that the perception on the welfare issues of commercial broiler production is influenced by social strata, their education level and age.

Keywords: Broiler, Perception, Production, Social, Welfare

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Phytoremediation of effluent generated by parboiling of paddy in rice mills

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Parboiled rice is gaining more popularity among Sri Lankans as it is healthier than raw rice. When paddy is parboiled, a huge amount of water is generated. Since this wastewater is high in nutrients, it may create environmental issues. This study aimed to find out a solution to overcome such issues using phytoremediation with aquatic plants. The aquatic plants, water hyacinth (*Eichhornia crassipes*), duckweed (*Lemna* sp.), azolla (*Azolla caroliniana*) and hydrilla (*Hydrilla verticillata*) were collected from fresh water ponds. The experiment was conducted with three treatments (undiluted, 50% dilution, 3-times dilution) with three replicates per each treatment. Chemical parameters, pH, Total Dissolved Solids (TDS), Electrical Conductivity, (EC) nitrate, nitrite, sulphate and phosphate of the parboiled wastewater were measured by multi-meter and colorimeter. After four weeks, EC, TDS, pH and colour were low in 50% dilution (1:1) when compared to undiluted treatment. These values were below the WHO standards for irrigation water. A dilution approach of parboiled effluent with fresh water in a 1:1 ratio (50% dilution) was best compared to other batches. In this study duckweed (*Lemna* sp.) has been selected as the best plant species to be used for phytoremediation of effluents generated in parboiling.

Keywords: Parboiled wastewater, Aquatic plants, Phytoremediation and irrigation standard

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An assessment of water absorption of a lightweight polyester resin reinforced sawdust bio-composite

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The main objective of this study was to introduce a waste material (an equal portion mixture of Mahogany/Ginisapu sawdust) as a reinforcement filler in making polyester composites. In this study different contents of raw and alkali-treated sawdust fillers were blended with the polyester resin in 10, 20, 30, 40 and 50 wt.% basis and a series of composites were pressed at room temperature at a pressure of 35 MPa. For comparison purpose pure polyester board was also pressed under the same conditions. Sawdust was sieved to select particle sizes in the range of 14 to 30 mesh and treated with 5 %wt. NaOH for 2 h. at 90 °C. Physico-mechanical properties of polyester composites (tensile strength, density, moisture content, water absorption, thickness swell, and water retention value (WRV) were obtained. In FTIR analysis the formation of ester linkages between -OH on cellulose and carbonyl groups polyester resin was confirmed. A water absorption test was determined to evaluate the dimensional stability of composites indicated that alkali treated sawdust composites were more hydrophobic than their untreated counterparts. Water absorption capacity reached its highest value for 40 wt.% sawdust, whereas for pure polyester board reached the lowest value of 0.15%. The pure polyester board has showed the highest density of 0.0012 g mm^{-3} and gradually decreased with increasing the filler contents. Water absorption measurement for treated and untreated 40 wt.% sawdust-polyester composites were 15.68% and 18.74% respectively. Therefore, it is possible to prove that these sawdust polyester composites can be used as a valuable substrate in lightweight components.

Keywords: Sawmill waste recycling, Unsaturated polyester resins, Physical-mechanical properties, Water absorption

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Effect of biochar on nitrate and ammonium retention in paddy soil columns

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Paddy cultivation occupies a prominent place in the agriculture sector in Asia, which relies on the intense use of nitrogen fertilizers. Excessive use of nitrogen fertilizers in agriculture over years results in several ecological disorders principally nitrogen leaching, eutrophication, and global warming. Nitrogen leaching has been a potential source of water pollution both surface and groundwater further, remains a major constraint in nutrient utilization. This study intended to assess the effect of biochar, a potential organic soil amendment on nitrate and ammonium ion retention on paddy lands; with the objectives of determining the nitrogen loss by leaching in paddy soils at different biochar levels under constant nitrogen fertilizer application. The soil samples (n = 16) were taken at six sampling locations at two depth levels (0-20cm and 20-40cm) from paddy fields in the Mapalana area and biochar prepared from discarded cinnamon sticks following traditional method were used to fill the soil columns for treatment after appropriate preparation. Three laboratory experiments were conducted with one control. A constant urea level of 0.405 g was applied separately to the three different soil columns in 01%, 2.5%, and 5% (W/W) biochar mixed with soil. The $NH4^+$-N and NO_3^--N concentrations were measured using ultraviolet and visible spectrophotometer. When the biochar content increased from 1% to 2.5%, a significant reduction of NH_4^+ and NO_3^- in leachate from 0.7 mg/l to 0.1 mg/l and 200 mg/l to 100 mg/l were shown respectively demonstrating minimum ammonium and nitrate ion levels in leachate during the 2.5% biochar level. However, no significant changes were recorded in nitrogen retention for 2.5% and 5% biochar levels. Thus, the study concludes 2.5% is optimum biochar level to enhance nitrogen retention in soil and reduce nitrate and ammonium leachate in the soil under recommended urea application rate for paddy.

Keywords: Ammonium leachate, Biochar, Nitrate leachate, Nitrogen retention, Soil amendment

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Activity of protein-based trypsin inhibitors present in local variety of *Canavalia ensiformis*

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Protein-based trypsin inhibitors isolated from different legumes have been recognized as effective agents for protease targeted therapy against certain diseases including cancers and neurodegenerative disorders. The current study was designed to evaluate trypsin inhibitory activity (TIA) in seeds of local cultivar of *Canavalia ensiformis* (Awara), released from Horticultural Crop Research and Development Institute, Sri Lanka. A concentration gradient (1.25%, 2.5%, 5%. 10% and 20%) of the aqueous seed extract was assessed for TIA using casein as the substrate and the total protein content was estimated by Bradford assay. The protein-based trypsin inhibitors contain in concentration with maximum TIA were fractionated by ammonium sulphate precipitation. It was observed that the 20% seed extract showed the highest TIA (60.76 ±1.30%), while 10% and 5% extracts exerted TIA of 40.64 ±0.85 % and 11.96 ±2.76 % respectively. The 2.5% and 1.25% concentrations did not show considerable activity. Total protein content of crude extract was 1.45 ±0.04 mg/ml and accordingly the specific TIA in 20%, 10% and 5% extracts were 41.90, 28.02 and 8.24 % per gram of total protein, respectively. The protein-based trypsin inhibitors fractionated using different ammonium sulphate saturations showed that the highest trypsin inhibitory activity was exhibited by the proteins precipitated using 60% ammonium sulphate saturation (56.62±0.81%). The protein fractions obtained by 30% and 90% ammonium sulphate saturations exhibited inhibitory activity of 48.51±2.11% and 36.81±3.11% respectively. The observed trypsin inhibitory activity in screening and partial purification assays suggest that the seeds of the local cultivar of *C. ensiformis* may contain therapeutically potential protein-based trypsin inhibitors.

Keywords: Protein-based, Trypsin inhibitors, *Canavalia ensiformis*, Therapeutically

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Bio-ethanol production from some marine algae by Baker's yeast and mixed culture from palmyrah toddy under submerged fermentation

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Algae are identified as third generation carbon sources for bioethanol production. Hence two different types of marine algae, *Sargassum* spp. and *Halimeda* spp. were selected for bioethanol production. These marine algae were collected from North sea of Jaffna District, Sri Lanka. Samples were cleaned, dried, and crushed to powder and soaked in 150 mL of absolute ethanol for 5 successive days at room temperature (31±3 ^{o}C) seperately. The supernatant was filtered through filter paper, and the samples were dried. Ethanol treated 10g of samples were mixed with phosphate buffer (pH 6.0), autoclaved and treated with α-amylase at 60^{o}C for 2 hours. After the incubation, fermentation ((L^{-1}) 4g $(NH_4)_2SO_4$, 4g $MgSO_4$, 8g KH_2PO_4, and 4g yeast extract) medium was added separately and autoclaved. Then the media were inoculated with 20 mL of Baker's Yeast (BY) and Palmyrah Toddy mixed Culture (PTC) inoculum separately and allowed to ferment at 100 rpm and room temperature (31±3 ^{o}C) for 72h in a rotary shaker. Bioethanol content was measured by ebulliometer. When BY was used as inoculum, *Sargassum* spp. and *Halimeda* spp. separately containing medium showed the highest mean bioethanol production (0.6% v/v, for both media) at 48 h of fermentation. The highest bioethanol (1.23±0.033 % v/v % v/v) production was obtained in a fermentation medium containing *Sargassum* spp. when PTC was used as the inoculum. When the different amount of PTC inoculum (5, 10, 15, 20, 25, 30, 35 and 40 mL) was used for both substrate separately, 20 mL of PTC inoculum showed highest bioethanol activity (1.26±0.016 % v/v) for *Sargassum* spp. and *Halimeda* spp. (0.91±0.016 % v/v) showed highest bioethanol activity in the presence of 30 mL inoculum at 48h of fermentation. Palmyrah Toddy mixed culture inoculum performed better than Baker's Yeast inoculum in the fermentation of selected seaweeds.

Keywords: Bioethanol, Marine algae, Palmyrah toddy

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Incorporation of rice husk ash with red mud in preparation of bricks: A preliminary investigation

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Utilization of waste materials into value added products is one of the key features of current global sustainable journey. Rice husks (RH) are the major agricultural waste materials and rich source of silica. The purpose of this research is to make clay bricks by adding rice husk ash (RHA) to enhance structural properties of fired clay bricks and produce environmental friendly green building material. Further, SiO_2 molecules present in the RHA can combine with Al and Fe available in the red clay to form a geopolymer to bring an additional strength to the bricks. RH was collected from local rice mills and burnt to obtained white colored ash. RHA was characterized by conducting FTIR, XRD and XRF testing to find out the composition, crystallinity and SiO_2 percentage. This confirmed the presence of amorphous inorganic SiO_2 around 85.2% (mass). For the testing of properties, five bricks samples were made by mixing RHA to clay from 0% to 40% w/w ratios along with the control. After following the conventional brick making process, the prepared fired bricks were subjected to several tests including water absorption test and compressive strength test. According to these test results, sample containing 10% w/w rice RHA has the highest compressive strength and the lowest water absorption, also shows better properties compared to conventional bricks. In this preliminary study, it can be concluded that by adding RHA into the red clay can produce strong, light weight and environmental friendly clay bricks as useful construction materials.

Keywords: Agricultural waste, Clay bricks, Rice-husk ash

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Performance evaluation of slow sand filter after pretreated with coagulant chemical in Kilinochchi wtp

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The Kilinochchi water treatment plant (KWTP) which has a Roughing Filter, an Aerator and Slow Sand Filters (SSF-KWTP) had been designed to meet the increasing water demand of Kilinochchi district. The Source for the KWTP is Dry Aru which is fed by Iranamadhu reservoir. Huge seasonal fluctuation of turbidity and the algal population in Dry Aru affect the performance of the KWTP and the plant shut down for several months. The decision has been taken to incorporate the coagulation flocculation treatment system to KWTP to improve the treatment efficiency. Slow sand filtration works primarily through biological activity on the sand bed and it is a chemical free treatment system. Adding pre-treatment chemical may affect the biofilm layer as well as the performance of the slow sand filter. Hence the purpose of the study is to evaluate the filtration efficiency of the slow sand filter after pretreatment with poly aluminium chloride (PACL) coagulant chemical. Real Slow sand filter model (SSF-Model) has been built and connected with coagulation flocculation system. Turbidity reduction percentage of the SSF-Model and SSF-KWTP was in the range of 75-97.05% and 90.63-97.30% respectively. Average colour reduction % of the SSF-Model was 83.87%. Algal removal efficiency of the SSF-Model was 58% and the SSF-KWTP was 63.7%. There was no significant difference in performance of SSF-Model in terms of Turbidity (4%), Manganese (3.9%), Total iron (0.4%) and Algal removal (5.6%) efficiency compared with the SSF-KWTP. Colour removal efficiency (14%) of SSF-Model was significantly lower than SSF-KWTP. It can be concluded that coagulation flocculation treatment system with pretreatment chemical as PACL can be incorporated to improve the treatment efficiency to KWTP.

Keywords: Slow sand filter, Filtration efficiency, Coagulation and flocculation

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Quadratic nonlinear optical properties of photochromic DTE–containing ruthenium complexes: A DFT study

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Interest in molecular switches has grown enormously in recent years due to their applications in current and prospective fabrication of smart soft materials and photonics technologies. A variety of organic and metal-containing molecular systems capable of switching quadratic and cubic nonlinear optical (NLO) properties has been investigated, but most of the reported compounds are restricted to switching between three states at most. In this study, multi-stimuli (photochemical, protic, electrochemical) switching of quadratic NLO properties of a ruthenium alkynyl complex containing a photochemically-active dithienylperfluorocyclopentene (DTE) bridge trans-[Cl(dppm)$_2$Ru(C≡C-1-C$_6$H$_4$-4-C≡C-DTE-C≡C-4-C$_6$H$_4$-1-NO$_2$)] afforded six stable and independently addressable states that have been studied systematically using density functional theory (CAM-B3LYP/6-311G(d)/SDD(Ru)). The calculations showed that, for the Ru(II) complexes, the photo-induced ring-closing reaction leads to a substantial increase in the NLO response, with the ring-closed forms exhibiting a better π-conjugation between the electron donor and electron acceptor substituents compared to their ring-opened analogues. On the basis of time-dependent (TD) DFT calculations, the lowest-energy charge transfer band is considerably red-shifted upon ring-closure, making a significant contribution to the total quadratic NLO response. Protonation of the alkynyl complexes to afford vinylidene complexes results in a reduction in the computed NLO response. This may be due to NLO-inefficient intraligand transitions dominating in the low-energy region of the optical spectra of vinylidenes. One-electron oxidation gives rise to a significant increase in the quadratic NLO data, the significantly red-shifted absorption bands in the electronic spectra of the oxidized forms appearing to favor large NLO responses. Each of the six stable stimuli-accessible species has distinct quadratic NLO responses, and with each pathway interconverting two of the species affording a possible binary (photochemical, protic or electrochemical) switch.

Keywords: Molecular switches, Nonlinear optics, Organometallics, Computational chemistry

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Chemical contamination in widely consumed grains available in local market

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Pesticide overuse and misuse may result in contamination of numerous food commodities with chemical residues leading to bioaccumulation through food chains and building up to exceeded levels of toxins inside the body and in the environment. Grains are extensively consumed in Sri Lankan meal due to its high nutritional values. Variety of grains are cultivated in our country and pesticides are used in cultivation as well as in storage to prevent pest attack. Therefore the investigation of the possibility of having pesticides or residues in grains is essential. In this study, four some selected grain types such as chick pea, green gram, corn and dhal collected from Matara area were analysed in duplicate for contaminants. Contaminants were extracted from each sample according to a slightly modified QuEChERS method (AOAC Official Method 2007.01) and analysed by GC-MS. It was observed that chick pea samples were contaminated with diethyl phthalate, mono-(2-ethylhexyl ester), and benzene dicarboxylic acid. Green gram samples were contaminated with diethyl phthalate and succinic acid while the corn samples were contaminated with diethyl phthalate and 4-amino-6-hydroxypyrimidine. No detectable contaminants were found in dhal samples. Most of the contaminants found were hazardous chemicals, solvents used in pesticides, compounds used in plastic manufacturing process. These findings well demonstrate the possibility of contamination of grains with toxic chemicals and the necessity of awareness of the contamination.

Keywords: Grains, Contamination, Hazardous chemicals, QuEChERS method

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Investigation of possible adulterations in coconut oil sold in the local market

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Adulteration of coconut oil, the most commonly used edible oil in Sri Lanka, is a serious issue, which has a severe impact on the health condition of the consumers. However, very few scientific studies have been conducted on the status of adulteration of coconut oil available in the local market. This study was focused to assess the quality and possible adulterations of coconut oil samples collected from the local market in the Southern province of Sri Lanka. First, physical and chemical quality parameters of the coconut oil samples were determined and then the qualitative determination of possible adulterants was performed. A survey was conducted using a structured questionnaire to investigate the factors that locals consider when buying coconut oil and evaluate the level of their awareness about the adulteration. According to the preliminary analysis performed for 15 coconut oil samples collected it was found that several samples were having unacceptable levels of saponification value (up to 283 mg KOH/g), acid value (up to 5.35 mg KOH/g) and peroxide value (up to 4.26 mequiv. of peroxide oxygen /1 kg of oil) based on local and international standards. Qualitative tests performed revealed that there were no detectable amounts of castor oil, mineral oil, argemone oil, rice bran oil or cottonseed oil present in in any of the coconut oil samples. However, after a thorough thin layer chromatographic analysis performed, it was found that 5 out of 15 samples collected were adulterated with palm oil. These 5 samples with suspicious palm oil adulteration were selected to further analyze using FTIR and GC-MS. It was observed that FT-IR data were inconclusive to detect palm oil in coconut oil. The GC-MS results are pending and will be reported in due course. The customer survey results revealed that possible adulterations is among the key factors considered by customers in purchasing coconut oil in the context of Sri Lanka.

Keywords: Adulteration, Coconut oil, Palm oil, Thin Layer Chromatography

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Diversity of the macrobenthic assemblage in the Mundal Lagoon, Sri Lanka

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There is a dearth of published information on the diversity of macrobenthic assemblages in lagoons. Therefore, we examined the diversity and composition of macrobenthos in the Mundel Lagoon in the northwestern province in Sri Lanka. Eight sites were selected considering the attributes in side of the lagoon. Macrobenthos samples were collected using Ekman grab sampler from May to July 2018 monthly basis. Water quality analysis was conducted in *in situ* and laboratory. Results revealed that 12 genus of macrobenthos (*Haminoeid* sp., *Littorinid* sp., *Nassariid* sp., *Naticid* sp., *Cerithiidea* sp*., Cerithiidea* sp., *Nodilittorina sp., Geloina sp., Mytilus* sp., *Peaneus Indicus, Nereidid* sp., *Pilargidiid* sp.) belonging to 11 families and four classes (Gastropoda, Bivalvia, Crustacea, Polychaeta) were recorded. Among them, two species of Polychaeta, and Bivalvia, seven species of Gastropoda, and one species of Decapoda were found. The highest and lowest abundance were recorded from the family Cerithiidae (53.10%) and Nereididae (0.21%) respectively. The highest and the lowest abundance of macrobenthos were found in the sampling sites, ML3 (middle area of the lagoon), and ML6 (proximity to shrimp farm and saltwater factory outlets) respectively. The Pearson correlation analysis showed there was no correlation between macrobenthos abundance and physicochemical parameters ($p>0.05$). This would be due to the short study period, and bottom water quality mainly affects the macrobenthic assemblage. Shannon diversity index (H') of the sites, ML1 to ML8 were 1.18, 1.57, 1.25, 1.59, 1.37, 0.56, 0.62, and 1.32 respectively. In conclusion, H' confirmed that ML6, and ML7 showed "poor" whereas other sites showed "moderate" stress conditions.

Keywords: Diversity, Macrobenthos, Mundel Lagoon, Shannon diversity index

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Analysis of global mineral market price for selected earth materials

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Earth materials play a vital role in day-to-day life as well as in the global economy. These earth materials are mainly used in industrial applications from ancient times. Ilmenite, rutile, and zircon can be categorized as heavy minerals, and they play a major role in the mineral industry in Sri Lanka. Rare earth elements (REE) are a combination of seventeen elements including the elements in the series of Lanthanides. In addition, Sri Lanka can be identified as a possible repository for rare earth elements (REEs) to the global mineral market. Consequently, the objective of this study is to examine and model the annual global market price variations of earth materials known as heavy minerals and REEs. In this study, the annual unit price variations of heavy minerals and REEs from 1950 to 2017 were analyzed using raw data obtained from the United States Geological Survey (USGS). Results show that the adequate models obtained for the annual prices of REEs, ilmenite, rutile, and zircon are ARIMA (2,1,2), ARIMA (2,1,2), ARIMA (1,1,0), and ARIMA (0,1,0), respectively, whereas minimum AIC values were used to identify the best fitting models. Besides, no ARCH behavior was confirmed at the preliminary analysis. Finally, the outcomes of this study can be used to improve the action plans of the mineral industry in Sri Lanka.

Keywords: Rare Earth Elements (REEs), Heavy minerals, Market value, Time series modeling

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Evidences of two male morphs of *Abscondita promelaena* (Walker) (Lampyridae: Luciolinae) in Sri Lanka

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The pale-yellow firefly, *Abscondita promelaena* was originally described from Sri Lanka. Two male morphs (M1 & M2) of *Abs. promelaena* have been recorded from Uva Province, Sri Lanka in 2011. There were no previous records of morphs of *Abs. promelaena* in Southeast Asia. Present study aims to further investigate the taxonomic and ecological evidence of M1 and M2 of *Abs. promelaena* in four selected habitats in Uva Province. The selected habitats were grassland, freshwater associated land, paddy field and forest from Wellawaya, Welimada, Bandarawela and Ella locations respectively. Males of *Abs. promelaena* were collected from 50 m^2 sampling area selected in each habitat from 18.00 to 20.00 by four sampling visits (January, February, July and August) in 2020. Two morphs were counted in the field. Twenty specimens of each morph were preserved in 70% ethanol and brought to the laboratory to take measurements and to dissect the genitalia. Nine morphometric measurements were obtained using light microscope (Nikon-ECLIPSE-E100) from a total of 174 (M1) and 126 (M2) specimens, and a comparative character examination was carried out. Both morphs recorded a similar dorsal colour pattern, i.e., pale-yellow elytra and pronotum, and dark brown mesoscutellum. Measurements of total width, pronotum width, elytral width, light organ width and antenna length are in similar range for both morphs. There were no observed differences in aedeagus, aedeagal-sheath, and flashing patterns of both morphs. They showed dissimilar ventral morphology, i.e., sternites 4 and 5 are black in M1, while only sternite 5 is black in M2. Total length, pronotum length, elytral length and light organ length of M1 are longer than those of M2. M1 is morphologically similar with the type. M1 showed high relative abundance in grassland, paddy field and forest habitats (52%, 56% and 54%) than M2 ($p>0.05$). M2 showed a significantly high relative abundance (73%) in freshwater associated habitat ($p<0.05$). In addition to the recorded morphological and ecological evidence, a molecular approach is suggested to confirm whether M1 and M2 morphotypes belong to the same species or not.

Keywords: *Abscondita promelaena*, Male morphs, Taxonomic ambiguity, Ecological evidence, Uva Province
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Variation of freshwater fish diversity in Podi wewa and Maunawa wewa in the Kurunegala district in Sri Lanka

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Anthropogenic activities may impact ichthyofauna in freshwater bodies, and therefore, baseline information on fish diversity is needed to monitor the trends in abundance. The present study was undertaken to identify and compare the diversity of freshwater fishes in Podi wewa (Site 1) in Ihala Kadigamuwa village and Maunawa wewa (Site 2) in Maunawa village, Kurunegala district, North-Western Province of Sri Lanka from October 2020 to May 2021. Weekly sample collections were made, and fish were identified to the species level by morphological features using standard taxonomical keys. Eight fish species belonging to five families from Podi wewa and six species representing five families from Maunawa wewa were identified. These species were *Glossogobius giuris* (Family Gobiidae), *Lepidocephalichthys thermalis* (Family Cobitidae), *Heteropneustis fossilis* (Family Heteropneustidae), *Puntius vittatus, Esomus thermoicus*, *Rasbora caverii* and *Puntius chola* (Family Cyprinidae), *Channa punctata* and *Channa striata* (Family Channidae), *Anabas testudineus* (Family Anabantidae), and *Trichogaster pectoralis* (Family Osphronemidae). Order Cypriniformes were the most species-rich group among the identified species. *Puntius vittatus*, *Rasbora caverii* and *Trichogaster pectoralis* were present at both sites 1 and 2. The most abundant species at site 1 was *Trichogaster pectoralis* (44.12%) and *Puntius vittatus* (94.6%) at site 2. Although the total abundance of fish in Podi wewa was lower (n= 68) than that in the Maunawa wewa (n= 268), the fish diversity (H′= 1.3141) and species richness (SR= 8) were higher at Podi wewa than those in the Maunawa wewa (H′= 0.4148, SR= 6) based on the Shannon Weiner index. Over-exploitation of water resources and fishery resources and water pollution are the major threats to the occurrence of fish species in these freshwater bodies. Therefore, strategies for conservation of fish species are needed in the future.

Keywords: Abundance, Diversity, Freshwater fishes, Maunawa wewa, Podi wewa

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Antibacterial activity of extracts of roots and seeds essential oil of Sri Lankan endemic plant, *Vateria copallifera*

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Vateria copallifera is one of the endemic plants in Sri Lanka. Essential oil and bark of this plant are used as wound washing medicament, as well as for treatments of haemorrhoids, bile related disorders, diarrhoea, rheumatic pains, and diabetes mellitus in Ayurveda. Because of these medicinal values, this study focuses on evaluation of antibacterial activity of acetone and methanol extracts of essential oil from roots and seeds. The plant materials were collected in Agalawatta, Sri Lanka and shade dried and powdered. Root was extracted by percolating separately with methanol and acetone. Essential oil was extracted from seed using acetone as the solvent. The extracts were filtered followed by removing the solvents with rotary evaporator. The antibacterial activity of extracts of *V. copallifera* was determined against *S. aureus* and *E. coli* using agar well diffusion method by employing Co-amoxiclav as the standard. The diameter of zone of inhibition (mm) were expressed as mean ± SD, and antimicrobial activity of extracts was analysed with two-way ANOVA. Mean values of inhibition zones of essential oil against *S. aureus* for the concentrations 40, 20 and 10 mg/mL were found to be 8.10 ± 0.10, 7.37 ± 0.32 and 6.50 ± 0.50, respectively. The methanol extract of roots exhibited inhibition zones against *S. aureus* for 40, 20 and 10 mg/mL as 24.37 ± 0.55, 20.63 ± 0.55 and 17.67 ± 0.76 respectively, whereas that of acetone extract were 21.20 ± 0.75, 18.33 ± 0.51 and 16.03 ± 0.50, respectively. Similarly, the mean inhibition zones of methanol extract of roots against *E. coli* were 19.17 ± 0.76, 17.47 ± 0.50 and 15.83 ± 0.76, and that of acetone extract were 21.43 ± 0.51, 20.37 ± 0.55 and 18.87 ± 0.32, respectively. Two-way ANOVA revealed that extract type ($p<0.001$) and tested bacteria ($p<0.001$) have significant effect on the antibacterial activity. Methanol and acetone extracts of *V. copallifera* roots extracts have higher antibacterial activity than the extract of essential oil of *V. copallifera* seeds.

Keywords: *Vateria copallifera*, Essential oil, *Staphylococcus aureus*, *Escherichia coli*, Co-amoxiclav

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Evaluation of photo protective and antioxidant property of *Azadirachta indica* leaf extract

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Chronic exposure to ultraviolet radiation is the major cause of photoaging and photo carcinogenesis. *Azadirachta indica* (Neem) is a plant known for its versatility in therapeutic applications due to its rich phytochemical constituents. Hence, this study focused on the evaluation of photoprotective and antioxidant properties of *A. indica* leaves. Air-dried leaves were powdered and extracted using 80% (v/v) aqueous methanol. The organic solvent was evaporated using a rotary evaporator and lyophilized to obtain the lyophilized extract. *In-vitro* photoprotective property of the extract was evaluated using 0.2 mg/mL methanolic solution and expressed in terms of spectrophotometric Sun Protection Factor (SPF) according to Mansur equation. The antioxidant activity of the extract was evaluated using 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and nitric oxide (NO) radical scavenging assay. Leaf extract (0.2 mg/mL) exhibited moderate photoprotective activity and SPF value was 12.932 ± 0.857. The antioxidant capacity of the leaf extract was 2567.28 ± 147.47 mg ascorbic acid equivalents/100g of dry weight with reference to the standard curve ($y = 0.7328x - 0.1471$, $R^2 = 0.9979$). NO radical scavenging capacity (%) of the leaf extract (1 mg/mL) was 43.902 ± 7.581. Hence, *A. indica* leaf extract can be successfully incorporated into cosmeceuticals as a natural active ingredient to enhance the photoprotective property and antioxidant capacity.

Keywords: *Azadirachta indica,* SPF, Antioxidant, NO Radical

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Identification of medicinal plants with their potential pharmacological action in Kaithady, Jaffna, Sri Lanka

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Siddha Medicine is one of the most ancient medical systems of Sri Lanka. According to Siddha system of medicine, the geographical lands are divided into five divisions known as '*nilam'*. They are mountain range – '*kurinchi'*, pastoral region of the forest – '*mullai',* the fertile land – '*marudham'*, the coastal region – '*neidhal'* and the arid-desert – '*paalai'*. The objective of the study is to identify medicinal plants in Kaithady, Jaffna, and report their potential pharmacological actions. This area includes coastal and fertile regions. The Kaithady map was used to locate and count the medicinal plants. The samples collected from the field were authenticated and verified in herbarium Unit of Siddha Medicine. The research was carried out from June 2021 to September 2021. A total of 113 medicinal plants species belonging to 44 families were identified. This comprises of fertile land medicinal plants (76.11%), costal regional medicinal plants (7.96%), and medicinal plants that are found in both fertile and coastal regions (15.93%). The pharmacological actions of the medicinal plants, with the counts, are as follows; tonic (36), astringent (25), diuretic (22), vermifuge (18), alterative (16), stimulant (16), cooling (15), expectorant (15) and demulcent (12). Considering the therapeutic use, 37 out of 113 identified medicinal plants were used to treat 'vatha' disease, 26 for respiratory diseases, 23 for skin diseases, 09 for diabetes mellitus and 07 for pediatric diseases. Out of these varieties, *Vernonia zeylanica* was identified as an endemic medicinal plant in Sri Lanka. Improperly planned cleaning of the bushes for various development schemes and over collection of medicinal plants due to the huge demand prevailing in the local markets may result in destruction of the natural habitats of these important medicinal plants.

Keywords: Kaithady, Medicinal plants, Pharmacological action

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Quality evaluation of different brands of Atorvastatin tablets available in Sri Lanka

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Atorvastatin is one of the mostly used statins in treating atherosclerosis. The substandard quality of generic medicines affects their therapeutic efficacy resulting in treatment failure. There are several generics of Atorvastatin available in Sri Lanka. In this study, quality of different brands of Atorvastatin (10 mg tablets) was evaluated using four pharmacopoeial tests such as uniformity of content, friability, weight variation and dissolution test. Uniformity of content of tablets were evaluated by Reversed-phase High-Performance Liquid Chromatography method (RP-HPLC). Other quality tests also were evaluated according to British pharmacopeial specifications. Mostly available fifteen brands of Atorvastatin were selected for the study from total of 21 brands of Atorvastatin. Atorvastatin tables were purchased from pharmacies in the Jaffna municipality area and evaluated for their quality. All brands were coded from S1 to S15. Descriptive statistics was used for data analysis with the help of MS Excel software. According to quality analysis, all the brands passed the friability test. Two brands (S1 and S15) were failed in uniformity of content in which S1 brand had 93% of drug and S15 brand had 107.27% of drug. Also, S15 failed in weight variation test and its weight variation was 6.7943%. S8 failed in the dissolution test in which it released only 68.067±1.50 % at the end of 45 minutes. Out of fifteen brands, three brands failed at least in one pharmacopeial test. Regulatory authorities should strictly monitor the quality of brands that are available in Sri Lanka.

Keywords: Atorvastatin, Brands, Evaluation, Quality, Sri Lanka

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A laboratory-based pilot study on anticancer property of *Alpinia calcarata* ("Araththa") and *Solanum surattense* ("Ela Batu") in immunosuppressed mice, rats and human cell lines

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Present study was undertaken to validate anti-cancer property of *Alpinia calcarata* and *Solanum surattense* in immunosuppressed mice, rats and human cell lines. Rat xenograft model of HeLa cells (human) was established. Rats were orally fed with both plant extracts at doses of 50 mg/kg and 100 mg/kg for three weeks. On the 21st day, two hours after treatment, Cyclophosphamide was orally given at a dose of 50 mg/kg to all rats. Right armpit of immunosuppressed rats was subcutaneously inoculated with 0.2 ml HeLa single-cell suspension. Growth of xenograft tumor was observed every day. After 20 days, maximum width, length and weight of each tumor were measured. Tumor volume and tumor inhibition rate were calculated. Statistically significant, low tumor mass [(2.73 ± 0.19) and (1.76 ± 0.15)] and tumor volume [(499.16 ±184.77) and (177.33 ±48.28)] were observed in *A. calcarata* treated rats, indicating its potential to suppress tumor growth. When comparing mean values of the size of armpit tumors among all treatment groups, higher mean values [(3.55 ± 0.36) and (3.42 ± 0.34)] can be identified in the groups of rats treated with *S. surattense* extracts. According to the results, *A. calcarata* extractions might be useful in cancer treatments. According to statistical analysis between treatment groups for size of tumors, it was evident that *A. calcarata* treated groups might slow down tumor growth significantly ($P<0.05$). Therefore, dose of plant extraction of *A. calcarata* may cause significant influence for size of armpit tumor. However, there was no significant difference ($P>0.05$) of tumor growth in rats treated with *S. surattense*. According to the results of this study *A. calcarata* extractions might be useful in cancer treatments.

Keywords: *A. calcarata,* Anti-cancer, Cyclophosphamide, *S. surattense,* Xenograft

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Dietary carbohydrate and fat intake are associated with increased percentage of glycated hemoglobin in patients with newly diagnosed type 2 diabetes mellitus: Evidence from a cross-sectional study

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Diet is one of the main factors in triggering glycemic parameters of patients with type 2 diabetes mellitus (T2DM). Present study aimed to determine the association between dietary intake and glycated hemoglobin (HbA_{1C}) in patients with newly diagnosed T2DM. The facts on dietary intake were collected using 24-hour recall from patients (n=158, age 30-60 years) with newly diagnosed T2DM who attended the University Medical Clinic, Karapitiya Teaching Hospital, Sri Lanka. Percentage of HbA_{1C} was estimated. Demographic, life-style and family history of diabetes data were collected. The patients were divided into quartiles of dietary intake to establish the associations of dietary intake with HbA_{1C}. Multiple linear regression at the 95% CI was used to assess the difference in average HbA_{1C} with quartiles of dietary intake with the adjustment for demographic, lifestyle and family history data and dietary intake variables. There were positive associations between daily dietary carbohydrate intake and HbA_{1C}, and between daily dietary fat intake and HbA_{1C}. Individuals in the 2nd, 3rd, and 4th quartiles of carbohydrate intake had on average HbA_{1C} of 0.312%, 0.376%, and 0.257% respectively compared to the individuals in 1st quartile (p_{trend} = 0.039). Individuals in the 2nd, 3rd, and 4th quartiles of fat intake had on average HbA_{1C} of 0.173%, 0.277% and 0.362% higher respectively compared to the individuals in 1st quartile (p_{trend} = 0.012). There were no associations of protein, fiber and glycemic load with HbA_{1C}. Higher carbohydrate and fat intake were associated with increased percentage of HbA_{1C} in patients with newly diagnosed T2DM.

Keywords*:* Carbohydrate intake, Fat intake, Glycated hemoglobin, Type 2 diabetes mellitus

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Toxicity assessment of a novel polyherbal mixture of 28-day repeated dose: A trial using Wistar Rats

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Herbal medicines are often consumed as polyherbal mixtures by people seeking conventional healthcare in the management of kidney diseases. The present study was designed to evaluate the potential toxic effects of a novel polyherbal mixture with potential nephroprotective effects. The toxic effects of the aqueous refluxed (4 hr) polyherbal mixture derived from the leaves of *Abelmoschus moschatus* Medikus., *Asparagus falcatus* L., and the whole plant of *Barleria prionitis* L. were evaluated at 200, 400 (equivalent therapeutic dose) and 600 mg/kg doses after repeated oral administration for 28 days to healthy Wistar rats (n=5/sex/group), following OECD guidelines. Samples were collected for biochemical, haematological and histological assessments. Results were analyzed statistically by one-way ANOVA. The results of renal (S. Cr; 62.21-71.56 µmol/L, BUN; 7.43-8.85 mmol/L) and liver function (ALT; 30.63-40.17 U/L, AST; 68.97-98.55 U/L, ALP; 250.89-311.91 U/L, ɣ-GT; 3.18-4.75 U/L) parameters, fasting blood glucose (5.42-5.57 mmol/L), lipid profile parameters (TC; 1.64-2.18 mmol/L, TG; 0.98-1.13 mmol/L, HDL; 1.05-1.22 mmol/L) and full blood count parameters of the experimental rats remained within the normal physiological range of the species ($p>0.05$). No significant differences were observed in the relative weights of the heart, lung, liver, spleen, kidney, and small intestine in either group of rats compared to the untreated control group ($p>0.05$). No signs of toxicity including the features of necrosis, fibrosis or inflammatory changes were observed in either group of rats during the histopathology assessment of excised vital organs. The findings revealed that the herbal mixture at the selected doses were toxicology safe *in vivo*.

Keywords: Biochemical and haematological assessment, Histology, Polyherbal mixture, Toxicity assessment

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Sri Lankan speech therapists during COVID-19: Knowledge on safety practices, service delivery and difficulties

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COVID-19 pandemic has interrupted the speech and language therapy services in Sri Lanka. With the rapid spread of the virus, the responsibilities of the speech and language therapists' (SLTs) included to reduce the risk of the virus transmission while continuing the services. The aim of the study was to describe knowledge on the safety practices and service delivery during COVID-19 among SLTs in Sri Lanka. A cross-sectional descriptive study was followed inviting SLTs who are registered in the Government Speech & Language Pathologists' Union, Sri Lankan Association of Speech & Language Pathologists, and recent graduates from the Speech and Hearing Sciences programme specializing in speech therapy. An online questionnaire was distributed among participants. All the data were analysed with descriptive statistics using Microsoft Excel 2013. A total of 90 SLTs participated with a response rate of 69%. Majority of participants were female (86%), below 30 years of age (58%), and were having work experience below 10 years (88%). The study indicated that 79% of speech therapists had awareness and adequate knowledge on safety practices. Over 85% of participants were following published guidelines by local and international associations. Reduction in routine caseload, closure of usual place of work (e.g. school, clinic), and immediate change to use remote method of service delivery (e.g. remote delivery, telepractice) were the reported difficulties faced by the SLTs during service delivery. However, 70% of SLTs have started implementing telepractice to their practice during the pandemic. While smartphone was commonly used device for telepractice (37%), voice-over Internet-Protocol apps such as WhatsApp, and Viber were most convenient mode (34%). Lack of cooperation of patients toward the telepractice, lack of patients' knowledge to access devices, and network coverage issues were the most prominent reasons for not implementing telepractice. Nevertheless, 41% of participants indicated that telepractice is an effective method to deliver speech therapy.

Keywords: COVID-19 guidelines, Knowledge, Service delivery, Speech therapists
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An investigation into the porosity and permeability properties of fabric materials using nanotechnology and fractal geometry

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Nowadays, nanotechnology is used in the apparel industry for manufacturing fabrics with enhanced physical properties, for example, with a higher level of comfort and antiviral characteristics than traditional approaches. Fractal geometry, on the other hand, is very useful for studying the surfaces of irregular shapes with complicated structural patterns making it straightforward to describe, model, and analyse such natural irregular complex structures. The main objective of the present study is to develop a mathematical model for the pore area fractal dimension of fabrics while controlling the porosity and permeability and then use that built-in connection and nanotechnology to investigate how fabrics can be improved to give maximum comfort while providing maximum protection to the user from different viruses. We used different structural patterns for fabrics such as plain woven, four-harness, and bidirectional stitched fibre mats with fractal characteristics in the irregular structure of the porous medium. An expression for the pore area fractal dimension of fabrics was developed using the unit cell concept. A relationship between porosity and permeability of fabrics was derived by combining Darcy's law and the Poiseuille equation together with the fractal dimension. It was studied how the permeability of fabrics increases/decreases with its porosity. Finally, it should be noted that the derived mathematical expression can be applied to materials used for the manufacture of face masks to study how to reduce the risk of viral penetration further.

Keywords: Porosity and permeability, Darcy's law, Poiseuille equation, nanotechnology, Fractal geometry

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Examining the level of secondary level mathematics teachers' pedagogical content knowledge in algebra

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Teachers' knowledge is considered to be a factor influencing student learning outcomes. Pedagogical Content Knowledge (PCK) is defined as the manner in which a teacher's content knowledge on a subject and pedagogical knowledge are related. Recent research on PCK has indicated that mathematics teachers' PCK is very low and it influences on students' understanding negatively. This study was focused on measuring the secondary level mathematics teachers' PCK in algebra, in the Galle education zone. A survey research design was used to conduct the study. A questionnaire, prepared with the help of five subject specialists, was used to collect data. The data obtained from 281 teachers who submitted complete answers to the questionnaire were analyzed quantitatively using SPSS (version 25) statistical software. The mathematics Teachers' PCK was measured in terms of addressing students' misconceptions and promoting students' algebraic thinking. The items of the questionnaire consisted of declarative, procedural and conditional knowledge categories. The correlation between the declarative, procedural and conditional knowledge with PCK was significant at 0.01 level (2- tailed) and concluded a good relationship among them. The study results revealed that 82.5% of participants were in the medium level of their PCK while 1.8% and 18.5% were in the low and high levels respectively. The mean and the standard deviation were 43.33 and 6.99 respectively. It revealed that the teachers' PCK is in the medium level. We invented that the mathematics teachers' PCK is not in a satisfactory level. Therefore, in order to enhance the students' mathematics understanding, the secondary level mathematics teachers' PCK should be professionally enhanced.

Keywords: Algebra, Algebraic thinking, Misconceptions, Pedagogical content knowledge, Secondary level mathematics teacher

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Forecasting daily Platts price of auto diesel using time series and neural network approaches

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Predicting price fluctuations of petroleum products are challenging as it is irregular, non-linear and complex. However, accurate predictions are vital to minimize the economic loss. The objective of this research work is to identify the most appropriate model out of time series and deep learning neural network models to forecast daily Platts price per barrel of auto Diesel. The daily Platts prices from January 2010 to March 2021 were collected from the Ceylon Petroleum Corporation. Initially, price movements were observed using descriptive statistics. Then, to capture the volatility in daily Platts prices, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was applied. Since the daily data used for modelling contains drastic changes, for instance, in 2014, the Long Short-Term Memory (LSTM) neural network was constructed next as it is more suitable to detect long-term dependencies and unexpected changes in sequential data than the standard recurrent neural network. The ADAM (Adaptive Moment Estimation) optimization algorithm was used to train the neural network. Finally, the prediction accuracies of both models were evaluated using Root Mean Squared Error (RMSE), and Mean Absolute Error (MAE). It was revealed that daily Platts prices oscillate significantly between $144.37 and $20.75. The GARCH (1,1) model was identified as the best time series model whereas LSTM network convergence was attained after 40 epochs with batch size of 60. Based on RMSE and MAE for GARCH (1,1) (0.026 ,0.012) and the LSTM (0.012, 0.007), it was concluded that LSTM neural network was superior to GARCH model in forecasting daily Platts price per barrel of auto diesel and reliable in capturing unexpected price movements in future than time series models.

Keywords: Auto diesel, Forecasting, GARCH, Neural network

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The use of constructivism in teaching mathematics in secondary classes by prospective teachers

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In teacher development programmes conducted by the National Colleges of Education (NCoEs) in Sri Lanka, the commonly used teaching-learning theory is the constructivist approach. The NCoE curriculum has been prepared to implement the teacher development process based on a student-centered teaching-learning methodology. Therefore, it is totally dependent on the constructivist approach. Here, we investigated how the prospective teachers who follow secondary mathematics courses at two NCoEs used the theory of constructivism in teaching mathematics during their teaching practice. Among all the 19 NCoEs in Sri Lanka, only these two NCoEs conduct both Sinhala medium and English medium secondary mathematics courses. The prospective teachers are expected to use the constructivist approach in which teachers play the role of a facilitator. The mixed-methods approach based explanatory sequential design was used in the research. The first phase was a survey using a questionnaire and the sample included 160 prospective secondary mathematics teachers in two NCoEs. In the second phase, focus group interviews were used. Findings revealed that though 93% of prospective teachers believed that they were familiar with student-centered teaching. A significant percentage (24%) did not use constructivist learning principles and practical activities in their teaching of secondary mathematics. However, findings of the interviews revealed that a number of prospective teachers did not use constructivist principles in mathematics teaching as they found it easier to plan and deliver teacher-centered lessons. Therefore, prospective teachers need to be given sufficient theoretical knowledge about constructivist practices in pre-preparation programmes at NCoEs. Adequate mentoring and continuous reflection of prospective teachers by their supervisors are essential to ensure the continuation of constructivist principles in teaching mathematics.

Keywords: Teacher development, Constructivism, Teaching mathematics, Secondary classes

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Non-Newtonian blood flow in an artery vessel under non-ionizing magnetic fields in chemotherapy

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The treatment processes of breast and other different non-skin cancers involve combinations of surgery, chemotherapy, and ionizing radiation. Radiation or surgery targets a specific area of the body. However, chemo can work throughout of the body. Even though both chemotherapy and ionizing radiation can be effectively used against many types of cancers, these treatment processes may harm to healthy tissues, too. To minimize the damages, cause through chemotherapy nonionizing magnetic fields has been proposed and examined. Because of promising results many scientists have paid their attention to this research area. In this work, we develop a Mathematical model for the description of the dynamics of the steady blood flow in arteries under chemotherapy. We consider blood flow in arteries filled with homogeneous porous medium under external magnetic force with constant permeability and variable permeability. Herschel-Bulkley and Casson fluid flow models were used to describe non-Newtonian behavior of the blood flow. An iterative method was used to obtain the shear stress under constant and variable permeability. The velocity profile and flow rate also approximated in two different fluid models. Change of the shear stress with the radial distance was observed for constant and variable permeability. These two situations were compared in two different fluid models for different flow parameters. We observed that the shear stress was increasing with the increase in radial distance and permeability factor in both situations. Furthermore, in both cases the plug core radius increases with the increase of the yield stress. In both fluid models, velocity increases with the increase of the constant permeability factor. In the absence of some exact parameter values, test values were used for the simulation purposes in MATLAB (R2018a). Hence, the study describes only the qualitative behavior of flow variables. Exact values could be used to describe the flow variables quantitatively.

Keywords: Casson fluid, Constant permeability, Herschel-Bulkley fluid, Magnetic force, Variable permeability

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A discrete dynamical model to make decisions during alcohol consumption

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Consumption of alcohol not only damages one's health, but also is the source of many socio-economic issues. In the worst-case scenario, it could even lead to unfortunate occurrences such as traffic collisions, domestic violence, mental health corruption, etc. Therefore, without any doubt, alcohol consumption continues to be one of the major problems in our society which needs everyone's attention.

From a mathematical point of view, the dynamics of alcohol in the body is quite interesting. The amount of alcohol in a person's blood is known as "blood alcohol level or "blood alcohol content" (BAC). The BAC of an individual is determined by four major factors namely, body weight, gender, quantity of alcohol consumed, and time elapsed from first drink until a breath or blood sample is taken. By using the relationship between those factors, we have developed a dynamical system that predicts the BAC of a person at any given time. To develop this model, we used a reasonable new rational function for the fraction of the alcohol that is eliminated from the body. The values derived from the above model can be compared with the benchmarks and depending on the results, we can conclude the overall effect made by alcohol on individual consumers. For example, this model can be used by individual consumers to determine whether they are within the legal limit for Driving While Intoxicated (DWI) prior to start their drive. Finally, this study encourages people to make intelligent choices about alcohol consumption.

Keywords: Alcohol, Dynamics, BAC, DWI, Decision making, Mathematical modelling

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Assessing the impact of vaccination on the spreading of COVID-19 through mathematical modeling

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Presently, COVID-19 (CoronaVirus-2019) virus attacks the whole world due to its high transmission rate. As a result of the efforts of several countries, many vaccines have been invented at present. Several compartmental mathematical models for COVID-19 can be found in the literature. In this paper, a new mathematical model that consists of eight compartments; susceptible (S), exposed (E), vaccinated (V), infected (I), self-quarantine (Q_1), quarantine in centers (Q_2), hospital isolated (H), and recovered (R) is proposed. Based on the model, the effectiveness of the vaccination factor for the spread of the disease is performed. Based on the matrix operator method, the disease-free reproduction number, R_{df}, of the model is derived. We estimate the effectiveness of the model parameters on the spread of the disease by analyzing the sensitivity of R_{df}. Based on the results, we observed that the vaccination rate is the most effective parameter, and the next effective parameter is the disease transmission rate. We determine the least vaccination rate (critical vaccination rate) which is required to prevent the spreading of the disease and interpret the variation of the population sizes against the vaccination rate.

Keywords: Disease-free reproduction number, Vaccination, Sensitivity analysis, Critical point

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Investigation of efficiency of the higher-level multigrid methods for solving a large system of linear equations which arises from discretizing numerical schemes of 1D Poisson equation

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Multigrid Methods (MG) are extremely effective numerical techniques in solving a large system of linear equations associated with boundary value problems in various fields such as engineering, physics, and medicine etc. The references show that, in general, the order of computational complexity of multigrid methods is $O(N)$ whereas classical linear system solver like Gauss-Seidel (GS) takes the order $O(N^2)$. The objective of this research is to implement the multigrid algorithm using MATLAB software and to solve a large linear system of equations using the implemented algorithm to evaluate the convergence nature of MG. In this study, a detailed investigation is carried out to show the efficiency of MG considering different levels of MG algorithm for 1D Poisson equation with Dirichlet boundary conditions. First, the problem was solved using classical iterative methods. The error behaviour and the required number of iterations in each case showed that such solvers are not good to solve associated linear system. Among the classical iterative solvers Gauss-Seidel is one of the fastest and the easiest solvers so it is chosen as the smoother for the multigrid methods. Then the two-level, three-level, and four-level v-cycle MG with GS as the smoother were implemented using MATLAB software. Secondly, the problem was solved using MG. Later, the solutions were obtained using the v-cycle multigrid methods. The obtained results indicate that the multigrid methods accelerate the convergence of the solution drastically.

Keywords: Multigrid, V-cycle, Iterative methods, Poisson equation, Dirichlet boundary conditions

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Estimation of land allocation for crops with a water management plan for Udawalawe water reservoir irrigation scheme

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Water reservoir management is one of the most significant aspects of a country's social and economic development. Key functions of water reservoirs are hydropower generation, irrigation, industrial and domestics water release, and flood control. Due to the high demand and the scarcity of water, a proper water management plan is a necessity. By this study, a stochastic model and a deterministic model are presented for estimating the proportion of land allocation for crop cultivation according to the availability of water. Udawalawe irrigation scheme is considered as a case study. Udawalawe water reservoir is mainly functioning as an irrigation water release which feeds about 22187 hectares for paddy and other crops. A chance constrained linear programming model is applied to determine the reliability of water releases from the Udawalawe reservoir alone which meets the irrigation demands. Then a goal linear programming model (GLPM) is proposed to determine the water release plan for irrigation, considering 5 main reservoirs of the Udawalawe irrigation scheme. MATLAB programming language is used to solve the proposed models. Inflow is forecasted using the monthly averages which gives the minimum Root Mean Square Error among the other compared models; seasonal naive, linear regression with least square error and minimizing maximum error, Holt-Winters' seasonal method and Seasonal Autoregressive Integrated Moving Average. Using the proposed GLPM, with an estimation of the proportion of lands allocation for paddy and other crops, a year ahead water release plan for irrigation is obtained.

Keywords: Water reservoir management, Goal programming, Stochastic model

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A preliminary study on the perceived mental stress among undergraduates at the University of Ruhuna due to online education during the COVID-19 period

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E-learning gained immense popularity during the COVID 19 period but had different impacts on the students. This study investigated the mental stress perceived by undergraduates in the faculties of the University of Ruhuna situated in Wellamadama, Matara, Sri Lanka, during online education, applying descriptive and inferential statistical techniques. Data were collected from July to October 2021 using a customized questionnaire in the form of a Google form. The number of students registered in the Faculties of Science, Humanities and Social Sciences, Fisheries and Marine Sciences & Technology, and Management & Finance was 1536, 2169, 363, and 1754, respectively. Taking the level of significance, the maximum size of the proportion, and the margin of error as 0.05, 0.5, and 0.07, respectively, the required sample size was computed to be 196 using the Daniel sample size formula. The proportion sample size of each faculty was found to be 51,73,12, and 59, respectively. The box plots show the stress variation, and most undergraduates agree that they suffer from stress due to online education. One-way ANOVA test results infer that mental stress among students between the faculties is highly statistically significant (p=0) and is insignificant on students' family income (p = 0.547), gender (p = 0.777), and living environment (rural, semi-urban, and urban) (p = 0.251). The post hoc comparison using Dunnett's T3 test indicates that the mean scores for the students in the faculties of Science and Humanities and Social Sciences are significantly different from those of the Faculty of Fisheries and Marine Sciences & Technology (p = 0.001). According to the student responses, we suggest that possible interactive teaching and learning methods must be used in online education. It is further recommended that the students spend their free time with their families and communicate with loved ones to reduce mental stress.

Keywords: Online education, Undergraduates, Mental stress, Daniel sample size formula, Dunnett's T3 test

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Zernike reconstruction of ocular aberrations with measurement noise

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The ocular aberrations (wavefront) can be used to describe the vision defects, and wavefront sensing devices (aberrometers) are used to measure the ocular aberrations (OAs). The Zernike polynomials (ZPs) are currently used in wavefront reconstruction algorithms of aberrometers. As the aberrometer measurements consist with noise, the measurements observed using aberrometers are not always accurate. It is therefore necessary to take multiple measurements from the patient in each sitting. However, taking multiple measurements also causes to induce the variations on measurements, and this variability of measurements is significant, and leads errors in clinical practice. Therefore, the variability should be taken into account during wavefront reconstruction. Consequently, unlike prior work, the accuracy of Zernike representation for the ocular aberrations with noise (due to the system noise and the variability of measurements) is studied. In the study, the noisy data is fitted using ZPs. Data sets are created using extracted data from arbitrary OAs, that is, synthetic data sets are used. Normally distributed very small random numbers are added into the data sets in order to create measurement noise. The magnitude of added noisy has been changed to range the signal-to-noise ratio (SNR) from 50.6956 dB to 31.6110 dB. The corresponding Zernike coefficients for each noised wavefront are computed, and visual acuity is used to examine the deviation of the reconstructed wavefront from the data set. The study concludes that the Zernike polynomials are not good enough to represent the wavefront with noisy level less than 38.6547 dB (signal-to-noise ration), and note that the aberrometer SNR is always between 20-30 dB. Moreover, this result is applicable for aberrometers including Shack-Hartmann aberrometer which uses Zernike polynomials as reconstruction algorithm.

Keywords: Zernike polynomials, Ocular aberration, Measurement noise

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Design and fabrication of a low cost automated tipping bucket rain gauge with locally available materials

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Rainfall measurement is a key requirement in some modern industrial and agricultural fields. Hydrological forecasting, flood control, landslide prediction and many hydrological models require accurate precipitation observations. Traditional or conventional rain gauges need time-consuming human mediation due to their manual operation. Due to the simplistic structure, ability to easily interface with an electronic controlling system, and relatively inexpensive design, the Tipping Bucket Rain Gauge (TBRG) has become one of the most popular automated rain gauges. However, for accuracy of data many such devices are required in a specific geographical area, a network of automated rain gauges. Since an automated rain gauge is an expensive instrument, a significant investment is required to install a high-resolution rain gauge network. The objective of this research is to design and fabricate a low-cost automated tipping bucket rain gauge using locally available materials and to enhance the durability with the aid of optical sensors to count the tipping bucket oscillations. The automated measuring, readout and data recording functions are controlled by a NodeMCU. The real-time updates of the rainfall information are displayed on a Liquid Crystal Display (LCD) attached to the rain gauge, and the same updates are sent to the "Thingspeak" online server. The fabricated system was tested under different conditions and maximum uncertainty was estimated as 2.09%. Accordingly proposed rain gauge can be implemented as a cost-effective solution to measure the rainfall remotely under the aforesaid uncertainty.

Keywords: Tipping bucket, Rain gauge, Precipitation, Rainfall, High-resolution

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Remotely operated ship hull painting robot

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Ship hull coating is a critical and difficult procedure in the shipping industry. This operation is usually carried out using human resources. To drive around the ship hull, this procedure necessitates two workers and a special vehicle. The cherry picker, a special carrying vehicle that requires gasoline to run is required and it raises the overall cost of the coating operation and increases the cost of repairs. However, it is not a part of the coating process and is the route to the ship's hull. Current techniques are extremely expensive and impossible to manage.

This Suggestion robot provides a solution to the problem with the current coating procedure. The key function of this robot is to paint the ship's hull without the usage of scaffolding or a special transport vehicle. Often, labour costs are reduced because only one human is required to operate the robot, and the robot is cost-effective. Another feature of this robot is that it has a high-efficiency coating process and a user-friendly remote control. Since the moving belts are driven by permeate neodymium magnets kept on the belts, the robot of ship hull painting moves on the ship hull without crashing. High torque four DC mortars control the robot's movement, as well as the paint keeping tank and spray gun used in the painting process, which rotate 180^0 clockwise and anticlockwise as the robot moves backwards. This is full control by wireless remote. The Proposed robot can solve the ship hull paint problem in the ship industry.

Keywords: Cherry picker, Painting robot, Ship hull coating

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The effect of Al_2O_3 nano-filler on ion interactions in ionic liquid based electrolytes using vibrational spectroscopy

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Ionic liquid (IL) based electrolytes are considered as safer electrolytes for future rechargeable batteries due to their non-volatility and non-flammability. To make them as electrolytes, suitable salts should be added. Lithium salts doped ILs have been studied up to a great extent, however, studies on incorporation of other salts based on sodium (Na) or magnesium (Mg) into ILs are lacking. Since ion transport properties such as ionic conductivity of these IL-salt mixtures depends on the molecular structure and interactions, observations of spectroscopic studies may help to develop these materials. In this work, ionic interactions of sodium triflate (NaTf) and magnesium triflate (MgTf) doped IL system based on 1-butyl-3-methylimidazolium trifluromethanesulfonate (BMIMTf) and alumina (Al_2O_3) nano-filler are explored by FTIR spectroscopy. The liquid electrolytes were prepared by adding a molar fraction (x = 0.1) of each salt in to IL. The 10 wt% of Al_2O_3 nano-fillller was added to each IL-salt mixture to investigate the change of solvation structure. The results clearly showed that the addition of Al_2O_3 nano-filler in to BMIMTf/NaTf mixture has a clear effect on ion interaction reducing ion-IL coordination. However, solvation structure of BMIMTf/MgTf system does not changed significantly with the addition of nano-filler. This indicates that the Al_2O_3 nano-filler is more favored to interact with monovalent cation (Na^+) rather than divalent cation (Mg^{2+}). These findings will guide experimentalists in optimizing IL-based electrolyte materials, which may enable the application of IL-based electrolytes in novel energy-storage technologies.

Keywords: Electrolytes, Ionic liquid, Nanofiller, FTIR spectroscopy

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Performance evaluation of machine learning models for epileptic seizures and brain tumor prediction from EEG

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An epileptic seizure is a symptom due to abnormal paroxysmal excessive neuronal activity in the cerebral cortex. Seizures are one of the symptoms leading to a diagnosis of a brain tumor in adults. Epilepsy is a tendency to have repeated epileptic seizures. The diagnosis is confirmed by detecting specific brain patterns of the electroencephalography (EEG). Existing work shows that epileptic seizures can be detected using machine learning methods with high accuracies. However, there is a need for classifying epileptic seizure patterns to predict possible tumors. In this paper, EEG data is used to predict possible brain tumors and classify epileptic seizure patterns using machine learning methods such as Random Forest, Logistic Regression, Naive-Bayes, and Neural Networks. We investigated the performance of these models using the EEG dataset available at the UCI machine learning repository. From the results, we concluded that the Neural Network model had the highest accuracy of 95.73% in predicting the possibility of brain tumors. Additionally, the results showed that EEG recordings taken from the tumor area and healthy area of the brain did not show a significant difference in their accuracies. The study also produced the highest accuracy of 87% from the Neural Network model by multi-classifying the EEG dataset under its five classes. Class 1, 2, and 3 originated from a presurgical diagnosis, with their epileptic zone correctly identified. Class 4 and 5 consist of EEG recording segments taken from healthy individuals with eyes open and closed respectively.

Keywords: Machine learning, Epilepsy, Electroencephalography (EEG), Neural networks, Brain tumor

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Medicinal plant leaf classification using gradient-based features

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Herbs are used since ancient times for healing various ailments in traditional medicine in various parts of the world. The identification or recognition of such plants has become a challenge for many, and the proposed method will help in overcoming these issues through classification of leafs using gradient-based features and Nearest Neighbour classifier in Support Vector Machines (SVM). The pre-processing steps involve binarization using Otsu's method, noise removal using median filter and resizing. After preprocessing, the preprocessed leaf image will be extracted and the gradient-based features will be analyzed using Scale Invariant Feature Transform (SIFT) where local will be based on the appearance of the object at a particular interest point, and moreover Histograms of Oriented Gradient (HOG) will be employed to focus on the structure or the shape of an object since Nearest Neighbour Classifier is used for Medicinal Plant Leaf classification in comparison with SVM-based classifiers. The proposed method is evaluated on 15 different leafs of medicinal plants consisting of 40 images per leaf. The recognition rate observed are 86.67% using SIFT and 87.78% using HOG. Testing results show that HOG descriptors significantly outperform the SIFT descriptors.

Keywords: HOG, SIFT, SVM, Medical plant leaf classification, Gradient-based features

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Performance prediction in time-sharing servers using simulation approach

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Although the concept of time-sharing was invented a long time ago to make better use of expensive processor time, it is still in use and applicable in the current era. To provide excellent customer service while minimizing operating and capital expenses, server performance must be managed efficiently and effectively. Consequently, it is necessary to assess the performance of a new time-sharing server to ensure that it performs as expected, prior to deployment. It is also crucial to analyze how an existing time-sharing server operates under various circumstances. As a result, it is vital to have a model that can predict server performance measures under varying load levels and server configurations. Identified parameters of the system are server parameters which are number of CPU cores, average processing time, maximum kernel-thread pool size, time quantum that causes a currently running thread to be preempted, context switch overhead, and load parameters which are number of concurrent users and their average think time. When measuring the performance (latency and throughput) of a time-sharing server, the previous work has not taken into account all of the parameters. By doing a thorough literature review, two approaches were identified (analytical modeling and simulation modeling) to create a model with above parameters, and discrete-event simulation (DES) was selected with its pros and relevancy for the study. As the initial experiments, we tested numerous scenarios by using the built DES model to review the effect of each parameter on the performance of time-sharing server and results were graphically represented.

Keywords: Time-sharing, Server-performance, Simulation

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IoT-based monitoring system for a telecommunication tower

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The internet of things (IoT), is a futuristic technology in which an object can be sensed, monitored, and controlled remotely using a cloud server network. The proposed IoT-based remote cell tower monitoring system has been introduced to address challenges in the operation and maintenance of remote telecommunication towers to a desired level. It will automatically monitor devices, update status, and produce alerts for different conditions. System users can monitor the cell tower status remotely via webpage and send sms alert when needed. The implemented system consists of a microcontroller as the main processing unit for the entire system. The process for input parameter collection is done through several sensor modules. In this proposed design, the transmitter section would be installed in the cell sites to monitor the desired conditions of the tower base house equipment such as generator, the battery, and the air conditioner. The information about desired parameters is sent to the operator through a Graphical User Interface (GUI) based application. The notifications about several faulty situations also can be sent to the user (site operator) via the GSM module for an update. In conclusion, implementing this kind of system will improve the proper management of the operation and maintenance of a remotely situated telecommunications tower.

Keywords: Internet of things, IoT, Remote monitoring, Telecommunication towers

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Implementation of an IoT-based smart pet clinic web application

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In the existing Sri Lankan culture, raising a pet has become an engrossing hobby. Nevertheless, pets can't raise with the busy lifestyle of humans. There are a variety of pet clinics, co-ordinations, applications, pet shows for pet's welfare. The root cause for this project was "How to implement a functional web application for a pet clinic, for its veterinarians, and pet owners to manage and communicate over an online platform". After identifying that problem, the project was started by following the Software Development Life Cycle's (SDLC) steps. Requirement analysis, design, implementation & coding, testing, and maintenance are the main five steps in SDLC. Throw-way, prototyping was used here as the methodology to repeat the design prototypes. Every specific technique for each step of the SDLC were used to develop the web application successfully. Pet collar feature is going to introduce to provide up-to-date health data of the pet to both pet owner and the pet clinic by applying Internet of Things technology for the use of Sri Lankan customers. Temperature, blood oxygen level, heart rate, location of the pet can identify by this pet collar. Admin, veterinarians, and pet owners were considered as main users. Customer and admin have two separate interfaces in the web application. Home, About, Services, Pet Shop, Appointment, Pet collar, Frequently Ask Questions and Contact were the main pages in customer interface. The web application named as HI PET. Ultimate result is a functional web application for Sri Lankan pet clinics.

Keyword: Pet Clinic Web application, Pet care systems, Pet collar

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A study on frequently used utility features of integrated development environments by programmers

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An Integrated Development Environment (IDE) is a software suite that brings together the essential utility features for computer programming. Even though several previous studies had been conducted by reputable scholars by elaborating the fundamental characteristics of IDEs for different programming languages, the particular discipline lacked an understanding of frequently used individual utility features provided with different IDEs. Therefore, this study was conducted with the intention of identifying frequently used utility features of IDEs by software developers to provide a comprehensive illustration for future studies on finding the impact of utility features on the programming skills of software developers. The top seven IDEs according to the market share were considered for the study. A deep systematic literature review was conducted to identify the most frequently used IDE utility features and their characteristics in terms of modern IDEs. In addition to that, twelve senior software professionals of the well-established software companies were interviewed to have a thorough conceptualization and validation according to the industry experiences. According to the findings of the study, Autocompletion, Error detection and Quick Fixes, Refactoring, Version Controlling, Debugging, Keyword Search, Go to Definition and Explorer were identified as the most frequently used utility features of integrated development environments by programmers. All these utility features increased the efficiency and productivity of programming tasks while creating a hidden cost in terms of using these IDE utility features. This opens a study area to research the impact of using IDE utility features on the programming skills of software developers.

Keywords: Integrated development environment, IDE, Utility features of IDE, Frequently used IDE features

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Identifying the authenticity of registered participants for an online Zoom session: A conceptual architecture

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The Covid-19 pandemic has resulted in drastic changes in the educational sector. Due to the social distancing health regulations, the education systems all around the world have adopted a distance and digitalized learning/teaching method. Learning and teaching in a digitalized classroom has its own benefits and limitations. This research focuses on a technical drawback that makes teachers unable to detect whether participants of a session are authorized participants or not. The given solution is a conceptual framework which is suggested as an add-on feature in Zoom. Using this feature, teachers can detect the authenticity of participants. According to the proposed framework, images of participants are captured automatically within a defined time interval. This is done by manipulating the camera and making the preview invisible. The captured images are sent to the Zoom cloud to authenticate the identity of the participant. A classifier model is trained using image feature vectors for authentication. Technologies and libraries like face embedding, Artificial Neural Network (Keras and Tensorflow), and OpenCV are used for this process. If proven to be genuine participants, they are accepted to the meeting from the waiting room. The validity of the participant in the session is checked time to time. Periodically captured images are sent to the participant validation. If a participant is detected as invalid during these occasions, he is removed from the session to the waiting room after alerting the host. Since this is a conceptual framework, it is required to be validated empirically. The host's inability to capture the images of participants, if they have not given initial camera access to Zoom and the cloud storage capacity depending on the number of participants are few limitations of this framework. However, it is ideal for online exam proctoring and paid online classes.

Keywords: Authentication, Framework, Image processing, Neural networks, Online sessions

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A novel approach for enhancing the patent authentication and management process using blockchain technology

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Patent authentication and management (PAM) protects individual and organizational intellectual property rights across the world. Patents are territorial, and patent applications are handled by local intellectual property (IP) authorities. As a result, the inefficient and time-consuming nature of the PAM process occurs on a global scale. Because of data management problems in the patent procedure, there are conflicts and legal proceedings among the applicant parties. Blockchain provides decentralized, secured, and transparent systems with immutable records. As a result, it might be seen as an innovative approach to patent domain challenges. The purpose of this study is to demonstrate how blockchain technology may help improve the PAM processes. Interviews with relevant stakeholders and literature reviews were conducted to determine the procedures and constraints of the present system. A novel architecture and a prototype of a consortium blockchain-based system compromising smart contracts was designed to solve such restrictions and constraints. In the proposed model, the consensus procedure is carried out by the World Intellectual Property Organization and Regional IP Offices. Finally, it was tested in a simulated environment with generated actors and data. The current study established the reliability of patent data and the efficient real-time updating of records at a reasonable cost. As a result, the patents filed for this network have gained credibility among IP offices. With this method, it is simple to approve or reject patent applications without relying on a single IP office. This prototype model demonstrated a significant improvement in propagating evidence of first ownership and assisting in the reduction of a significant number of litigations. Furthermore, this research demonstrates the blockchain system's position as a distributed database, which aids in the cross-validation of reliable systems such as secure government document management processes.

Keywords: Consortium blockchain, Patent authentication and management, Smart contracts, Ethereum

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