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Multidisciplinary Research for Tomorrow's challenges

YSCMR 2021

21st October 2021

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ACKNOWLEDGEMENTS

We are extremely proud to note the successful completion of the Young Scientists' Conference on Multidisciplinary Research (YSCMR) 2021, organized by the Young Scientists' Association of the National Institute of Fundamental Studies (NIFS-YSA). Without the unanimous contribution by many, this event would not have been a success. Thus, we would like to express our deepest gratitude to all those who helped us in numerous ways!

We would like to thank the Chairman Prof. Athula Sumathipala, Acting Director Senior Prof. Ranjith Premalal De Silva, Acting Secretary Prof. Lalith Jayasinghe, Editorial committee members and Advisory Committee, NIFS-YSA for their valuable guidance and encouragement.

We also thank the Director's office, Science Education and Dissemination Unit, Accountant and the Accounts Division, Administrative Officer and the Administrative division of the NIFS for the tremendous support rendered.

MESSAGE FROM THE CHAIRMAN, NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES

I am delighted to send this message in my capacity as the Chairman of the National Institute of Fundamental Studies, which is a prestigious premier research institution in Sri Lanka.

This is once again an unprecedented event, as it was undertaken for the second time during the COVID 19 global challenge. In spite of all the challenges and restrictions to gather face to face, the Young Scientists Association (YSA), which is a part of the NIFS, has done a commendable marvellous job in organising this conference. It has successfully received 174 abstracts of which, 79 would be oral presentations and 63 presented as speed-talks.

Organising a conference of this magnitude is a huge challenge. Organising a conference of this nature at a time of a pandemic is much more difficult. However, the Young Scientists Association has lived up to the expectation. YSA, which is comprised of postgraduate students, undergraduate students and volunteers at the NIFS are continuing to consolidate their activities. COVID -19 has beyond any doubt has reiterated the significant role of science, technology and research globally. The powerful nations, which has a relatively higher capacity for science, technology and research managed to produce vaccines within a short period of time. Most of the Low and Middle Income Countries have less capacity and human resources for science, technology and research and clearly lags behind.

The lasting legacy of the pandemic is to recognise these gaps and develop sustainable capacity for preparedness. The knowledge sharing exercises such as this Young Scientists Association conference can provide incremental contributions along the right direction.

I would like to thank the organizing committee for asking me to share my thoughts. I would once again like to congratulate the Organising Committee for the spirit and courage shown in holding this event in spite of COVID -19 challenges.

Professor Athula Sumathipala
Chairman,
National Institute of Fundamental Studies,
Hanthana Road,
Kandy.

MESSAGE FROM THE DIRECTOR, NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES

I am pleased to send this message to the Young Scientists Conference 2021, organized by the National Institute of Fundamental Studies (NIFS) Young Scientists Association. NIFS is the premier national institute for fundamental research in Sri Lanka founded in 1981 and it marks its existence of 40 years serving the nation. The institute takes pride in securing the services of a large group of senior scientists while providing opportunities for young scientists to be involved in advanced fundamental research at the institute. Our scientists supervise postgraduate research students both local and overseas in variety of fundamental science disciplines. Over the last 40 years, NIFS has provided a training venue for over 1,600 graduate students, at Masters and Doctoral studies in chemical, physical, biological, environmental and social sciences. The publication profile witnesses the contribution of the institute towards the furtherance of science and knowledge sharing domain. The institute has secured state-of-the art laboratories with testing facilities and is in the process of expanding its services in testing and quality assurance. As a part of NIFS 'leadership development program' for young researchers, NIFS Young Scientists' Association (NIFS YSA) was established in 2018 to introduce a conducive environment for advanced fundamental research and a vibrant research culture. In line with our corporate objectives, NIFS-YSA is recognized as a well sought-after platform for our young scientists' to develop their research careers. In 2019, the NIFS-YSA organized its first annual research symposium, enabling young researchers within NIFS to present and share their research and the initiative was continued in 2020 reaching large number of national and international institutions and securing their contributions at the conference.

In 2021, NIFS-YSA came forward to join hands with the activity portfolio of 40-year celebrations and ensured the activities in the new normal are safe and secure within the health guidelines. While congratulating the members of the organizing committee, advisory committee and editorial committee for the successful launch of YSCMR in 2021, I wish all the success in every activity towards ensuring a better research culture in Sri Lanka.

Senior Professor Ranjith Premalal De Silva,
Acting Director,
National Institute of Fundamental Studies,
Hanthana Road,
Kandy.

MESSAGE FROM THE CHAIRPERSON, NIFS- 40TH ANNIVERSARY CELEBRATION

This year is a special year for the National Institute of Fundamental Studies, as we are completing 40 years since the establishment of this institute. Being a person who has seen the institute since its early days, I consider it an honour and privilege for me to write this message as the Co-Chair of the 40th Anniversary Commemoration Committee.

Basic and fundamental researches are essential for a country to stay ahead in knowledge. A country that relies on other countries for knowledge will always stay behind. Further, unique and local issues need to be addressed in local context. Realising this fact, the then Institute of Fundamental Studies was established by an Act of the Parliament in 1981. The founding director was Prof. Chandra Wickramasinghe. In 1985, late Prof. Cyril Ponnamperuma, the second director, brought the institute to Kandy and developed it into a fully fledged research institute with modern laboratory facilities. During last four decades, this institute has gone through different phases of development, produced a number of excellent scientists, inventors and academics, and contributed immensely to the scientific knowledge and to the national development. As the only institute in Sri Lanka mandated to conduct basic and fundamental research, the NIFS plays a unique role, both in knowledge generation and dissemination. Conferences, workshops and colloquia are essential parts of dissemination of science.

This year's Young Scientists' Conference on Multidisciplinary Research is held as a part of the 40th Anniversary Commemoration events. The Young Scientists at the NIFS continued with this conference despite the additional challenges we are facing this year.

Many distinguished scientists agreed to deliver keynote speeches and public webinars. The overwhelming number of abstracts submitted to the conference is evidence for the level of interest, especially amongst the younger generation of scientists. I wish to thank all those who worked hard and contributed to the40th Anniversary events, including the Chairman, Director, organising committee, reviewers, authors, sponsors, as well as academic and non-academic staff of the NIFS. I wish this conference a success.

Prof. Deepal Subasinghe
Chairperson,
40th Anniversary Celebration,
National Institute of Fundamental Studies,
Hanthana Road,
Kandy.

MESSAGE FROM THE ADVISORY COMMITTEE, NIFS - YOUNG SCIENTISTS' ASSOCIATION

It's a great pleasure to write this message on behalf of the advisory committee of the Young Scientists Association (YSA) of the National Institute of Fundamental Studies (NIFS). It is a very proud moment for the advisory committee as, the Young Scientists Association of NIFS, organizes its third consecutive research conference; 'Young Scientists' Conference on Multidisciplinary Research 2021 (YSCMR 2021)". YSCMR 2021, is held as a virtual conference, adhering to the health guidelines given by the Government of Sri Lanka under the pandemic situation due to COVID-19. This year, the virtual platform and the successful history of the conference, have been helpful to attract a large number of abstracts of research conducted in different parts of the world under the themes of Biological Sciences, Chemical sciences, Physical Sciences and Social Sciences.

Carrying the theme, "Multi-disciplinary research for tomorrow's challenges", YSCMR 2021 has given the opportunity, not only for local and international early career researchers and postgraduate students to present their research, but also for the organizing committee who are the young scientists of the National Institute of Fundamental Studies, to build up their team spirit by working together, to make this event a success.

As the advisors of the YSA, working with the young scientists of the NIFS has been an immense joy, to experience the enthusiasm, leadership qualities and determination of the organizers of the YSCMR 2021. Organizing this event was challenging from the beginning due to the unexpected lockdowns imposed in the country to control the COVID-19 pandemic. However, with the commitment and dedication of the organizing committee, the event has now come to a reality and, we would like to congratulate the organizing committee and all the presenters of YSCMR 2021.

YSCMR 2021, is a significant event for the NIFS this year, since this is organized as a key event of the series of celebrations to commemorate the 40th anniversary of the NIFS. As the advisors of the YSA we would like to thank our keynote speaker, Professor Panduka Karunanayake and our guest speaker Prof. Tom Welton for accepting our invitations and delivering the speeches. We hope that the young scientists will get inspired by their talks and we hope that this event will create new collaborations among the participants and will be an unforgettable experience.

Dr. Shalini Rajakaruna
Advisor
Young Scientists' Association
National Institute of Fundamental Studies.

MESSAGE FROM THE EDITOR-IN-CHIEF, YSCMR 2021

The YSA is conducting the third international annual conference on multidisciplinary research for young scientists. This year too, the conference is conducted in a virtual mode, a consequence of the Corona pandemic, which we yet to come to terms with. This year also marks the 40th anniversary of the founding of the NIFS, and this conference is a part of the anniversary celebrations.

Organizing this conference is a formidable task. It is more so when the activities need to be coordinated between different disciplines, finding and obtaining the consent of reviewers on subjects that are quite foreign to the students, handling the reviews, corresponding with the authors and reviewers amongst other activities. When you add another dimension of conducting all this in a virtual mode, the tasks go beyond the realms of a formidable challenge.

The YSA in general, and the teams of research assistants behind this conference in particular, have gone beyond their call of duty, attending to the minor and major details to make this conference a success. They made my task of handling over 170 abstracts not only easier, but also a pleasant one.

I wish to place on record my sincere gratitude to the co-editors on the editorial board who did a tremendous job in handling the different disciplines in finding reviewers for the abstracts, besides corresponding with the authors and reviewers. We are extremely thankful to our reviewers for the insightfulness of their reviews and improving the standards of the published abstracts. I also thank the Science Education and Dissemination Unit (SEDU) and the Computer Unit of the NIFS for handling the technicalities of conducting six parallel sessions effectively.

Prof. M.C.M. Iqbal
Editor,
Young Scientists' Conference on Multidisciplinary Research 2021,
National Institute of Fundamental Studies,
Hanthana Road,
Kandy.

MESSAGE FROM THE CONFERENCE ORGANISERS, YSCMR-2021

It brings us great pleasure to write this message on behalf of the organizing committee of the Young Scientists' Conference on Multidisciplinary Research (YSCMR), 2021 organized by the Young Scientists' Association of the National Institute of Fundamental Studies (YSA-NIFS). YSCMR 2021 is the 3rd consecutive research conference organized by the YSA-NIFS and this year we have taken a step forward in organizing an International conference, opening opportunities for the international research community. With the existing COVID-19 pandemic this year too we accepted the challenge in organizing the conference as a virtual conference for postgraduate students and early career researchers. NIFS is celebrating its 40th anniversary this year, and it was a great honor for the young scientists of NIFS to contribute by organizing this conference as a part of the celebration.

The YSA was established in 2018 and since its inception, the YSA has been a very active organization within the NIFS, organizing and conducting events to mould and groom the future scientists of Sri Lanka. YSA includes postgraduate students, undergraduates and volunteers of NIFS who engage with research at the NIFS. The aim of the YSA is to support early career researchers to achieve research excellence. We engage with activities as a community of young people encouraging members to share their knowledge, improve their research skills and also develop their personalities while working in unity and a sense of team spirit within the institution. With the theme of Multidisciplinary Research for Tomorrow's Challenges, the conference was organized under four themes; Biological Sciences, Chemical Sciences, Physical Sciences and Social Sciences, for which we received more than 170 abstracts from both Sri Lankan and foreign students. Organizing an event of this scale especially as a virtual event and with the travel restrictions within the country was truly a challenge for the organizing committee. This event would not have been a success without the immense support given by our fellow research assistants at NIFS. Their dedication and contribution gave true meaning to what teamwork is. We also would like to thank the former co-chairs of the YSA for creating a strong foundation for us to continue this venture. We also take this opportunity to thank the Chairman- NIFS, Acting Director-NIFS, Editor-in-Chief, Editorial Committee, Advisors of YSA, for their guidance and encouragement throughout the process. Also, our heartfelt gratitude goes to the expert panel of reviewers, chairpersons of technical sessions, scientists and administrative staff of NIFS for their support to make this event a reality. We would also like to thank the support given by the Science Education and Dissemination Unit (SEDU) of NIFS for their immense support in organizing the sessions and the valuable guidance. And also, we extend our heartfelt appreciation to our Keynote Speaker, Prof. Panduka Karunanayake and Guest Speaker, Prof. Tom Welton for accepting our invitation and delivering their valuable and timely speeches at the conference. We would like to congratulate all the presenters of YSCMR 2021 and hope this virtual conference will give you the opportunity to network and share your knowledge with the research community from around the world.

Umair Kaleelullah
&
Kavindya Samarakoon
(Co-chairs, YSCMR 2021)

Maheshika Perera
&
Lasanga Amarasena
(Co-chairs, NIFS-YSA)

List of Abstracts

BIOLOGICAL SCIENCES

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Development of gelatin (pharmaceutical by-product) based dog food

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Background: The pet food market is a well-established industry in developed countries, but it plays a minor role in Sri Lanka. Instead of importing dog food, there is a potential to manufacture dog food in Sri Lanka.

Objectives: This study was conducted to develop a gummy like textured dog food using pharmaceutical by-product gelatin (PBG), poultry by-product meal (PBM) and Gotu kola (*Centella asiatica*) in order to achieve a low-cost pet food by using industrial by-products available in Sri Lanka.

Methods: Using different percentages of the above raw materials, eight different types of dog food formulation were processed to select the best suitable gummy liked dog food. The selected dog food formulation was composed of 90% of PBG, 8% of PBM and 2% of Gotu kola. According to the above percentages, PBG was melted by using a hot plate, and both mixtures of PBM and Gotu kola were mixed with melted PBG, and the mixture was poured into a moulder and allowed to cool at room temperature. Physiochemical and microbiological qualities were analyzed for a period of four weeks at weekly intervals. A palatability test was performed using four to five month old four local crossbred dogs for a period of two days.

Results: Proximate composition, moisture content, crude protein (CP) and crude fat (CF) content of the dog food were 16.27%, 75.33% and 3.51%, respectively. The pH and total variable aerobic plate count in prepared dog food changed significantly ($p<0.05$). Palatability of prepared dog food was very high as the dogs had consumed all the supplied daily allowance of the pet food very fast. Digestible crude protein value of selected dog food was 82.64%.

Conclusion: The developed dog food with 90% of PBG, 8% of PBM and 2% of Gotu kola could be used as a dog treat with its high palatability and digestibility.

Keywords: *By-product, Dog food, Gelatin, Gotu kola, Gummy*

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Validation and psychometric properties of the sri lankan version of the fear of COVID-19 scale

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Background: The Coronavirus-19 disease (COVID-19) outbreak has created unprecedented mental health issues among the general population. The Fear of COVID-19 tool was developed to assess the severity of COVID-19-related fear.

Objectives: The goal of this study was to validate the Fear of COVID-19 Scale (FCV-19S) into Sinhala and Tamil languages for the Sri Lankan context.

Methods: A cross-sectional validation study was conducted using online technology (online form, emails and social media) based on the snowball sampling method from 17th March – 24th March 2021. The FCV-19S was translated into Sinhala and Tamil using the forward-backward translation process. Both the forward and backward translations of the scale were assessed and evaluated for cultural appropriateness among the investigators.

Results: A total of 286 Sri Lankan adults had participated in the study. The mean age of the total sample (n=286) was 26.23 (±5.04), with a majority (78.7%) belonging to the age group between 18-29 years, while 82.9% were female participants. The study showed both the Sinhala version and Tamil version of the FCV-19S had strong internal consistency as demonstrated by high Cronbach's alpha (0.849 and 0.878, respectively). In terms of concurrent validity, the Fear of COVID-19 Scale (FCV-19S) and the Kessler's psychological distress scale (K6+ scale) had positive correlation (Sinhala version- r 0.305, p= 0.001, Tamil version-r = 0.306, p= 0.001). Original factor structure with one dimension did not show good fit to both subsets of data (Sinhala subgroup CFI -0.836, TLI-0754, RMSE – 0.205, SRMR-0.094, Tamil subgroup CFI -0.820, TLI-0730, RMSE – 0.232, SRMR-0.099). A two-factor model (with physical and emotional outcomes /domains of fear) was the best-fitted model to both subsets of data (Sinhala subgroup TLI-0.900, RMSEA-0.125 Tamil subgroup- TLI -0.889, RMSEA-0.146).

Conclusion: The cross-culturally adopted FCV-19S appears to be a reliable and valid tool for assessing COVID-19 fear among Sri Lankans, with good psychometric properties.

Keywords: *Fear of COVID-19 scale, Psychometric properties, Validation, Sri Lanka*

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Comparative analysis of the nutritional profiles of bitter gourd (*Momordica charantia*) and spine gourd (*Momordica dioica*) grown in Sri Lanka

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Background: Bitter gourd (*Momordica charantia*) and spine gourd (*Momordica dioica*), locally identified as *Karavila and Thumba karavila*, respectively, are commonly consumed popular vegetables in Sri Lanka and some Asian countries.

Objectives: This study was conducted to evaluate the comparative nutritional profiles of fruits of *M. charantia* and *M. dioica*.

Methods: Healthy and undamaged fruits of medium maturity were collected using a stratified random sampling design from all agro-climatic zones. Composite samples were prepared by oven drying a portion of the sample at 45 °C and freeze-drying the rest. Proximate composition, mineral contents, fatty acid profile and vitamin composition were determined using standard procedures and presented on a fresh weight basis.

Results: Between studied two *Momordica* species, *M. charantia* contained the highest quantities ($p<0.05$) of protein (1.28±0.05%), dietary fibre (3.68±0.11%), Fe (1.09±0.02 mg/100 g), polyunsaturated fatty acids (linoleic acid - 8.35±0.10 mg/100 g and α-linolenic acid - 14.06±0.22 mg/100 g) and vitamin A (68.30±0.61 μg/100 g). *M. dioica* comprised of the highest ($p<0.05$) contents of ash (1.18±0.09%), total carbohydrate (7.28±0.05%), almost all essential minerals (Ca, Mg, K, Na, Ba, Zn, Mn, Cu, Sr, Rb, Al, Co, Ni, Se, Mo, V, Ga, Bi, Li and Be), and vitamins D_2 (2.43±0.00 μg/100 g), K_1 (5.04±0.05 μg/100 g), E (21.06±0.88 μg/100 g), B_1 (94.94±0.13 μg/100 g), B_2 (75.79±1.17 μg/100 g) and C (134.73±2.05 mg/100 g). Among highly concerned heavy metals, higher ($p<0.05$) Cd (0.47±0.07 μg/100 g), As (0.48±0.01 μg/100 g) and Cr (10.09±0.22 μg/100 g) contents, were found in *M. charantia*.

Conclusion: Between two nutritional profiles, the nutritional significance of *M. dioica* was superior to *M. charantia*. Higher heavy metal contents found in *M. charantia,* which is more commercially cultivated than *M. dioica*, might result from malpractices of cultivation, packaging and storage.

Keywords: *Momordica, GLC, HPLC, ICP-MS, Proximate composition*

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Antibacterial and anticandidal activities of the fungus inhabiting the Sri Lankan lichen *Parmotrema* sp.

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Background: Bioactivities of lichen inhabiting fungi are being harnessed for applications in various areas worldwide. Due to increasing microbial resistance to commonly used antibiotics and reduced effectiveness of standard drugs, the achievement of natural bioactive compounds has been paid more attention. Therefore, it is timely to explore the antimicrobial potential of Sri Lankan lichen inhabiting fungi**.**

Objectives: This study was carried out to determine the antibacterial and anticandidal potential of fungi inhabiting the Sri Lankan lichens.

Methods: The lichen, *Parmotrema* sp., was collected from Samanalawewa wilderness, Sri Lanka, for the study. A fungus associated with the lichen was isolated by plating surface-sterilized thallus pieces onto potato dextrose agar medium and emerging fungal tips from the plated pieces were transferred onto a fresh medium to obtain pure cultures. Colony characteristics and micromorphology of the pure culture of the fungus were also examined. Crude extract was obtained from the fungal isolate *via* solvent extraction using ethylacetate (EtOAc). Then the EtOAc extract was screened in triplicate for antibacterial and anticandidal activities by agar disk diffusion assay with disks containing 0.168 mg/µl and 0.336 mg/µl disk strengths using bacteria*: Escherichia coli* (ATCC® 25922), *Pseudomonas aeruginosa* (ATCC® 27853) and *Staphylococcus aureus* (ATCC® 25923) and a clinical isolate of *Candida albicans*. Ciprofloxacin and Fluconazole were used as positive controls for the antibacterial and anticandidal assays, respectively.

Results: EtOAc extract showed antimicrobial activity against gram positive and negatives as well as *Candida*. The diameter of the inhibition zones (mm) were reported as 2.73±0.26, 2.58±0.03, 1.55±0.05 and 9.91±0.18 for 0.168 mg/µl and 5.91±0.19, 16.10±0.36, 19.64±0.17 and 10.26±0.16 for 0.336 mg/µl against *Escherichia coli* (ATCC® 25922), *Pseudomonas aeruginosa* (ATCC® 27853), *Staphylococcus aureus* (ATCC® 25923) and *Candida*, respectively.

Conclusion: Therefore, the isolated fungus inhabiting the lichen *Parmotrema* sp. can be suggested as a good candidate for further research of screening antibacterial and antifungal properties. Molecular identification of isolated fungus and the isolation of bioactive compounds should be carried out in order to get a more accurate understanding.

Keywords: *Lichens, Bioactivities, Parmotrema sp., Trichoderma virens, Antimicrobial activity*

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Community-based Mango tree planting to meet the prevailing climate change challenges in the Sammanthurai area

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Background: Overcoming the prevailing Climate Change Challenges (CCC) in Sri Lanka is vital for the development of the nation. Conservation and restoration are the natural solutions to increase carbon storage to prevail over greenhouse gas emissions in landscapes. Participation of the general public in tree planting could contribute to mitigating climate change to some extent.

Objectives: To identify the feasibility of implementing community-based mango tree planting to overcome prevailing climate change challenges.

Methods: The Sammanthurai Divisional Secretariat Division (DSD) in the Eastern province of Sri Lanka was selected for this study. Interviews, field surveys, site inspections, and Questionnaire Surveys were used to gather primary data from the Department of Agriculture and DSD Office. Data from DSD annual reports and Census Department reports were used as secondary data. Public interest in planting a mango tree was assessed. Soil condition and soil pH were measured at different locations. The climatic requirements for mango were evaluated. The cost, technical, financial, and environmental benefit analyses were done.

Results: About 84% of the public is interested in planting a mango tree in their home garden, and 12% are willing to grow it as commercial farming. According to the experimental results and site observations, the soils in this study area were identified as quite suitable for Mango tree planting. The study area will be financially benefited by Rs. 684.4 million as Net Present Value (NPV) with 66.96% of Internal Rate of Return (IRR) for the yield period of 15 years. It will also increase the mango productivity of the country by one percent annually.

Conclusion: The proposed Mango tree planting to prevailing CCC in the Sammanthurai area is financially and environmentally viable. The proposed Mango tree planting is to be implemented to develop the nation and safeguard the environment with natural solutions.

Keywords: *Climate change, Mango tree, Tree planting, Natural solution*

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Preparation of *Moringa oleifera* incorporated toothpaste and comparison of its properties with commercial preparations

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Background: In novel dentistry, most herbal toothpastes are more acceptable and safer with minimum side effects than synthetic preparations. *Moringa oleifera* is also known to be an effective agent to be used in non-invasive dentistry attributable to its composition.

Objectives: To formulate herbal toothpaste by incorporating the leaves of *M.oleifera* to evaluate and compare the formulated toothpaste with commercial preparations.

Methods: The toothpaste base formulation was optimized and incorporated with *M.oleifera* leaf powder to develop the *Moringa* toothpaste. It was evaluated for selected physicochemical properties, including pH, spreadability, foamability, and moisture content. The anti-bacterial activity of the *Moringa* toothpaste was evaluated against oral pathogenic bacterium *Staphylococcus aureus* using the disc diffusion method. The evaluated properties and anti-bacterial activity were compared with those of commercial preparations.

Results: The leaf powder percentage to be incorporated into the optimized toothpaste base formulation was selected as 5 % (w/w). The tested physicochemical properties including pH, spreadability, foamability, and moisture content were found to be 6.26, 4.32 cm, 15.5 ml, and 43.6% for the *Moringa* toothpaste and 6.26-9.67, 5.36-5.95 cm, 10-23 ml, and 22-39.6 % value ranges for the commercial preparations respectively. Accordingly, the *Moringa* toothpaste showed equal or near physicochemical properties to those of commercial preparations. The anti-bacterial activity of the *Moringa* toothpaste with a zone of inhibition (ZOI) of 1.67±0.029 cm was found to be comparable with that of a commercial preparation (ZOI=1.716±0.076 cm).

Conclusion: This study concludes that the herbal-based toothpaste formulation incorporated with the natural ingredient *M. oleifera* leaf powder shows acceptable and comparable properties with the selected commercial toothpaste preparations.

Keywords: *Anti-bacterial activity, Comparative study, Moringa oleifera, Toothpaste*

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The effect of light intensity on seed germination and early seedling development of Chilli plant: *Capsicum annuum* L.

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Background: Chilli (*Capsicum annuum*) is an important herb used in traditional medicine and an essential ingredient in meals in Sri Lanka. Seed germination is a critical process affecting crop yield.

Objectives: The current study investigated the effect of different light intensities on seed germination and early seedling development of *C. annuum*, commercially important Chilli variety MI-II.

Methods: The experiment was carried out in a completely randomized design with four replicates in greenhouse conditions at 25±5 °C (day and night) in 60% relative humidity. Seeds were germinated under four constant light intensities, 70, 115, 220 $\mu molm^{-2}s^{-1}$ and complete darkness (as a control group), using white LED lights. The photoperiod of 16 h was maintained for the treatments. Light intensities were measured using a calibrated LUX meter. At the end of the experiment, germination percentage, seedling length (cm), and dry seedling weight (g) were measured. Seedling vigour index I and II were calculated. Data were analysed using a one-way ANOVA statistical test.

Results: Seed germination percentage under 220 $\mu molm^{-2}s^{-1}$ light intensity was significantly higher than that under other treatments (97%). Seeds of the control group showed the lowest germination percentage (55%). However, seeds under complete darkness had the highest seedling development while seeds under 220 $\mu molm^{-2}s^{-1}$ light intensity had the lowest seedling development when all the growth characteristics measured are concerned. The statistical analysis showed that germination and seedling development were significantly different among different light intensities. ($P<0.05$)

Conclusion: Present investigations showed that light intensity plays an important role in seed germination and seedling development. High light intensity (220 $\mu molm^{-2}s^{-1}$) increases the germination, and low light intensity (70 $\mu molm^{-2}s^{-1}$) decreases the germination of *C. annuum* seeds. However, low light intensity increases seedling development, and high light intensity decreases seedling development. The effect of light intensity on improving chilli yield should be further studied.

Keywords: *Germination percentage, Light intensity, Vigour index*

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Development and evaluation of healthy multigrain wheat free bread from locally available flours in Sri Lanka

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Background: Strong evidence from contemporary studies indicates that intake of refined grain, more particularly wheat flour bread, is widely assumed to be associated with adverse health outcomes, including increased risk for cardiovascular disease (CVD), type 2 diabetes (T2D) and obesity.

Objectives: To evaluate the feasibility of replacing the wheat flour with locally available flours of rice (*Oryza sativa*), and foxtail millet (*Setaria italica*) in bread making.

Methods: The preliminary sensory study and physical quality characteristics of bread were used to determine the optimum percentage of baking powder (0.3g/100g flour) and fermentation time (3 hrs) and this optimal combination was used in further studies. Then optimum level of flour combination for bread making was found out based on the physical and sensory attributes of the bread. Extracted gluten (10g/100g flour) was required to be added to this flour combination to improve the texture. Proximate analysis was conducted and compared the product with wheat flour bread.

Results: The combination of unpolished (45g/100g), polished (45g/100g) and foxtail millet (10g/100g) was identified as the ideal combination for bread making. The proximate results showed that the wheat free bread was in an acceptable quality consisting of moisture (38.69g/ 100 g DW), 6.72% fat, 15.83% protein, 2.7% ash, 1.59% fibre, 36.76% total sugar and 13.43% reducing sugar. Wheat flour bread consisted of moisture (33.94g/ 100 g DW), 4.7% fat, 10.72% protein, 2.1% ash, 0.92% fibre, 37.06% total sugar and 21.83% reducing sugar. Nutrient content of the developed bread is significantly ($p<0.05$) higher than the normal bread.

Conclusion: These findings were promising and the developed multigrain bread can be used as an alternative for wheat flour bread based on the physical quality and nutritional benefits and to popularize locally available raw materials.

Keywords: *Foxtail millets, Rice flour, Bread, Gluten*

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Impact of germination on carbohydrate composition, gelatinization and functional properties of Kodo millet (*Paspalum scrobiculatum*) grain flour

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Background: Millet is type of a cereal belonging to the family Poaceae. The utilization of millets in functional food formulation is high in developing countries. However, except finger millet, other millet types including *Paspalum scrobiculatum* (Kodo millet) are still found to be underutilized in Sri Lanka. Thus, it is very important to analyse the possibility of incorporating such food sources in novel food products in the food processing industry. In this study, more attention is on improving the existing nutritional and physicochemical qualities in selected *Paspalum scrobiculatum* flour by germinating, which is considered as an inexpensive and effective pre-processing technique.

Objectives: The current study investigated the variation in carbohydrate composition, gelatinization parameters and functional properties of *Paspalum scrobiculatum* grain flour upon germination.

Methods: *Paspalum scrobiculatum* grains were germinated for 72 hours and then they were dried and ground to obtain flour. The standard analytical methods were followed in determining carbohydrate composition (total starch, amylose and amylopectin, total dietary fiber), some functional properties (water holding capacity (WHC), oil holding capacity (OHC), swelling power and water solubility), and gelatinization parameters of germinated and non-germinated samples of *Paspalum scrobiculatum* flour.

Results: Total starch, amylose and amylopectin contents were significantly ($p<0.05$) decreased in germinated *P. scrobiculatum* flour while dietary fiber content was significantly ($p<0.05$) increased from 8.11 to 17.94% after germination. WHC and OHC significantly ($p<0.05$) increased due to germination as from 2.08 to 3.50 g/g and 1.47 to 1.77 g/g, respectively. Swelling power and water solubility which reflect the hydration capacity of flours were significantly ($p<0.05$) decreased after germination. Peak gelatinization temperature was significantly ($p<0.05$) increased in germinated flour (75.93^{o}C) compared to non-germinated (75.41^{o}C) flour of *P. scrobiculatum*.

Conclusion: These findings encourage germination as a pre-processing technique in improving nutritional and functional properties of *P. scrobiculatum* flour in order to incorporate in functional food formulations.

Keywords: *Functional, Gelatinization, Germination, Millet, Paspalum scrobiculatum*

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Population genetic structure of common wild rice *Oryza rufipogon* Griff. in Sri Lanka

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Background: *Oryza rufipogon* Griff. (2n=2x=24) is a perennial wild rice species widely distributed in the tropics and subtropics of monsoon Asia as the progenitor of the Asian cultivated rice. It is widely distributed in wet and intermediate zones in Sri Lanka and has proven to be a precious gene pool for rice genetic improvement.

Objectives: In Sri Lanka, our recent field observations showed that the current geographic range of this species has significantly reduced. A better understanding of its population genetics will be of great significance in *in-situ* conservation, germplasm collection, and rice genetic improvement.

Methods: Genetic diversity and population structure were studied using 33 microsatellite loci in 132 individuals consisting of five natural populations from Weeraketiya, Thihagoda, Kalutara, Madampe, and Seeduwa areas in Sri Lanka.

Results: All 33 loci displayed high polymorphism (66.67 ~ 72.73 %) among the 05 populations, with a total of 230 alleles identified. Estimates of the genetic diversity, either at population level (H_e = 0.378) or at the species level (H_e = 0.639) were relatively high given the small area of the island. Population SL13-R (H_e = 0.442, I = 0.779) maintained the highest diversity while SL06-R (H_e = 0.295, I = 0.442) reported lowest. AMOVA revealed among population variance (37%) and within-population (63%) variance. Partial Mantel tests showed that the population divergence of Sri Lankan *O. rufipogon* based on distance isolation was statistically insignificant. The UPGMA tree illustrated that all five populations were genetically structured into three well-separated major groups, and the Weeraketiya population was separated as a single population. Thihagoda and Kalutara populations are the most genetically close populations in the cluster.

Conclusion: Our results indicated a higher level of within-population variance than among population variance in Sri Lankan *O. rufipogon* due to the outbreeding nature of this species.

Keywords: *Conservation, Genetic diversity, O. rufipogon, Population genetic structure*

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Prognosis of Diabetes mellitus in Siddha system of medicine

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Background: Diabetes mellitus (DM) is a metabolic non-communicable disease. A number of methods are recommended to diagnose and prognosis of DM in the Modern medical system. However, specific methods are also documented in the Siddha system of medicine. But the comparative study of Siddha and Modern diagnostic and prognostic methods in DM has not been studied previously.

Objectives: The study aimed to test the prognosis of DM based on the Siddha system of medicine compared to modern medicine.

Methods: An analytical cross-sectional study was conducted to compare the Siddha diagnosis methods using *Neikuri* (oil drop urine investigation) and *Manikkadai* (forearm circumference) with fasting blood sugar (FBS). Sixty DM patients, both sexes, aged 18 – 64 years, were randomly selected from Government Siddha Medical College, Palayamkottai, District Headquarters Hospital, Thoothukudi, and Gopalasamudram village, India, according to the inclusive and exclusive criteria with informed concern. All patients were investigated with both Siddha and modern diagnostic methods in their baseline to seventh visit (40 days of standard treatment according to Siddha Medicine) with the medicine of *Mathumega chooranam*.

Results: The study documented the affected *doshas* could be detected by the *Neikuri.* In *Neikuri* at the baseline, 52 urine samples were irregular shape (FBS 291 mg/dL ±154.3) and 08 were round shape (FBS 224.9 mg/dL ±63.8). Irregular shape observed in high FBS (FBS >290 mg/dL), and it changed to round shape when reduced FBS and it was significant ($p<0.05$ *value*). 75% of the irregular-shaped urine samples were transformed to a round shape when reduced the FBS. The mean value of *Manikkadai* was 8.4 at the baseline and significantly ($p<0.05$) increased to 8.8 when reduced the FBS.

Conclusion: The current study concluded that the *Neikuri* and *Manikkadai* could serve as a prognosis method for DM. However, further studies will be needed before clinical practice.

Keywords: *Diabetes mellitus, Neikuri, Manikkadai, Mathumega chooranam, Siddha medicine*

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Detection of large deletions in *WT1* gene in a cohort of 46,XY DSD children in Sri Lanka

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Background: 46,XY Disorders/Differences of Sex Development (DSD) occur when the person's genetic sex is incompatible with the gonadal sex due to genetic variations in individuals with 46,XY karyotype. The Wilms' tumour suppressor gene (*WT1*) is a transcriptional regulator and a tumour suppressor gene involved in kidney and genitalia development. In 46,XY DSD, large deletions in the *WT1* gene lead to conditions including Wilms' tumour/aniridia/genital anomaly/mental retardation (WAGR) syndrome. It is believed that genetic alterations in *WT1* gene can cause conditions like Wilms' tumour (WT) that may be associated with 46,XY DSD.

Objectives: Study to identify the large deletions in the *WT1* gene in a cohort of 46,XY DSD children in Sri Lanka.

Methods: Four children with ambiguous genitalia with 46,XY karyotype, diagnosed as having 46,XY DSD, within the age group of 2 weeks to 10 years were selected. The DNA extraction of the patient samples (n=4) and reference samples (n=3) taken from healthy males were carried out using QIAmp® DNA Blood Mini Kit. The Multiplex Ligation-dependent Probe Amplification (MLPA) technique was used for detecting large deletion in the *WT1* gene, and Coffalyser.Net was used to analyse the results.

Results: Patients subjected to the MLPA analysis did not present with any deletions in the *WT1* gene because no copy number variations were detected.

Conclusion: The study results showed no evidence to support that the deletions in the *WT1* gene do not cause 46,XY DSD in the subjects.

Keywords: *46,XY DSD, WT1, WAGR, MLPA*

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Determining the relevance of HLA/KIR matching/mismatching on kidney and liver transplantation rejection: A meta-analysis

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Background: Liver and kidney are important organs transplanted for solid organ transplantation. However, there are cases wherein graft rejection occurs due to foreign HLA proteins. Furthermore, the function of Natural Killer (NK) cells and their receptors in solid organ transplantation is not yet fully elucidated.

Objectives: This study aims to determine the relevance of matching HLA/KIR with the outcome of kidney and liver transplantation.

Methods: Articles were screened according to the inclusion and exclusion criteria provided which garnered eight final studies. Next, data were tabulated using a standardized extraction form. A meta-analysis was conducted to formulate conclusions regarding the significance of HLA/KIR matching and mismatching in kidney and liver transplantations. Fixed- and random-effects models were utilized to compute and establish 95% CI and pooled ORs wherein p-value of less than 0.05 is considered significant. Combination of Chi-square based Q test and I^2 statistics were used to identify presence of heterogeneity (PH<0.10) which was resolved with a funnel plot.

Results: Overall analysis shows that only the HLA-Bw4/KIR3DL1 combination was found to significantly affect the fate of transplanted graft [Q=7.12 (PH=0.42); I^2=2%; OR=0.73 (95% CI: 0.57-0.92; *p-value*=0.009)]. Our results show that the presence of HLA-Bw4/KIR3DL1 combination substantially decreases the odds of allograft rejection of kidney and liver transplants. Other combinations, on the other hand, such as HLA-C1 and KIR2DL2/3, HLA-C1 and KIR2DS2/3, HLA-C2 and KIR2DL1/DS2, and HLA-Bw4/KIR3DS1 were found to be insignificant (*p-value*>0.05); hence, they do not influence the allograft rejections.

Conclusion: Determining the role of NK cells in solid organ transplantation is essential to increase graft survival rates. In this meta-analysis, only the combination of HLA-Bw4/KIR3DL1 between donors and recipients was found to significantly affect the survivability of the graft by decreasing its odds of rejection.

Keywords: *Liver, Kidney, Solid organ transplantation, Graft rejection, HLA/KIR matching*

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Biofilm biofertilizer leads to mitigate climate change

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Background: Removing carbon (C) from the atmosphere and storing it in the soil is called soil carbon sequestration (SCS). In the phase of degradation of natural ecosystems like forests, agroecosystems might play a crucial role in SCS. In agroecosystems, Biofilm biofertilizers (BFBF) have been reported to reinstate the lost soil biodiversity and soil C accumulation that lead to increase the grain yield and SCS. However, the effect of BFBF on the organo-mineral complexation (OMC) which greatly affects the stabilization of sequestered soil C has not been studied.

Objectives: Therefore, the present study was carried out to evaluate the effect of BFBF on the OMC of paddy soils.

Methods: Twenty-six representative paddy fields spread over thousands of hectares in four districts were selected to apply the two treatments i.e. farmers' chemical fertilizers (CF, i.e. urea, TSP & MOP) practice (425 kg CF ha^{-1}), and BFBF practice (2.5 L of BFBF with 225 kg CF ha^{-1}). Soil pH, moisture (SM), organic C (SOC), labile C (SLC), respiration (SR, MicroResp^{TM} assay), cultivable bacterial abundance (SBA), and fungal abundance (SFA) were analyzed, and ATR-FTIR spectroscopic study was performed to qualitatively assess the OMC.

Results: A significantly ($P < 0.05$) higher SBA and SFA, followed by a lower SR were observed in the BFBF practice due to low priming triggered by microbial immobilization of fresh C. In addition, transmittance readings of FTIR spectra showed increased aromatic C in soils treated with BFBF compared to farmers' CF practice. The spectra also showed enhanced aggregation and consolidation of mineral-associated organic matter due to BFBF application.

Conclusion: As such, application of BFBF promoted OMC and reduced SR, possibly due to enriched microbial abundance which could finally contribute to mitigate climate change.

Keywords: *BFBF, Climate change, Organo-mineral complexation, Paddy cultivation, Soil carbon sequestration*

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Role of proline in stressed *Rhizophora mucronata* Lam. mangrove plant; increased proline synthesis or lower utilization?

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Background: Mangrove tidal forests which are at the confluence of sea and land are frequently subjected to harsh environmental conditions. Although the mangrove plant communities are adapted to such extreme conditions, stress intensity (magnitude × exposure time) highly matters in initial mangrove seedling establishment. This knowledge is thus useful in mangrove restoration since mangrove propagules and seedlings are commonly used in such attempts.

Objectives: This study was, therefore, aimed to investigate one of key physiological processes, proline metabolism i.e. synthesis and utilization (metabolic regulation), in mangrove seedlings of *Rhizophora mucronata* under different salinity levels (salt stress).

Methods: Under plant-house conditions, one month old seedlings of *Rhizophora* with 2 unfurled leaves were used for the salt stress experiment with the treatment levels; fresh water: 0 psu, moderate salinity: 13-15 psu and high salinity: > 30 psu. Three replicates per each treatment level and 09 seedlings per each replicate (in total, 81 seedlings) were assigned and the replicates were placed according to a completely randomized design (CRD). Proline content of the plant leaf tissues, taken from different treatment levels was determined by using ninhydrin-based colorimetric assay and total protein content was quantified by biuret method. One-way ANOVA was performed to check the significant difference of the obtained concentrations among the treatment levels at 95% confidence interval.

Results: According to the results, the highest proline content (i.e. 47.8±4.2 $\mu molg^{-1}$) was recorded in the *Rhizophora* plants grown in high salinity. The proline content was significantly lower ($p<0.05$) in the plants (i.e. 6.3±0.8 $\mu molg^{-1}$) grown in moderate salinity level. The total protein content did not show any significant difference between freshwater and moderate, but significantly lower ($p<0.05$) in high saline condition, 1.28±0.81 mg g^{-1} DW.

Conclusion: Increase of proline under high salinity conditions could be linked with stress tolerance of *Rhizophora* plants and could result from increased proline synthesis and/or lower proline utilization for protein synthesis.

Keywords: *Biochemical response, Stress intensity, Mangroves, High salinity, Restoration*

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The effect of red and blue light on seed germination and seedling development in Chilli (*Capsicum annuum* L.)

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Background: The quality of light, controls and triggers several important functional and structural responses in plants. Recently, red and blue LED lights are used to increase the efficiency of crop production.

Objectives: The current study investigated the effects of red and blue light on seed germination and seedling development of Chilli, a high-value crop that is cultivated worldwide**.**

Methods: The experiments were carried out as a completely randomised design with three replicates, under greenhouse conditions with a daily mean temperature at 27 °C and 60% relative humidity. In the germination experiment, seeds were germinated under monochromatic red (660 nm), monochromatic blue (440 nm), and white (control) light treatments. The photoperiod of 16 h was maintained. The photosynthetic photon flux density (PPFD) level was maintained to 100±10 $\mu molm^{-2}s^{-1}$ for all lighting systems, by adjusting the height to the light source. After 10 days, germination (%), seedling length, seedling dry weight, and seedling vigor index (SVI) were recorded. In the greenhouse experiment, potted plants were grown under the same red and blue light treatments, but control group plants were grown without LEDs. After 30 days, leaf area, plant length, and dry weight were measured. All data were statistically analysed.

Results: The statistical analysis showed that germination and seedling development were significantly different among different light ($P<0.05$). Germination percentage (98%) under red light treatment was significantly higher. The highest seedling length and dry weight were produced under control light treatment. SVI was highest in red light treatment. In the greenhouse experiment, leaf area, plant length, and dry weight were higher under blue light treatment.

Conclusion: According to the results, red light promotes seed germination. Control light treatment is effective for increasing seedling length and seedling biomass. However, blue light promotes the further development of leaf area, plant length and plant biomass. Future studies on this will warrant improving productivity.

Keywords: *Capsicum annuum, LEDs, Light quality, Seedling development, Vigor index*

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Comparative embryogenesis of four aquarium fish species exhibiting different degrees of parental care

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Background: Actinopterygii display the highest diversity in parental care among vertebrates. Therefore, they are ideal models to determine the role of parental care during development.

Objectives: This study investigated the rate of embryogenesis among fish species exhibiting different levels of parental care using four commercially important ornamental fish species; *Danio rerio, Betta splendens, Pterophyllum scalare* and *Cyprinus carpio.*

Methods: The development of each species was monitored from egg stage to larval stage. The rate of development was critically evaluated among the four species, and against existing data of species from the same families, to decide the influence of parental care on growth rate. A two-sample T-test was conducted to determine the significance of the presence of parental care on each development stage.

Results: *B. splendens* exhibited male-only parental care while *P. scalare* showed biparental substrate brooding. Both *D. rerio* and *C. carpio* showed no parental care and engaged in egg cannibalism. *C. carpio* hatched at 36 hours post fertilization. *D. rerio* and *B. splendens* hatched at two days post fertilization (DPF), whereas *P. scalare* hatched at 3 DPF. Embryos that experienced parental care had a comparatively slower rate of development. In such embryos body pigmentation and eye formation were completed after hatching and larvae remained attached to the nest or substrate several days after hatching. Species that received no form of care gained feeding and locomotory independence earlier. A two-sample T-test showed that species which received parental care exhibited significantly longer development periods ($p < 0.05$) than the species that do not receive any form of care.

Conclusion: The results indicate that species which lack parental care complete each development stage comparatively earlier than the species that experience some type of brood care.

Keywords: *Embryo, Developmental rate, Parental care, Aquaculture, Substrate brooding*

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Environmentally safer control methods Brown Plant Hopper (BPH) control under rice cultivation in Ampara district – Review study

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Background: Ampara District is the major paddy cultivation area of Sri Lanka. Among the paddy production constraints, insect pest attack has been identified as the major constraint to increase the rice production in this area. Previous year (2019) annual paddy production was nearly 33 0713 MT and 28 9193 MT in *Maha* and *Yala* season, respectively, that is lower than the expected yield. The lower production was associated with the Brown Plant Hopper (BPH) attack.

Objectives: BPH infect rice crops at all stages; hence, control measures should be implemented from land preparation to harvesting. Therefore, this study was aimed to propose possible BPH control methods as an IPM package under cultivation in Ampara district.

Methods: Previously done researches and literature were reviewed to find environment-friendly pest management measures to manage BPH attack.

Results: This IPM package includes deep ploughing and levelling of the land, use of BPH tolerant rice variety, Bg379-2 with recommended seed rate (100 kg/ha) and avoiding the susceptible variety Bg94-1. Draining water at frequent intervals and monitoring of the field for pest injuries at two weeks intervals. Synchronized rice cropping and crop rotation with secondary crops are also necessary. When there is one or more BPH per tiller, neem-based insecticide *Azadirectin* (3-5 ml/l) can be sprayed. The land should be allowed to dry for two days if the attack is at reproductive stage (8-10/hill). Further, irrigation should be stopped immediately and harvesting should be done within ten days. This IPM package can reduce the cost of rice production by 5000 LKR per acre.

Conclusion: Nowadays remarkably higher number of pesticides are used by farmers leading to several health issues. Hence, the proposed IPM package will be an efficient strategy to control BPH in paddy cultivation in Ampara District.

Keywords: *Brown plant hopper, Crop rotation, IPM package, Insecticide*

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Livelihoods on Mangrove ecosystems and their impact: A case study from the Jaffna peninsula

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Background: Mangrove ecosystem is recognized as vital in sustaining the livelihoods of households around mangrove forests mainly in developing countries. However, indiscriminate exploitation of mangroves for commercial, industrial, and housing needs causes negative impacts on the environment.

Objective: To study the livelihoods that cause degradation of mangrove ecosystems in Jaffna peninsula.

Method: A structured questionnaire was used to obtain data from the households in the Mandaitivu area. The study was based on primary and secondary data. The primary data was gathered from 90 respondents belonging to three identified stakeholder groups of the mangrove ecosystem in the study area, i.e. residents living close to mangroves, fishermen and the general public, selected through stratified random sampling method.

Results: Around 87% of the households depended on the mangrove ecosystem for their livelihood and survival either directly for extracting timber, fuelwood or indirectly for supporting off-shore fisheries by serving as a nursery ground. Of the households, 57% used mangrove plants as firewood which was the main source of energy for cooking and industrial purposes. Nearly 83% of the respondents stated that there was a considerable amount of coastal erosion compared with the previous years. 33% of respondents reported the occurrence of flood accumulation during heavy rains only, while 22% of respondents reported that they were experiencing the same comparatively higher than that in the past. All the respondents reported, they had poor quality drinking water.

Conclusion: Based on the households' observation, experience and perception, the degradation of the mangrove ecosystem caused flood accumulation, coastal erosion and poor quality drinking water in the study area. Creating awareness on approaches towards adopting sustainable mangrove forest management to ensure sustainable livelihoods in this area is therefore urgently needed.

Keywords*: Degradation, Livelihood, Mangrove*

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Phytochemical and potential pharmacological properties of *Pavetta indica*: A review

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Background: *Pavetta indica* is a medicinal plant native to Sri Lanka which belongs to the family of *Rubiaceae*. In folk medicine, Ayurveda and Siddha medical systems, the leaves and roots of this plant are used in indigenous clinical practices, especially for treating visceral obstruction, haemorrhoidal pains, and rheumatism and eye diseases. Furthermore, leaves are traditionally used to treat liver disease, urinary infections, and fever. Despite its usage in indigenous clinical practices, there is information available on comparative pharmacognostic, physicochemical, phytochemical, ethnopharmacological data and antioxidant capacity of this herb.

Objectives: To review the pharmacological activities and bioactive compounds of *Pavetta indica* and to provide scientific evidence to evaluate the potential effects of the plant as an aid for forthcoming studies.

Methods: Under the Preferred Reporting Project for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, a review of published studies reporting the medicinal properties of *Pavetta indica* was carried out.

Results: The extract of this plant and pure compounds isolated from it have been demonstrated to possess multiple pharmacological activities such as hepatoprotective, anti-inflammatory, antioxidant, antidiabetic, neuroprotective, anti-dementia, anti-cancer, anti-microbial, anti-helminthic, diuretic properties, and wound healing activities through in-vitro and in-vivo tests. Furthermore, phytochemical studies have underlined various classes of bioactive compounds, mainly carbohydrates, glycosides, alkaloids, phytosterols, saponins, tannins, proteins, amino acids, phenolic and flavonoids. These phytoconstituents are significant and can be attributed to their medicinal characteristics.

Conclusion: This review discussed the phytochemistry and pharmacology of *Pavetta indica*, as well as its potential as a therapeutic plant. A variety of phytochemicals have been extracted from this plant. Most of these studies have been conducted either in vitro or using rats. Thus, extensive studies should be encouraged on this plant to discover more beneficial medications and therapeutic effects.

Keywords: *Pavetta indica, Pharmacological properties, Medicinal uses, Phytochemistry*

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Analysis of linkage among seven X-chromosomal short tandem repeat markers (X-STR) in Sinhalese pedigrees

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Background: Recently, X-STR based DNA typing was introduced to Sri Lanka to resolve certain challenging kinship cases that cannot be resolved efficiently by other commonly used forensic markers (autosomal STR, Y-STR). However, since X-STRs are located on the same chromosome, they cannot segregate independently. Thus, linkage can have a significant impact on the biostatistical calculations of forensic casework involving X-STR. Hence, quantifying the linkage between markers is an essential prerequisite for applying a X-STR marker system to any population. Although linkage can be conveniently measured by calculating the pairwise recombination rates, it can vary substantially between ethnic groups requiring individual investigation on each population separately.

Objectives: The study was aimed to examine the recombination rates between markers of two selected X-STR clusters, DXS7132-DXS10079-DXS10074-DXS10075 (cluster I, Xq12) and DXS6801-DXS6789-DXS6809 (cluster II, Xq21), among the Sinhalese population.

Methods: Finger pricked blood collected from 81 random three-generation Sinhalese families, including 81 grandfathers with daughters and 162 grandsons, was used to extract DNA using the Chelex method. All seven X-STR markers were genotyped by a multiplex PCR assay established previously. The pairwise linkage among markers was calculated with the maximum LOD score method using Mendel v12.

Results: All the adjacent marker pairs within and between the two clusters showed a significant linkage with maximum LOD scores >3.0 (within-cluster I: 27.88-30.47, within-cluster II: 15.14-20.08, between cluster I and II: 5.85). Crossing over events within the two clusters were rare (cluster I: no recombinations; cluster II: three recombinations).

Conclusion: These findings suggest that the haplotypes defined by the two studied clusters are likely to be inherited among Sinhalese stably over generations suggesting their suitability to be used in kinship analysis. However, the observed linkage between the two clusters prohibits the use of product rule between them during the biostatistical calculations involving casework.

Keywords: *Recombination rate, Haplotype, X-STR Clusters, Three generation pedigrees, Kinship analysis*

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Response of Cowpea and Tomato to drought stress imposed during different phases of reproductive growth

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Background: Drought has been a significant challenge for crop production worldwide, leading to yield losses and crop failures in a wide range of crops.

Objectives: The aim of the present study was to investigate the impact of moisture stress during different phases of reproductive growth of Cowpea (*Vigna unguiculata* L.) and Tomato (*Solanum lycopersicum* L.).

Methods: A pot experiment was laid as Completely Randomized Design (CRD) in a poly-tunnel. Moisture stress was imposed during flowering, pod initiation, and pod filling stages of cowpea, and flowering and fruiting stages of tomato. All pots were maintained at 80% of field capacity until the drought treatments were imposed. The plants were kept till wilting after the imposition of the drought treatments in each phase and then the plants were supplied with half the amount of water that was supplied to the control to maintain 80% of field capacity. The impact of moisture stress on plant growth, nutrient uptake, and yield of the both crops were measured.

Results: Moisture stress did not cause a significant impact on plant height and number of leaves of both crops. Plants grown under moisture stress during reproductive growth, particularly in the grain filling stage recorded an increment of total rooting depth compared to the control. Accumulation of phosphorus (P) and potassium (K) in shoots of cowpea was enhanced under moisture stress while this tendency was noted only for shoot P in tomato exposed to drought in the fruiting stage but did not change grain nutrient content of cowpea. There was a greater reduction of grain yield of cowpea under moisture stress at all growth phases though it did not change grain nutrient content.

Conclusion: Drought stress remarkably influences growth of both crops, without causing any reduction of grain N, P, and K accumulation of cowpea.

Keywords*: Cowpea, Drought, Moisture stress, Reproductive growth, Tomato*

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A preliminary study of renin-angiotensin system (RAS) gene polymorphisms among a cohort of Sri Lankan chronic kidney disease patients

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Background: Chronic kidney disease (CKD) has a high prevalence in Sri Lanka. Its familial clustering indicates an underpinning genetic susceptibility that requires thorough investigation. Components of the renin-angiotensin system (RAS), particularly angiotensin-converting enzyme (ACE), angiotensinogen (AGT) and angiotensin II type 1 receptor (AGTR1) that regulates blood pressure and fluid and electrolyte balance plays a key role in kidney function. Accordingly, their genetic polymorphisms are likely to associate with CKD risk and its multiple aetiologies. However, this has not been tested for Sri Lankans except for the ACE gene.

Objectives: The study was aimed to investigate the association between CKD and three selected RAS gene polymorphisms (rs1492078 of AGTR1 gene, rs5050 of AGT and rs4295 in ACE) among a cohort of Sinhalese CKD patients.

Methods: The study was approved by the Ethics Review Committee of the Institute of Biology Sri Lanka. Thirty CKD patients (age >35) with multiple aetiologies (hypertensive nephropathy:16; diabetic nephropathy:9; other:5) were recruited from the National Hospital Kandy. Thirty healthy volunteers, matched for age and sex served as controls. DNA was extracted using Wizard® Genomic DNA purification Kit from the 3 ml of blood drawn from participants. All three polymorphisms were genotyped with PCR-RFLP methods developed in-house. The association between CKD, hypertensive nephropathy and diabetic nephropathy was tested with binary logistic regression using SPSS v 26.

Results: The observed genotype and allele frequencies (rs1492078: CC:0.3, CT:0.533, TT:0.167, T:0.433; rs5050: GT:0.25, TT:0.75, GG:0, G:0.125; rs4295: CC:0.383, CG:0.583, GG:0.033, G:0.325) did not differ significantly between the CKD and control groups for either of the three polymorphisms tested. Further, none of the polymorphisms indicated a significant association with CKD ($P>0.05$), hypertensive nephropathy or diabetic nephropathy.

Conclusion: The genetic predisposition to CKD among the selected cohort of Sinhalese is unlikely to be mediated via the three tested polymorphisms and need to be further verified with a larger sample.

Keywords: *Angiotensin-Converting Enzyme (ACE), Angiotensinogen (AGT), Angiotensin II Type 1 Receptor (AGTR1), Hypertensive nephropathy, Diabetic nephropathy*

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Variations of the Palmyrah (*Borassus flabellifer* L) fruit quality in Jaffna district

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Background: Palmyrah palms (*Borassus flabellifer* L) growing in Sri Lanka provide potential benefits to the people in various ways.

Objectives: This study was conducted to investigate the quality parameters of ripe palmyrah fruits collected from different places in the Jaffna District.

Methods: A total of 84 ripe fruits were collected from 12 locations in Jaffna district. The quality parameters such as weight, volume, specific gravity, colour, pH, total soluble solids, and titratable acidity of the fruit pulp were determined using standard methods. Descriptive statistics and cluster analysis were carried out for the data using SPSS 16.

Results: It was found that the specific gravity of the collected fruits varied from 0.74 to1.54 (1.02 ± 0.17). The pH value of the fruits indicated weak acid range from 4.61 to 6.89. Total soluble solids varied from 9 to 19 (14.21 ± 2.24) indicating a wide range of the sweetness level. However, there was no significant difference ($p<0.05$) observed in the titratable acidity of the all collected fruits. After adding distilled water into the fruit pulp, the colour of pulp was distinguished as yellow and orange. The results of the dendrogram using all the parameters showed that the high rescaled distance was recorded for the palmyrah fruit collected from the premises of University of Jaffna, which had yellow colour skin with 10.4^{o} brix. These fruits showed that the pH and specific gravity value were 5.76 and 0.94 respectively. Fruits collected from eight sites such as Mathakal, Karainagar, Navali, Urumpirai, Kondavil, Kokuvil, Meesalai, and Uduppiddy were observed to be in a similar group and showed black colour skin and orange colour fruit pulp.

Conclusion: Based on the dendrogram, quality of the palmyrah fruits collected from eight sites were grouped into one and other fruits were found in different groups.

Keywords: *Dendrogram, Quality parameters, Skin colour*

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Production of quality compost using locally available waste in combination with *Spirulina subsalsa*

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Background: Due to the over usage of chemical fertilizers there is a high risk of environmental pollution. Therefore, it is necessary to find an alternative source for fertilizers.

Objectives: The study was aimed at producing a good quality compost using different combinations of locally available resources.

Methods: Six treatments (T1- Kitchen waste (KW)+ *Gliricidia* leaf (GL) + Yard waste (YW), T2 – KW + *GL* + YW + *Spirulina* biomass (SB), T3 - GL+ Cow dung (CD) + YW, T4 - *GL* + CD + YW + *SB*, T5- YW + CD, T6 - YW + CD + SB) were designed in completely randomized design and materials were composted in plastic bin with initial C:N ratio of 35:1. After 4th, 6th and 8th weeks, physical properties (sand content, decomposition rate in terms of particle size and moisture content) and chemical properties (pH, C, N, and C: N ratio, K, P and Ca) were measured.

Results: Compost produced in all treatments complied with SLS standards in terms of moisture content, pH, C, N, C/N ratio, K and Ca except P. Compost of T5 and T6 did not comply with the SLS standard of less than 10% sand percentage and decomposition rate of more than 80%. However, other four treatments of T1, T2, T3 and T4 complied with the SLS standards for sand % and decomposition rate. The results of nitrogen and decomposition rate in T1 and T2 compost revealed that use of *Spirulina* does help to increase the compost quality compared to without *Spirulina* application.

Conclusion: As the compost produced in T1, T2, T3 and T4 complied with SLS standards in all parameters except P, these treatments could be recommended to produce compost with suitable P supplements.

Keywords: *Compost, Yard waste, Gliricidia, Kitchen waste, Cow dung*

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Myofascial trigger points in patients with non-specific neck pain

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Background: In recent years, non-specific neck pain has become a frequent complaint due to poor head postures and mechanical causes. It is characterized by Myofascial Trigger Points (MTrPs) in palpable taut bands of skeletal muscle that refer pain to a distance, and that cause distant motor and autonomic effects.

Objective: The objective of this study was to assess the prevalence of MTrPs in the upper trapezius, sternocleidomastoid, levator scapulae and sub-occipital muscles in subjects with non-specific neck pain in two hospitals, Sri Lanka.

Methods: This cross-sectional descriptive study was carried out among 31 patients with non-specific neck pain, presented to the Department of Physiotherapy, Teaching Hospital Peradeniya and National Hospital, Kandy, Sri Lanka. Participants were referred by a physician for non-specific neck pain and MTrPs were determined by a physiotherapist based on the criteria described by Simons et al.

Results: The prevalence of MTrPs among patients with non-specific neck pain was 100%. Each of the 31 patients exhibited at least two MTrPs in the analyzed muscles. The mean number of MTrPs on each patient was 4.71± 2.036. MTrPs of the upper trapezius muscle fibres were the most prevalent in 96.8% of the participants. MTrPs in the sub-occipital, sternocleidomastoid, levator scapulae muscle fibres, reached a prevalence of 58.1%, 45.2% and 35.5%, respectively. 76.74% of the total number of MTrPs in all the muscles analyzed were found to be active MTrPs while 23.26% were latent [number of MTrPs (n) in upper trapezius: n_{active}:35; n_{latent}:22, sub-occipital: n_{active}:32; n_{latent}:1, sternocleidomastoid n_{active}:21; n_{latent}:1, levator scapulae n_{active}:11; n_{latent}:6].

Conclusion: MTrP is a common source of pain in subjects presenting non-specific neck pain. Our study determined the presence of both active and latent MTrPs in this population with a higher prevalence of active MTrPs compared to latent MTrPs in all individual muscles.

Keywords: *Non-specific neck pain, Myofascial trigger point, Prevalence, Active, Latent*

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A preliminary study on anti-cancer potential of *Osbeckia octandra* L. (Heen Bovitiya) leaf extract on YD-38 human oral squamous cell carcinoma *in-vitro*

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Background: Cancer has become a huge burden all over the world making it a leading cause of death. Therefore, many research activities are being conducted on various therapeutic drugs for curing. *Osbeckia octandra* is a plant endemic to Sri Lanka which is used in traditional medical practitioners due to its hepato-protective, antioxidant and antimicrobial effects.

Objectives: The study was designed to examine the anti-cancer potential of *O. octandra* leaf extract using an *in vitro* cell culture model with human oral squamous cell carcinoma (OSCC) cells, YD 38.

Methods: *O. octandra* leaf powder (100 g) was extracted using hexane, ethyl acetate and methanol sequentially by sonication at room temperature. The solvents were evaporated using a rotary evaporator and dissolved in Dimethyl Sulfoxide (DMSO). YD-38 cells were cultured under standard cell culture conditions in six-well plates and treated with leaf extracts with 0, 0.3, 3.0 and 30.0 µg/mL. Doxorubicin with the concentration of 5 µM was used as the positive control. After 24 hours of incubation the cells were stained with Trypan blue and viability percentages were calculated with the cell count obtained from haemocytometer.

Results: Cell viability percentages decreased with increasing concentrations of *O. octandra* methanol extract showing dose dependency with 30 µg/mL as the lowest ($p<0.05$) cell viability percentage. A significantly lower ($p<0.05$) cell viability percentage was observed with respect to exposure to 3 µg/mL concentration of the ethyl acetate extract while treatment with hexane extract showed no significant reduction in the viability of YD-38 cells.

Conclusion: The results of this preliminary study clearly suggest that the methanol and ethyl acetate extracts of *O. octandra* show cytotoxic effects on OSCC cells. In-depth studies are warranted to identify the compounds responsible for the bioactivity and the underlying mechanisms of action.

Keywords: *Osbeckia octandra, Human oral squamous cell carcinoma (OSCC) cells, Anti-cancer*

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Nutrient uptake and growth of *Eleusine coracana* when coexisting with *Panicum maximum* under nutrient-limited soil conditions

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Background: Presence of multiple plants in nutrient-limited environments can induce strong intra- and inter-specific competition for such nutrients among the co-existing plants. Nutrient uptake by crops when they co-exist with weeds under nutrient-limited conditions is still poorly understood.

Objectives: This study investigated nutrient uptake by finger millet (*Eleusine coracana* L.) in the presence of the upland weed, guinea grass (*Panicum maximum* L.), under nutrient-limited conditions.

Methods: A pot experiment was conducted in a complete randomized design using fertilized and unfertilized soils with different neighbor-densities of the two species including monocultures and mixed cultures, with three replicates. Monocultures consist of one and three plants of the same species in a given pot. Mixed culture system contained finger millet:guinea grass plant combinations of 1:2 and 2:1. The effect of interspecific competition on nutrient uptake and growth of finger millet were measured.

Results: Root and shoot dry weight of finger millet was reduced by 39% and 61%, respectively, in the presence of guinea grass compared to that when neighbors were from the same species. The same tendency was observed for the accumulation of nitrogen (N), phosphorus (P), and potassium (K) in the root and shoot of the crop. The greatest reduction of tissue nutrient concentration of finger millet was recorded in finger millet:guinea grass plant combination of 1:2. Except for shoot N concentration, there was no change in P and K accumulation of finger millet plant between the monocultures having one and three plants per pot ($P>0.05$).

Conclusion: The results suggest that the growth and nutrient uptake of finger millet is suppressed when it co-exists with guinea grass indicating the strong interspecific competition between the species under nutrient-limited conditions.

Keywords: *Interspecific competition, Nutrient uptake, Nutrient-deficient condition, Finger millet, Guinea grass*

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Optimization of polyphenol extraction from the petals of *Clitorea ternatea* flowers

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Background: *Clitorea ternatea* flowers are rich sources of polyphenols. However, for the effective utilization of these flowers as natural antioxidants in functional foods, the maximum quantity of polyphenols should be extracted from them. For industrial scale processes such as herbal tea and food supplement production, it is important to use cost effective and labour intensive approaches for extraction. Thus it becomes necessary to optimize various process parameters that influence the yield of polyphenols from *C. ternatea*.

Objectives: To develop mathematical models for the yield of Total Phenolic Content (TPC), Total Anthocyanin Content (TAC) and antioxidant activity and to simultaneously optimize the process parameters (solid to solvent ratio, ethanol concentration, time and temperature) to obtain maximum TPC, TAC and antioxidant activity in terms of DPPH radical scavenging activity.

Methods: Solid liquid extraction technique was used and central composite design was chosen to study the effects of 4 process parameters on the response variables. Response surface methodology and analysis of variance was used to determine the regression coefficients and the statistical significance of the model terms. TPC and TAC were evaluated using the Folin-ciocalteau method and pH differential method, respectively.

Results: The values obtained for the lack of fit were insignificant ($p>0.05$) for all the models, indicating that the obtained model terms are adequate to optimize the process parameters. Considering the interactive effects, solid to solvent ratio and temperature showed a significant ($p<0.05$) positive output on TPC. Ethanol concentration and extraction time and the interactive effect between temperature and extraction time had a significant ($p<0.05$) positive effect on the yield of TAC. Temperature and solid to liquid ratio showed a significant positive effect on the DPPH radical scavenging activity ($p<0.05$).

Conclusion: The generated optimum conditions for maximum TPC and TAC with maximum DPPH radical scavenging activity was 37.21% aqueous ethanol, 1:50 solid to solvent ratio at extraction temperature of 45°C and time 50.75 minutes.

Keywords: *Clitorea ternatea, Polyphenols, Response surface methodology*

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Changes in Tomato morphology in response to intensity of greenhouse environment control

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Background: In tropical regions, greenhouse covers transmit heat waves from the incident radiation, increasing internal temperature to levels unbearable for crop plants. Therefore, it is crucial to accommodate environment control methods for maintaining optimal temperature levels inside greenhouses.

Objectives: To investigate the morphological changes of tomato crop (*Solanum lycopersicum* L.) to three greenhouse designs, having differential temperature control systems.

Methods: The greenhouse designs were: (T1) a high-intensive greenhouse with a double cladded polythene roof and an Internet of Things (IoT)-based control of exhaust fan and misting system, (T2) a semi-intensive greenhouse with a single hard plastic roof and a timer controlled misting, and (T3) a less-intensive greenhouse with a single polythene roof, with natural ventilation. The impact of greenhouse environment control systems on plant external morphology, anatomy, yield parameters, and the greenhouse environment conditions were determined. Statistical analysis was done using repeated measures ANOVA. Internal and outside environmental data were taken using an automatic data acquisition system.

Results: The results indicated a favourable internal air temperature for crop growth in T1 during daytime (<35 ºC), in comparison to high maximum daytime temperatures of T2 and T3 (up to 45 ºC). The highest light intensity was recorded in T2, whereas the favourable relative humidity (50 – 70%) was maintained in T2 and T3 during the daytime. The fruit weight and fruit diameter of tomatoes were significantly higher in T1 at the early harvesting period. Some of the plant anatomical and flowering parameters were found substantially sensitive to internal environmental conditions, showing symptoms of environmental stress in T2 and T3. Greenhouse environment control methods did not cause a significant impact on plant vegetative growth.

Conclusion: The IoT-based control system, could be selected for greenhouse environment control, based on the yield, fruit quality, and the favourability of the internal environmental conditions.

Keywords: *Environment control methods, Internet of things, Protected agriculture*

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Knowledge, attitude, practice of skin whitening and adverse effects among selected undergraduates at KIU: A cross sectional preliminary study

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Background: Skin whitening (SW) is one of the rapidly growing fields in the global cosmetic industry. Despite the serious complications involved, skin whitening products (SWP) continue to have a high demand. Limited data is available related to the knowledge, attitude, practice and adverse effects of SW among the general public.

Objectives: This study aimed to ascertain knowledge, attitude, practice and adverse effects of skin whitening among selected undergraduates at Kaatsu International University (KIU).

Methods: A descriptive cross-sectional study was conducted using a pretested online self-administered questionnaire among undergraduates at KIU using convenience volunteer sampling method. Out of the total 502 online volunteer responders, only 480 who successfully completed the questionnaire were subjected to analysis. The data were analyzed using SPSS version 25.

Results: Out of a total of 480 volunteers, 65 were males (13.5%) and 415 were females (86.5%). Percentage of 34.8 (167/480) were skin whitening users (SWU) and the majority of them [91.6%(153/167)] were found to be females at the age of 18-24 years. The most commonly used [85.6%(143/167)] skin whitening product (SWP) was creams. Out of the SWU, 46.7%(78/167) were daily users. The most common motive for the purchase of SWP was to clear the skin of acne [45.8%(220/480)]. Quality [71.9%(345/480)] and the ingredients [60.4%(290/480)] were the factors considered in the purchase of SWP. Majority of SWU [83.2%(139/167)] had experienced adverse effects (AE) such as acne [54%(75/139)], skin pigmentation [23.7%(33/139)], rashes [16.5%(23/139)], allergies [7.2%(10/139)], pruritus [7.2%(10/139)] and dry skin [10.1%(14/139)]. Majority of the users [86.2%(144/167)] were aware of the harmful health effects of SW. A moderate attitude towards SW was observed among the majority [49.6%, (238/480)]. A statistically significant association was observed between the SW use and AE ($p<0.05$).

Conclusion: Despite being aware of the harmful effects, 34.8% have used SWP. This study reveals that SW usage is associated with AE. Therefore, users must pay attention to natural skin health rather than using skin whitening with adverse effects.

Keywords: *Skin whitening, Adverse effects, Knowledge, Attitude, Practice*

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Study of a cohort of children with Homocystinuria in Sri Lanka for selected variants in Cystathionine beta synthase (*CBS*) gene

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Background: Homocystinuria is a rare inborn error of homocysteine metabolism and an autosomal recessive inherited disorder, which leads to abnormal accumulation of Homocysteine and its metabolites in blood and urine, and causes cardiovascular, skeletal, optical and neurological complications. Due to the cystathionine β-synthase (*CBS*) gene mutations, the production of the CBS enzyme is interrupted and prevents conjugation of Homocysteine and Serine from forming Cystathionine.

Objectives: This project was designed to study two mutations in the *CBS* gene associated with homocystinuria, c.833T>C (I278T) in exon 8 and c.19del in exon 3, in a cohort of children in Sri Lanka who are already diagnosed with clinical symptoms and followed up by a clinical pathologist at Lady Ridgeway Hospital for children.

Methods: Blood samples from eight children, who are confirmed to have the CBS deficiency, with many lethal clinical outcomes according to the hospital records, were collected, and mutation analysis was performed by Single Base Extension mini-sequencing and Sanger sequencing.

Results: According to the results, out of 8 patients, none of them had c.833T>C polymorphism, but four patients have the homozygous condition for c.19del mutation in the *CBS* gene, even though all these patients were reported with severe symptoms.

Conclusion: According to the results, c.19del is prominent among Sri Lankan children while c.833T>C is absent. However, further studies are needed with a larger cohort of patients since the current sample size is insufficient to conclude the outcome. In future studies, defining the spectrum of *CBS* mutations in Sri Lanka, investigating family pedigrees to understand the inheritance of these mutations could be utilized to create a mutation database and develop an early diagnosis procedure for patients with homocystinuria.

Keywords*: Homocystinuria, Cystathionine β-synthase, Mutation*

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Culturable bacterial pathogens in midstream urine of chronic kidney disease patients in Vavuniya, Sri Lanka: A preliminary study

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Background: Contribution of the midstream urine microbiome to chronic kidney disease (CKD) is clinically relevant, yet it's understudied**.**

Objectives: To identify bacteria from midstream urine of CKD patients with comorbidities of diabetes mellitus (DM), hypertension (HT) and other causes, in Vavuniya.

Methods: A total of seventeen (n = 17) midstream clean-catch urine samples were collected from CKD patients (56.59 ± 12.91 years) at the District General Hospital, Vavuniya, belonging to CKD + HT (n = 8), CKD + DM (n = 2), CKD + HT + DM (n = 3) and causes of CKD other than DM and HT (n = 4). Non-CKD healthy controls (n = 8; 56 ± 11 years) were included for comparison. Samples were transported on ice and immediately refrigerated at 4°C until processed. 10µl per sample was inoculated onto Luria-Bertani (LB) agar plates in duplicates and incubated aerobically at 37°C for 24 hours. Morphologically different bacterial colonies were subcultured in LB broth to obtain pure isolates, which underwent gram staining, and biochemical analyses for preliminary identification.

Results: Mean colony count for CKD subjects was 2,500 ± 967 CFU/mL and 286 ± 181 CFU/mL for controls. The CKD + HT + DM group had the highest mean colony count. In total, 24 bacterial isolates were obtained from the patients' urine of which 45.8% were gram positive cocci, 37.5% were gram negative rods and bacterial genera Staphylococcus (33%), Streptococcus (12.5%), Pseudomonas (4%), Klebsiella (4%) and Proteus (4%) were identified. *Staphylococcus, Corynebacteria, Proteus, Escherichia,* and *Citrobacter* were found in controls.

Conclusion: Various viable uropathogens in the midstream urine of CKD patients were identified using culture-based tests. This preliminary study is currently ongoing to further identify the midstream urine microbiome in CKD with molecular techniques too, as culture alone is insufficient.

Keywords: *Chronic Kidney Disease, Midstream urine microbiome*

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Comparison of the effect of organic pesticides with a synthetic pesticide recommended for the control of Chilli Leaf Curl Complex disease

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Background: Chilli (*Capsicum annuum* L.) is a major cash crop grown in Sri Lanka. However, the yield loss due to chilli leaf curl complex (CLCC) infestation is high and therefore farmers are moving away from chilli cultivation leading to large quantities of chilli imports annually. Most synthetic chemical sprays have not been successful in controlling CLCC and also, they pollute the environment. Thus, it is important to find organic solutions as substitutes.

Objectives: Testing two liquid biopesticides made out of plant materials on the effectiveness of CLCC control.

Methods: The experiment was conducted at the University sub-campus, Mahailluppallama, University of Peradeniya, Sri Lanka, which belongs to the DL1b agro-ecological region, during the period of April to August 2021. The chilli variety, MICH1 was tested under three treatments, Garlic (*Allium sativum* L.) and Bird's eye chilli (*Capsicum frutescens* L.) fruit mixture (T_1), Neem (*Azadirachta indica* A.Juss) seeds and Holy Basil (*Ocimum tenuiflorum* L.) leaf mixture (T_2), and Department of Agriculture (DOA) recommended pesticide (control/T_3). The experiment was conducted as a RCBD with four replicates and the relevant treatment solution was sprayed once a week to the plants starting from 3-WAP (weeks after planting) to 8-WAP. Plant morphological characteristics were recorded from 3-WAP and the Disease Severity Index (DSI) was calculated. The yields were measured starting from 9-WAP.

Results: The number of infected leaves and the DSI were not significantly different ($P<0.05$) between treatments during the first seven weeks after planting. Also, the yield was not significantly different ($P<0.05$) between treatments.

Conclusion: The results imply that both the plant extracts have responded similar to the DOA recommended synthetic pesticide. Therefore, there is no negative effect of using the tested biopesticides and also, there is a great potential of developing these natural plant extracts as effective biopesticides in controlling CLCC in the future.

Keywords: *Chilli Leaf Curl Complex, Garlic extract, Neem extract, Organic pest control*

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Estimated tree canopy cover by remote sensing technique over manually measured tree basal area in determination of species dominance

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Background: Forest structure, which refers to the configuration and distribution of different plant species and sizes, plays an essential role in forest ecology, management and conservation oriented researches. Dominance index to identify dominant plant species is considered to be an important characteristic for the description of plant communities. Dominance index can be calculated by considering frequency, biomass, density and cover of the selected forest. However, at present remote sensing techniques have become much popular in forest studies.

Objectives: This study was aimed to investigate the accuracy of using canopy cover over tree basal area in determining the species dominance.

Methods: Rekawa mangrove forest in southern Sri Lanka was subjected for the study. One plot (size: approximately 1806 m^2) was selected and visited the site to manually record the basal area of the species present (M1 method). All the true mangrove species present were considered. Crown cover of the same species present in the aforementioned plot was mapped using Google earth pro (2020.11.14; source: CNES / Airbus) to a maximum zoom level (M2 method). Relative dominance (RD) was calculated separately for two above methods and the values were compared.

Results: According to M1 method, the RD is as follows: *Rhizophora mucronata* (RD: 0.32), *Lumnitzera racemosa* (RD: 0.23), *Excoecaria agallocha* (RD: 0.21), *Avicennia marina* (RD: 0.07) and *A. officinalis* (RD: 0.08). In M2 method, *R. mucronata* was recorded as the most dominant species (RD: 0.29) while *L. racemosa* (RD: 0.26) and *E. agallocha* (RD: 0.24) co-occur with *R. mucronata* being the 2nd and 3rd dominant species. *A. marina* (RD: 0.06) shows a high relative dominance than *A. officinalis* (RD: 0.07).

Conclusion: Apparently the trend of species dominance is best reflected by crown dominance with at least 86% fidelity for true mangrove species. Therefore, use of canopy cover in studying community structure of mangrove forests will be more advantageous and reliable.

Keywords: *Community structure, Dominance, True mangroves, Remote sensing, Conservation*

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Optimized CTAB based protocol for DNA extraction from medicinal plant *Costus speciosus*

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Background: *Costus speciosus*, a rich source of diosgenin, has been extensively investigated in the pharmaceutical industry due to its therapeutic properties. Molecular authentication of *C. speciosus* is an initial step in drug development for which high-quality genomic DNA is crucial. However, extraction of genomic DNA from *C. speciosus* is challenging due to high amounts of polysaccharides, polyphenols, alkaloids and other secondary metabolites.

Objectives: To develop an optimized cetyl-trimethylammonium bromide (CTAB) protocol to extract genomic DNA from polysaccharides and polyphenols rich *C. speciosus*.

Methods: The optimized protocol, modification of the CTAB extraction procedure of Doyle & Doyle (1987), required maceration of 80 mg of young leaf sample in 1200 µL of DNA extraction buffer (2% CTAB, 5 M NaCl, 1 M Tris-HCl pH 8.0, 0.5 M EDTA pH 8.0) followed by DNA extraction with an equal amount of chloroform: isoamyl alcohol (24:1v/v). High concentrations of sodium chloride (5M) and 3M of potassium acetate were used during isopropyl alcohol (IPA) incubation to remove polysaccharides while extended chloroform: isoamyl alcohol and 70% ethanol washing were performed to eliminate proteins and excessive salts, respectively. DNA yield from modified and Doyle & Doyle (1987) protocols were compared. The purity of genomic DNA was determined by A260/A280 ratios and ISSR-PCR analysis using UBC_811 primer.

Results: Average DNA yield from optimized protocol was 236 ng/µl and was 4.6 times greater than the Doyle & Doyle protocol. NanoDrop spectrophotometer resulted in a single prominent absorbance peak at 260 nm, and the ratio of absorbance at 260 nm to absorbance at 280 nm was 1.8-2.0. The DNA obtained through modified protocol was quite suitable for ISSR-PCR, resulting in reproducible bands with UBC_811 primer.

Conclusion: Optimizing the concentration of reagents according to the biochemical content of plant material is crucial when establishing a protocol to isolate high-quality genomic DNA from *C. speciosus*.

Keywords: *Costus speciosus, Medicinal plants, DNA extraction protocol, CTAB, Secondary metabolite*

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CRISPR-Cas9 off-target prediction via transfer learning pipeline

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Background: Application of CRISPR-Cas9 gene-editing technology in gene therapies to treat genetic diseases suffers from the risk of off-target effects. Biological Predictors with higher precision are needed for off-target risk assessment of guide RNAs beforehand the implementation of gene therapies. Deep supervised learning approaches have shown superior performance on off-target predictions and remained to be enhanced.

Objectives: The application of convolution neural networks (CNNs) for image recognition tasks in the biomedical domain like cancer classification, demographic and disease prediction has gained highly accurate results. Based on that, the current study analyses utilization of pretrained convolution neural network (CNN) models under a transfer learning pipeline to build an accurate deep supervised predictor for off-target risk assessment.

Methods: Three mostly adapted off-target datasets, CIRCLE-Seq(584,949 samples), GUIDE-Seq(213,943 samples), and HTGTS(10129 samples) were curated from parallel studies on the domain. As a pre-processing step, a three-dimensional representation of DNA-RNA sequence pairs was designed. Then a pool of pretrained CNNs was formed, including VGG19, VGG16, XCeption, ResNet50, and MobileNetV2, and different classification models were designed based on those pretrained architectures. Finally, designed models were fine-tuned and validated on off-target datasets.

Results: The off-target classification model with baseline VGG16 achieved the best training and validation AUCROC scores of 99.8% and 88% respectively and also reached a higher level of accuracy close to state-of-art prediction models.

Conclusion: Transfer learning is a more appropriate technique for improving CRISPR-Cas9 off-target prediction skills of deep supervised learning models, and the novel three-dimensional representation of features expands the applicability of pre-trained models. As future works, it is intended to integrate epigenetic and energetic features to enhance prediction accuracy.

Keywords: *CRISPR-Cas9, Gene-editing, Off-target risk, Transfer learning*

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Quantification of nitrate leaching from leafy red onion cultivation under growers practice of fertilizer use in Kalpitiya

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Background: Intensive agriculture practices together with indiscriminate use of fertilizer seriously affect groundwater quality in Kalpitiya due to excessive permeability of sandy Regosols.

Objectives: To quantify the nitrate leaching from red onion cultivation in Kalpitiya under grower-managed fertilizer practices compared to the Department of Agriculture (DOA) recommended practices.

Methods: Lysimeters with 0.28 m^2 area were installed 90 cm below the soil surface before the cultivation. The grower use rate (T1) and DOA recommended (T2) rates of all fertilizers were applied as two treatments and replicated three times in 7.2 m^2 plots. Prior to the planting of Jaffna local variety, compost (10 t/ha) was applied for both treatments. Fertilizer for T1 was four split applications of urea at 100 kg/ha, onion fertilizer (12:9:9) at 125 kg/ha, blue granules (12:12:17) at 62 kg/ha and calcium nitrate at 62 kg/ha at ten days intervals. For T2, fertilizers were applied as recommended by DOA. Irrigation was done twice a day and leachates from each lysimeter were collected and volume was recorded at weekly intervals and harvest was recorded 48 days after planting. Nitrates of leachate were analyzed using an ion-selective electrode (CPI 505).

Results: The cumulative leached nitrate after 48 days from T1 and T2 were 32.61 g/m^2 and 29.69 g/m^2 respectively. The harvested leafy onions from T1 and T2 were 18,727 kg/ha and 15,581kg/ha, respectively. The concentration of nitrate in leachate ranged from 17.3-160 mg/L in T1 and 37.4 -131mg/L in T2. Both treatments showed higher levels than WHO permissible levels of nitrate (50 mg/L) in drinking water. The nitrate leaching from T2 was lower than T1 even though the crop yield of T2 was lower.

Conclusion: Both systems showed leached nitrate concentrations above safe limits, which emphasizes the need for change in nitrogen fertilizer management for this crop on sandy Regosols.

Keywords: *Groundwater contamination, Nitrate leaching, Sandy regosol, Agrochemicals*

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Quantifying nutrient requirement of Cashew (*Anacardium occidentale* L.) plantations for a higher yield

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Background: Cashew is an important cash crop in Sri Lanka. There is an unmatched gap between actual (4-5 kg/tree/year) and potential yield (15 kg/tree/year) set by the Cashew Corporation, Sri Lanka (CCSL). The main cause for low yield is the insufficient nutrient supply.

Objectives: The study aimed to quantify nutrient requirement of cashew plantations considering nutrients inflows and outflows and compare it with current recommendations.

Methods: Nutrient budget was calculated based on nutrient inflows which include fertilizer application and soil nutrient pool, and nutrient outflows of consumption by tree, removal by yield as cashew nut, and other losses. Ten years yield records were obtained from plantations of CCSL. The off-take nutrients were quantified by laboratory analysis of harvested nuts. The nutrient requirement for different growth stages of trees were assessed based on published data. The nutrient budget was calculated and fertilizer requirement was quantified under two scenarios. The first scenario assumed no loss of nutrients from the system. Second scenario assumed that the loss of nutrients is equal to the nutrients supplied through the soil. In both scenarios nutrients from leaf litter, flowers and cashew apples were considered recycled based on current practices.

Results: The harvested nuts contained 1.97% N, 0.24% P, and 0.68% of K. The plant dry weight increment in terms of N, P and K was 3000 g/tree/year, 494 g/tree/year, and 1776 g/tree/year, respectively. Soil analysis showed that soil nutrient content was very low as 0.19% of N, 5.21 ppm of P and 4.60 ppm of K. Accordingly, required fertilizer for expected yield in the first scenario was Urea- 3954.8 g/tree/year, TSP-3937.6 g/tree/year and MOP-3754.2 g/tree/year. Fertilizer requirement according to the second scenario was Urea-6987.4 g/tree/year, TSP-3966.7 g/tree/year and MOP-3760.9 g/tree/year, which were much higher than the recommendations.

Conclusion: This huge gap between required and currently applied nutrient amount could be the reason for the unmatched gap between potential and present yields.

Keywords: *Cashew, Fertilizer requirement, Nutrient budgeting, Yield gap*

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Study of a cohort of children with Homocystinuria in Sri Lanka for selected variants in Methylenetetrahydrofolate reductase gene

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Background: Homocystinuria is an inherited, inborn error of homocysteine metabolism leading to the abnormal accumulation of homocysteine and its metabolites in blood and urine. Children with this condition could develop ocular diseases, abnormal blood clotting and skeletal abnormalities. Single nucleotide polymorphisms (SNPs) in the Methylenetetrahydrofolate reductase gene *(MTHFR)* interrupts the formation of the enzyme MTHFR, and it prevents homocysteine from being metabolized. Hence the homocysteine levels increase than the optimum levels.

Objectives: The main aim of this study was to find the association of the SNPs, c.665C>T (p.Ala222Val) and c.1286A>C (p.Glu429Ala) of the *MTHFR* gene, in a cohort of children who have been clinically confirmed with homocystinuria.

Method: In the current study, blood samples from eight children with homocystinuria who are followed up by the Lady Ridgeway Hospital, Colombo, were collected. The SNPs were detected using SNaPshot minisequencing, and the results were further confirmed by direct sequencing.

Results: Out of the 8 patients, 7 patients were heterozygous for c.1286A>C (percentage 87.5%), and the remaining patient was heterozygous for c.665C>T (percentage 12.5%). However, according to the clinical observations done in Lady Ridgeway Hospital, all of these patients were reported with similar clinical symptoms.

Conclusion: Although the results indicate that the SNP c.1286A>C was more prominent than the SNP c.665C>T, these results could vary depending on different socio-demographic factors, including gender, region and ethnicity. Furthermore, family history can also be a significant factor affecting this condition. Hence further studies are necessary with a larger cohort to confirm the association of these variants with homocystinuria in the Sri Lankan context. This could facilitate early diagnosis procedures for patients with this condition. Moreover, it would be useful to initiate a mutation database for the spectrum of the disease, which can be beneficial in enhanced patient care and be utilized for prospective studies.

Keywords: *Homocystinuria, Methelenetetrahydrofolate reductase, Snps*

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Comparative efficacy of a phytogenic product and an antibiotic growth promoter in improving growth performance and meat quality in broilers

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Background: The use of antibiotic growth promoters (AGPs) for poultry production is banned worldwide mainly due to their potential residues in poultry products and the consequent development of resistance against pathogenic bacteria which threaten natural immunity. Phytogenic compounds have gained recent attention as potential alternatives for AGPs due to their antioxidant and antimicrobial properties.

Objectives: The objective of this study was to evaluate the comparative efficacy of a commercial phytogenic product [*ESSENCIAL® ONE* (ES)] containing a mixture of essential oils and plant extracts, and a commercial AGP (*Agimycin 200 WSP*) consists of chlortetracycline (CTC) on growth performance and meat quality in broilers.

Methods: The treatments were control (without ES or *Agimycin 200 WSP*); ES-1 = 0.05% v/v of ES; ES-2 = 0.1% v/v of ES; and CTC = 0.25 g/L of *Agimycin 200 WSP* and administered in drinking water. A total of 120, day-old male Cobb-500 broilers (5 cages/treatment; 6 birds/cage) were used, and growth performance and meat quality of broilers reared for 35 days were evaluated. Data were analyzed in CRD using least significant difference and Friedman tests at 0.05 significance level.

Results: At d 35, birds given ES-1 had the lowest WG (weight gain; $P<0.05$), whilst the WG in Control, ES-2 and CTC were similar ($P>0.05$). Neither feed intake nor feed conversion ratio was influenced by treatments ($P>0.05$). The malondialdehyde concentration of the breast meat was the lowest ($P<0.05$) in birds provided with ES-2. The taste of breast meat from Control, ES-1 and ES-2 were more acceptable compared to CTC ($P<0.05$). However, aroma, texture, juiciness and overall acceptance had no difference ($P>0.05$) among treatments.

Conclusion: *ESSENCIAL® ONE* supplementation at 0.1% (v/v) was the most suitable level as an alternative for AGP in drinking water to improve WG and reduce the fatty acid peroxidation level in broiler chickens.

Keywords: *Antibiotic growth promoters, Broiler, Growth performance, Meat quality, Phytogenic compound*

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Coconut fat consumption and prevalence of cardiovascular disease risk factors among selected group of adult men in Sri Lanka

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Background: Prevalence of Cardiovascular disease (CVD) as well as its associated risk factors is gradually rising in Sri Lanka becoming the most challenging health problems of today. Coconut is the most common fat source in Sri Lankans usual diet and makes a significant contribution for their saturated fat (SF) intake.

Objectives: The aim of this study was to assess the patterns of coconut consumption and prevalence of CVD risk markers among a selected group of adult men as a part of an on-going research study.

Methods: Healthy adult men (n=158) aged 30 - 60 years were recruited for the study using a convenient sampling method. Information on socio demographic, health characteristics and usual food intake pattern were obtained using an interviewer administered questionnaire along with a three day diet diary including two weekdays and one weekend. Coconut consumption pattern was determined referring to a sub questionnaire on the daily usage of coconut at household level attached to the three-day diet diary. Anthropometric and blood pressure measurements were taken according to standard procedures using calibrated standard equipment.

Results: The daily mean coconut fat (CF) intake was 46.7 g and it was about 84% of their total daily fat intake (55.4 g/day). Almost 89% of their SF intake consisted of SF derived from CF. Majority of CF 33.3 g (71%) was contributed from coconut milk, while coconut oil (15%) and grated coconut (15%) contributed sparingly. Average daily household coconut consumption was 1.5. Mean BMI and the waist circumference across study group were 24.4kgm^{-2} (SD± 4.8) and 88.7 cm (SD±10.9), respectively, while majority (63%) were either overweight or obese. However, mean blood pressure parameters were within the normal range which is 78 mmHg for diastolic blood pressure and 127 mmHg for systolic blood pressure.

Conclusion: In conclusion, there was a significant contribution of CF towards the total fat (84.2%) intake and SF intake (89%) of average adult men while a higher proportion was derived from coconut milk compared to coconut oil and grated coconut. Study group had a higher prevalence of overweight and obesity, which is a contributory factor for CVD risk.

Key words: *Coconut fat, Coconut milk, Blood pressure, BMI*

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Evaluation of the antibacterial activity of *Averrohoa bilimbi* fruit and leaf extracts against *Escherichia coli and Staphylococcus aureus.*

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Background: The prospect of post-antibiotic era is becoming an alarming reality with the rapid emergence of antibiotic resistant pathogenic bacteria. Many plant derived compounds show promising antibacterial activity even though it is scarcely being investigated. One such underutilized fruit is *Averrhoa bilimbi* that has been used as an herbal remedy for various diseases since ancient times.

Objectives: This study aims to investigate the antibacterial activities of ethanolic and methanolic extracts of *A. bilimbi* fruit and leaf against *Escherichia coli* (ATCC 25922) and *Staphylococcus aureus* (ATCC 25923) through antibiotic susceptibility testing (ABST), minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) determination.

Methods: The plant extracts were obtained with cold maceration using 80% (v/v) concentration ethanol and methanol as the solvents. ABST was carried out by well diffusion and the zone of inhibition was measured. Broth macro dilution was used to quantitatively evaluate bacteriostatic and bactericidal properties of the *A. bilimbi* extracts and the results were taken in triplicates and statistically analysed.

Results: Results from well diffusion demonstrated that all extracts were effective against both strains of bacteria used in the study. Two-way analysis of variance (ANOVA) was used to evaluate the significance of the ABST results. Methanolic extract of bilimbi fruit was found to be significant. MIC of the methanolic extract of bilimbi leaf against *S. aureus* and *E.* coli was 25 mg/mL and 12.5 mg/mL, respectively. Additionally, MBC of the methanolic extract of bilimbi leaf against both test organisms was concluded as 100 mg/mL.

Conclusion: The study demonstrated that methanolic and ethanolic extracts of bilimbi leaves and fruits have antibacterial properties against *Escherichia coli* and *Staphylococcus aureus.* Further studies are required to identify, quantify and purify the phytochemicals in *A. bilimbi* leaves and fruits and to evaluate the full spectrum of their antibacterial activity.

Keywords: *Averrhoa bilimbi, Antibacterial activity*

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Molecular characterization and genetic variability among isolates of *Rigidoporus* spp. causing white root disease of Rubber (*Hevea brasiliensis*)

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Background: The white root disease fungus, known as *Rigidoporus microporus*, is the most economically destructive root pathogen of the tropical tree *Hevea brasiliensis*, also known as Para rubber. Para rubber is principally valued for its latex content, which is a significant industrial commodity. Besides species within the genus, *Rigidoporus* infects over forty alternative cultivated and wild host species. The morphological and biochemical identifications of fungi require a considerable time and a high skill level. Molecular identification is fast, reproducible, applicable at initial stages of infection, and provides high specificity to distinguish between the species and subspecies, etc. of fungi. Understanding of genetic variation in *Rigidoporus microporus* isolates causing the white root disease of rubber would be useful in assessing the virulence and for the improvement of effective disease management systems.

Objectives: Present study was conducted to identify and differentiate *Rigidoporus* isolates by molecular tools.

Methods: DNA was extracted from ten isolates morphologically identified as *Rigidoporus* spp. from different localities and hosts. Internal Transcribed Spacer region of nuclear ribosomal RNA (rRNA) gene was amplified using ITS 1 and ITS 4 primers and the amplicons were bi-directionally sequenced. The resultant sequences were searched over GenBank database at National Center for Biotechnology Information (NCBI) and Barcode of Life Data System (BOLD). A dendrogram was constructed using ITS sequence by Molecular Evolutionary Genetics Analysis (MEGA) software. PCR amplification of Inter Simple Sequence Repeat (ISSR) regions was also carried out and a dendrogram was constructed based on ISSR polymorphism using PHYLogeny Inference Package (PHYLIP).

Results: The sequences were identified as *Rigidoporus microporus* and deposited in the GenBank database.

Conclusion: Dendrograms constructed using both the ITS and ISSR markers revealed a considerable genetic variation among the isolates and a relationship between geographical distributions of the isolates with clustering patterns of isolates.

Keywords: *Dendrogram, ISSR, ITS, PCR*

Acknowledgment: Current study was supported by the Institute of Biochemistry, Molecular Biology and Biotechnology, University of Colombo Sri Lanka and the Rubber Research Institute of Sri Lanka

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Preliminary study of human pathogenic bacteria in the hot springs of Sri Lanka

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Background: Thermal springs are one of the extreme environments which harbour natural microbial populations including potential pathogens. High-throughput sequencing provides a more comprehensive insight into human bacterial pathogens in the environment.

Objectives: The current study investigated potential human pathogenic bacteria in the thermal springs of Sri Lanka through a metagenomic approach.

Methods: The water samples (n=2, totalling 3 L from each spring) were collected from Mahapelessa (44.5 ºC), Wahawa (42.8 ºC), Maha Oya (53.8 ºC) and Nelumwewa (44.2 ºC). Composite water samples (100 ml) from each hot spring were used for genomic DNA extraction (6 replicates) by modified Boom's method. The extracted DNA was subjected to 16S rRNA metagenomic sequencing (V3-V4 region) using the Illumina platform. The raw data were analysed to identify microorganisms (Operational taxonomic units/OTU) and their relative abundance. OTU analysis was carried out with a cut-off similarity of 97%.

Results: Most of the potentially pathogenic bacteria identified from hot springs belonged to the phyla, Proteobacteria and Firmicutes. *Burkholderia* (11.93%) and *Pseudomonas* (0.52%) were the most common pathogenic bacterial genera in all thermal springs. Based on the bacterial composition, the highest proportion of potential pathogens was from Mahapelessa (12.87%), followed by Maha Oya (6.15%), Wahawa (1.93%) and Nelumwewa (0.57%). The highest abundance of bacterial pathogens has been reported from Mahapelessa and Maha Oya, with temperatures varying from 45 ºC to 55 ºC. Diverse bacterial pathogens dominated the microbial community in investigated hot springs, including *Acinetobacter* sp. (2.29%), *Bacillus licheniformis* (0.07%), *Bacillus pumilus* (0.24%), *Burkholderia cepacia* (9.72%), *Enterobacter asburiaein* (0.19%), *Pseudomonas aeruginosa* (0.21%) and *Vibrio fluvialis* (0.06%) from Mahapelessa, *Bosea* sp. (0.42%) from Wahawa, *Delftia tsuruhatensis* (5.44%) from Maha Oya and *Burkholderia multivorans* (0.20%), and *Bosea* sp. (0.19%) from Nelumwewa.

Conclusion: The present investigation reports different dominant bacterial pathogens in geothermal springs in Sri Lanka and the significant differences in relative abundance could be observed for the diverse temperature ranges between hot springs.

Keywords: *Hot springs, Metagenomics, Pathogenic bacteria*

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RNA yield in serum extracellular vesicles of tuberculosis patients: using combined polymeric precipitation and filtration method

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Background: Extracellular vesicles (EVs) are an emerging platform for future biomarker discovery. EVs play a significant role in cell-to-cell communication and transportation of diagnostically significant molecules such as proteins, lipids, and nucleic acids. The most common method of EV isolation is differential centrifugation. However, more simple, fast, and cost-effective methods are demanding for resource-limited settings.

Objective: To identify a simple, fast, and cost-effective EV isolation method to obtain sufficient RNA yield for further downstream analysis.

Method: A total of 20 clinical samples were collected from active (ATB, n=14) and latent tuberculosis (LTB, n=6) patients (age ≥ 18 years); male (n=11) and female (n=9) attending the Kandy Chest Clinic. Serum was isolated from 4 ml of blood collected into separator tubes by centrifugation at 3,200 rpm for 15 mins at 4ºC. For EV isolation, 500 µl of serum was mixed with an equal volume of 16% polyethylene glycol (PEG) 6000, 1.0 M NaCl, and incubated at 4 ºC for 2h. Then the sample was centrifuged at 5,200 rpm for 20 mins and the subsequent pellet was washed three times with 50 µl of PBS. Finally, the pellet was resuspended in 1 ml of PBS and filtered through a 0.22 µm-Nylon filter. RNA isolation was performed using guanidinium thiocyanate–phenol–chloroform extraction and quantified using QuantiFlour^{R} RNA System (Promega).

Results: The mean serum EV-derived RNA (EvRNA) concentration of ATB and LTB were 5.19 ng/µl±2.76SD and 7.84 ng/µl±4.45SD, and the total EvRNA yield was 196.38 ng±97.01SD and 277.66 ng±164.63SD, respectively. There was no significant difference between the total EvRNA yield of the two groups ($t(18)= 1.39$, $p>0.05$). However, the obtained total RNA yield was 20 times higher compared to the minimum necessary concentration for downstream analysis (10 ng).

Conclusion: Accordingly, the combined polymeric precipitation and filtration method gives sufficient serum EvRNA for further downstream analysis.

Keywords: *Extracellular vesicles, PEG, RNA, Serum, Tuberculosis*

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Detection of IS6110 insertion sequence in serum extracellular vesicles of tuberculosis patients reported to Kandy Chest Clinic

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Background: Detection of sufficient bacterial RNA in latent tuberculosis biomarker identification is challenging. The discovery of extracellular vesicles (EVs) in biological fluids opened a new field of study. EVs carry both bacterial and host derived molecules. The content transported via EVs depends on the cell type and the pathological state of the cell. EV content is mostly derived from the host RNA and proteins (99%) and the pathogen content is comparatively less (1%). The insertion sequence IS6110 is an essential genetic sequence and a gold standard epidemiological marker for *Mycobacterium tuberculosis* complex (MTBC).

Objective: To identify the presence of serum EV-derived mycobacterial RNA in both active and latent tuberculosis patients using IS6110 insertion sequence.

Method: Total RNA was extracted from serum derived EVs (500 µl) using combined 8% polyethylene glycol (PEG)6000 precipitation and filtration (0.22 µm-Nylon filter) method. Complementary DNA (cDNA) was synthesized from 16 RNA samples collected from active tuberculosis (ATB, n=10), and latent tuberculosis (LTB, n=6) patients (age ≥ 18 years) from males (n=9) and females (n=7) attending the Kandy Chest Clinic. A conventional polymerase chain reaction (PCR) was carried out using IS6110 insertion sequence in a 25 µl PCR reaction mix containing 5 µl of template (6ng), 5x PCR buffer, 0.4 mM dNTPs, 2.0 mM $MgCl_2$, 1.5 units of Taq polymerase (Promega), 0.4 mM of Pt8 (Forward) and Pt9 (Reverse) primers. The amplified PCR products were run on 2.0% agarose gel along with 100bp ladder to visualize the band pattern.

Results: Four ATB samples (n=4/10) and one LTB sample (n=1/6) showed positive results with a total of five positive samples (n=5/16) among all tuberculosis patients.

Conclusion: Mycobacterial RNA could be detected in serum derived EVs using conventional PCR. The low detection rate of mycobacterial RNA may be due to the lack of optimal isolation protocol specific to the chosen biological sample.

Keywords: *Conventional PCR, Extracellular vesicles, IS6110, Serum, Tuberculosis*

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Microencapsulation and potential food application of phlorotannins from *Sargassum ilicifolium*

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Background: Brown seaweeds are rich in phlorotannins which have proven excellent bioactivity. However, they are hardly stable in processing, storage, and gastrointestinal environment disturbing the expression of their full bioactive potential in the human body.

Objectives: This study aimed to apply the encapsulation principle to perpetuate the storage and processing stability as well as *in vitro* bioactivity of phlorotannins.

Methods: Phlorotannins from *Sargassum ilicifolium* were isolated through polarity-based solvent fractionation and encapsulated in a chitosan-tripolyphosphate carrier. Encapsulation properties, storage and processing stability of formulated particles as well as sensorial effects of its fortification on carrier vehicle; jelly were determined. Total phlorotannin content, DPPH, nitric oxide scavenging, reducing power, and α-amylase inhibition assays were performed upon *in vitro* digestion and colon fermentation to investigate the relative bioactivity retention of phlorotannins through encapsulation.

Results: Semi-purified ethyl acetate fraction recorded the highest phlorotannin content; 854.380±48.417 mgPGE/g. Encapsulation efficiency and loading capacity of encapsulated particles figured 85.128±0.029% and 62.568±0.057% respectively while FTIR spectra evidenced effective encapsulation of bioactive in the wall material. Formulated particles seemed cylindrical and averagely 12μm sized through Scanning Electron Microscopy. Low-temperature storage helped better retention of active compounds in both encapsulated and free form than ambient conditions. Encapsulated form reported 56.400±2.339% of total phlorotannin content and 62.549±17.388% of total antioxidant capacity retention in 175^0C processing temperature. Product attributes remained unaltered when fortified with encapsulated phlorotannins. Free phlorotannins exhibited higher antioxidant activity in initial digestion stages while the effects seemed more pronounced towards later digestion stages for the encapsulated compound.

Conclusion: *Sargassum ilicifolium* is a promising source of phlorotannins and chitosan is an effective wall material for their encapsulation. The encapsulation helps preserve phlorotannins and the targeted delivery to their predominant absorption site; the large intestine. Thus, encapsulation widens the scope for better exploitation of phlorotannins vitality in functional food formulations.

Keywords: *Sargassum ilicifolium, Phlorotannins, Stability, Bioactivity, Targeted delivery*

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Development of a tissue culture protocol for direct and indirect regeneration of traditional Rice varieties in Sri Lanka

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Background: Rice (*Oryza sativa* L.) is one of the most important cereal crops that belong to the family Poaceae. Sri Lanka possesses a large number of traditional rice varieties with a huge genetic potential for the improvement of rice. With genetic engineering approaches, agronomically important traits from traditional varieties can be transgressed to cultivated rice. For the successful application of the aforesaid technologies, the development of an efficient plant regeneration system is required.

Objectives: This study was conducted to formulate a protocol for direct and indirect regeneration from seed explants of the traditional rice varieties; *Pachchaperumal, Suwandel* and *Kuruluthuda*.

Methods: Six different sterilization methods were tested to establish *in vitro* culture of rice seeds. For seedling emergence, rice seeds from each variety were placed on ½ Murashige and Skoog (MS) medium without plant growth regulators. For indirect regeneration, 20-day old calli initiated from modified N_6B_5 medium with 1 mg/L of α-Naphthalene acetic acid (NAA), 1 mg/L of 6-Benzylaminopurine (BAP) and 2 mg/L of 2, 4-D were transferred into ½ MS medium without plant growth regulators and kept under dark and light conditions. The results were analysed using the Chi-Square test.

Results: De-husked seeds sterilized with 70% ethanol for 5 minutes, 40% NaOCl and two drops of Tween 20 for 10 minutes followed by 40% NaOCl for another 10 minutes produced cultures without contaminations. After 10 weeks of culture initiation, the highest percentage (50%) of seedling emergence was observed in the variety *Suwandel.* Four weeks after culture initiation, variety *Pachchaperumal* initiated the highest percentage of calli both under light (100%) and dark (80%). Highest number of plantlet initiation from calli was observed in *Suwandel* under light.

Conclusion: Among the varieties tested, the highest percentage of seedling emergence and the highest calli initiation percentage was shown by *Suwandel* and *Pachchaperumal* respectively. However, the highest plantlet initiation from calli was shown by *Suwandel* under light.

Keywords: *Rice, Calli, Pachchaperumal, Suwandel, Kuruluthuda*

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A review of the impact of climate change on Paddy production in Sri Lanka

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Background: Rice is the primary staple crop for almost 50% of the world population. In 2050, its demand will be increased by 28%. It is the primary cultivated crop in Sri Lanka occupying 34% of the total cultivated area.

Objectives: The agricultural sector in Sri Lanka is vulnerable to climate change. Therefore, understanding the impact of climate change on paddy production is crucial to mitigate future difficulties by adopting additional efforts.

Methods: The Scopus database was used to obtain thirty relevant publications on the impact of climate change on paddy production published between 2010 and 2020. The articles focused on Sri Lankan territories are selected and conference proceedings are excluded.

Results: Climate change alters the precipitation regime, sea-level rise and temperature, which are highlighted in 23, 16, and 40% of the articles, respectively, with 20% highlighting all three. As for sea-level rise, the effects of salinity can permeate throughout whole deltas and change hydrological systems. Uncontrolled flooding hinders rice production because rice cannot survive if submerged under water for long periods. Higher temperatures can decrease rice yields as they can make rice flowers sterile and the quality of rice grain will be decreased. A 1% increase in temperature and rainfall leads to 3.44% and 0.12% decrease in current paddy yield, respectively. Furthermore, CO_2 levels, humidity changes and water scarcity affect the yield. Rainless days for a week in upland and for two weeks in shallow lowland rice-growing areas can significantly reduce rice yields. Rice diseases and pests are strongly influenced by climate change. Furthermore, water shortages, irregular rainfall patterns, and related water stresses increase the intensity of some diseases.

Conclusion: Climate change causes crop damage, low productivity and high production cost leading to income losses for farmers and increasing their poverty level. Therefore, adaptation practices are important to reduce these vulnerabilities.

Keywords: *Climate change, Paddy, Sri Lanka*

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Antioxidant potential of some traditionally used hepatoprotective herbs and their combination as a foundation for finding a remedy for non-alcoholic fatty liver disease

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Background: Non-alcoholic fatty liver disease (NAFLD) is identified as the most common chronic liver disease, worldwide. Since oxidative stress is a key etiological agent of this disease, antioxidants may have a protective role during the progressive stage of this disease.

Objectives: The objective of this study was to evaluate the *in vitro* antioxidant potential of a polyherbal formulation prepared from three traditionally used hepatoprotective herbs in Sri Lanka; the whole plant of *Vernonia cinerea* (Little ironweed), leaves of *Atalantia ceylanica* (Yaki Naran) and leaves of *Osbeckia octandra* (Heenbowitiya).

Methods: The herbs were authenticated, washed, air-dried and ground into a fine powder. They were mixed in a 1:1:1 ratio and extracted in hot water. Following the same conditions, individual ingredients were also extracted for the purpose of comparison. The antioxidant potential of the extracts was estimated using 2,2′-diphenyl-1-picrylhydrazyl radical (DPPH) and Trolox equivalent antioxidant capacity (TEAC) assays. All tests were done in triplicates and the results are expressed as mean± SD (n=3). The antioxidant potentials were compared using one-way ANOVA followed by a post hoc Tukey's test. $P<0.05$ was considered statistically significant.

Results: The IC_{50} of the DPPH radical scavenging assay for the tested polyherbal formula was 3.21±0.06 µl/ml. It was significantly lower than that of *V. cinerea* (5.28±0.26 µl/ml) and *A. ceylanica* (7.09±0.09 µl/ml) but significantly higher than that of *O. octandra* (0.09±0.01 µl/ml). The TEAC of the tested formula was 4.84±0.07 µg/ml which was significantly higher than that of *V. cinerea* (3.51±0.03 µg/ml), and significantly lower than that of *O. octandra* (23.99±0.77 µg/ml).

Conclusion: The *in vitro* antioxidant potential of the tested polyherbal formula is higher than that of *V. cinerea* and *A. ceylanica* extracts alone. Further studies are warranted to evaluate the antioxidant potential of this formula using cultured hepatocytes and an animal model.

Keywords: *Antioxidant, Atalantia ceylanica, Hepatoprotective, Osbeckia octandra, Vernonia cinerea*

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Sediment quality analysis in Kalametiya lagoon, Southern Sri Lanka and phytoremediation capacity of *Typha angustifolia* L.

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Background: Coastal lagoons are highly affected by heavy metal (HM) pollution. Therefore, it is imperative to study the potential factors causing prolonged retention of HMs in lagoons and methods to minimize the effects of HM pollution.

Objectives: To determine the quality, textural characteristics and geochemical associations of surface sediment that determine the bioavailability of the HMs, Chromium (Cr), Cadmium (Cd), Arsenic (As), Mercury (Hg) and Lead (Pb). Furthermore, the phytoremediation capacity of *Typha angustifolia* L., one of the commonly found water sedges was investigated

Methods: Sediment samples (n=13) obtained using the grab sampling method were examined for sediment quality parameters, grain size analysis, sequential extraction and semi-quantitative analysis of sediment surface attributes utilizing a Scanning Electron Microscope. HM accumulation in roots, stems, and leaves of *Typha*, were determined to formulate Partitioning Index (PI) ie. HM fraction in one particular part of the plant relative to the whole plant and Uptake Co-efficient (UC) ie. HM concentration in the plant body comparable to the sediment.

Results: Fine particle fraction of sediments significantly contributed ($p<0.05$) to the retention of Cr, As, Hg, and Pb, except Cd. Pb and Cr were strongly associated with the Fe-Mn bound phase whereas As, Cd and Hg with the soluble phase in sequential extraction. Furthermore, surface attributes of fine particles and high angularity are suggested to be the key factors that determine the HM retention in fine sediments. Among the studied metals, UC for Hg was below one. Excessive PI was observed in *T. angustifolia* leaves than in roots or shoots.

Conclusion: High, dissimilar UC (Cr, Cd, As, Pb) and low UC (Hg) estimated for the metals reflect the phytoremediation capacity of *T. angustifolia* plants and its varying affinity towards HMs. Fine particles retain higher content of HMs than coarse particles and vary with geochemical associations. *Typha angustifolia* is a worthy choice for phytoremediation.

Keywords: *Heavy metals, Phytoremediation, Sediment quality, Typha angustifolia, Kalametiya lagoon*

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Potential distribution of *Sonerila* in Sri Lanka

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Background: *Sonerila* is an iconic tripetalous member of the family Melastomataceae found in tropical montane forests across South (SA) and Southeast Asia (SEA). It has been recognised that Sri Lanka (SL) has 22 *Sonerila* species which all are endemic to the country whilst many of them are threatened in the wild. Regardless of its importance, there had been little focus on the geographic distribution of genus *Sonerila* not only in SL but across all its distributions.

Objective: The study aims to understand the potential habitat suitability for *Sonerila* in SL and identify the potential habitats for future collection and conservative purposes.

Method: The study is based on 1,519 geo-referenced species occurrence data recorded in Global Biodiversity Information Facility (GBIF) through the species distribution modelling approach across SA and SEA. Occurrence data were cleaned for duplicates and problematic records using "CoordinateCleaner", in R version 3.6.1. Distributions were modelled against 19 bioclimatic variables with a 30 arc-second (~1 km at the Equator) spatial resolution in MaxEnt version 3.6. The model fitted with default parameters and performed three replicate runs with 5-fold cross-validation. A jackknife test was performed to understand the importance of each bioclimatic variable. Model performance was evaluated against the AUC of the ROC, Training omission rate and the *p*-value.

Results: The distribution of *Sonerila* species broadly spread in SA and SEA while the potential habitats are highly concentrated in SEA. The results show that Borneo, Sri Lanka and India have the highest suitability habitats for *Sonerila*, followed by Sumatra, Java, the Philippines, Sulawesi and PNG. Central Highlands of Sri Lanka (at or above ~1800 m) show a remarkably high *Sonerila* species richness which supports the highest plant species diversity of Western Ghats - Sri Lanka biodiversity hotspot. Further, distributions were largely affected by temperature annual range (<100), annual precipitation (>2000 mm), temperature seasonality (0) and precipitation of the driest quarter (400 - 600 mm) of the region.

Conclusions: Sri Lanka is one of the highest potential suitability habitats for *Sonerila* species occurrence but seemingly underexplored for *Sonerila* richness. Specifically, the Central highlands complex of SL will probably be having a very high species richness. Some of these areas are already known for *Sonerila* presence with several collection records, but notably, the size of the potential distribution is significantly larger than the current occurrence records, hence these insights will guide future explorations and conservative aspects.

Keywords: *Sonerila, Melastomataceae, Species distribution modelling*

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Determination of proximate chemical composition and cadmium content in commonly consumed freshwater fish in Ampara district

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Background: Fish are high in nutrition and have a variety of health benefits for humans. Three freshwater fish species namely *Channa striata, Heterophenus fossili and Osphronemus goramy,* are locally available and usually consumed in Ampara district were studied.

Objectives: There is hardly any recent study performed on proximate chemical composition and cadmium content of these fish species to ensure the requirement of compliance with food regulations and other commercial specifications. Thus, there is a necessity of determining the chemical composition of these species to fill the information gap which helps in developing consumer safe, nutritionally balanced and cost-effective diets for people in Ampara district.

Methods: Ten individual samples of each fish species were collected from the local market and the proximate composition and cadmium content in samples were analysed by standard methods. Data were statistically analysed by using SPSS software.

Results: The results revealed that the average protein and moisture contents of the fish varied from 14.3±0.1 % to 20.2±0.2 % and 77.90±0.57 % to 79.18±0.14 % respectively, where *H. fossili* was found to be with the highest protein and moisture contents followed by *C.striata*. The minimum (0.12±0.008 %) and maximum (0.63±0.019 %) fat contents were reported for *C.striata* and *H.fossili* respectively. The mean values of the ash contents varied among the three species from 0.12±0.006 % to 0.86±0.037 % at $p < 0.05$. The cadmium concentration was varied between 0.020±0.001 ppm to 0.022±0.001 ppm, which is still within the FAO recommended safety level. A significant difference was observed ($p<0.05$) in moisture, protein and ash contents among the species whereas fat and cadmium contents showed no significant differences.

Conclusion: The species *H. fossili* could be preferred for continuous consumption as it has a higher content of protein and all three species are safe for consumption as far as the cadmium content is concerned.

Keywords: *Cadmium, Freshwater fish, Proximate, Ampara*

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Assessing spatial allocation of coastal and marine utility areas in the North-Western region of Sri Lanka

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Background: Coastal and Marine ecosystems of the North-western region of Sri Lanka, provides numerous services, are rich in biodiversity and also vulnerable to degradation due to anthropogenic activities. Marine Spatial Planning (MSP) is an area-based management framework for marine space to improve the decision making that address the different management objectives of multiple stakeholders to ensure the resource sustainability of the area.

Objectives: The study aims to develop a marine spatial plan which can address the conflicts arising among human uses and the marine environment of North-western region of Sri Lanka, to ensure protection and sustainable use of coastal/ marine resources.

Methods: MSP was developed using a GIS and Remote Sensing based approach. This included collection of geographical data available with institutions relevant to natural resource use planning and management. The land-use data were analysed using ArcGIS 10.4.1 software to assess suitability of the current allocation of coastal lands and waters for various uses.

Results: Analyses indicated that proposed new marine protected areas (MPAs) with its core zone that includes dugong habitats overlaps with the areas year marked for aquaculture development. Proposed oil and gas exploration sites are located in common fishing grounds and close proximity to the highly productive and environmentally sensitive areas such as Bar Reef Marine sanctuary and Vankalai sanctuary.

Conclusion: Special attention should be given to areas with conflicts of interests of various stakeholders when declaring them as protected areas. According to the present study, MSP is the paramount solution for overcoming increasing pressures on marine environment due to different activities and minimize the multiple user conflicts in such areas.

Keywords: *GIS, Marine spatial planning, Marine biodiversity*

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Comparison of steviol glycoside contents in conventionally propagated plants, tissue cultured plants and callus of *Stevia rebaudiana* using HPLC

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Background: *Stevia rebaudiana* leaves are the source of non-caloric sweet steviol glycosides and stevioside, rebaudioside A, rebaudioside C and dulcoside A are the main four glycosides. Growth stage of a plant is one of the main factors which affect the amount of steviol glycosides present in leaves and the amounts can vary in conventionally propagated plants and *in vitro* cultures.

Objectives: Study was designed to determine the possibility of obtaining steviol glycosides through *in vitro* technology and to find out the best growth stage of plants for harvesting leaves.

Methods: Leaf discs taken from *in vitro* germinated seedlings were used for callus induction and nodal segments were used for *in vitro* direct organogenesis. Regenerated shoots were transferred into the rooting medium and well developed and well rooted plantlets were acclimatized. Phytochemicals were initially extracted into methanol, evaporated using a rotary evaporator and re-dissolved in acetonitrile: deionized water (3:7) ratio solvent mixture. Steviol glycoside contents of conventionally propagated plants at different growth stages were compared with those of tissue cultured plants and callus cultures using HPLC. HPLC system with C18 column and UV–Vis detector set to a wavelength of 210 nm was used. Mobile phase consisted of a 30:70 mixture of acetonitrile and deionized water that was used at a constant flow rate of 1 mL/min.

Results: Leaves of plants at the onset of flowering showed highest stevioside content (10.943 ± 0.08 mg/mL). Leaves of three months old tissue cultured plants (onset of flowering) contains higher amount of steviol glycosides (8.479 ± 0.07 mg/mL Rebaudioside A, 11.462 ± 0.03 mg/mL Stevioside, 1.936 ± 0.04 mg/mL Rebaudioside C and 0.646 ± 0.01 mg/mL Dulcoside A) than conventionally propagated plants and calli.

Conclusion: Onset of flowering is the best growth stage to harvest Stevia leaves for steviol glycoside extraction and tissue culture can be suggested as the better alternative to overcome limitations in conventional propagation and to produce genetically uniform better-quality Stevia plants for large scale cultivation.

Keywords: *Stevia rebaudiana, Steviol glycosides, Tissue culture, Callus, HPLC*

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Detection of microcystin and nodularin in water and rice samples collected from CKDu endemic Girandurukotte, Sri Lanka

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Background: Cyanotoxins get into the human body via drinking and consuming edible plants irrigated with cyanotoxin-contaminated water. Cyanotoxins have gained serious attention due to their nephrotoxic, hepatotoxic and neurotoxic activities.

Objectives: The presence of microcystins (MCs) and nodularin (NOD) in water and rice samples collected from CKDu endemic Girandurukotte were investigated.

Methods: Totalling 53 water samples, including well waters of CKDu (n=25), CKD (n=9), and healthy residents (n=12), reservoirs (n=2), water treatment plant (n=1), tube-wells (n=2) and springs (n=2) were collected. Water samples were inoculated into cyanobacterial-specific BG11 medium. Rice samples (n=31) were also collected from above-mentioned residents. Methanol extracts of each sample were analysed by high-performance liquid chromatography (HPLC) to detect the presence of MCs and NOD using SIGMA-ALDRICH 33578 as MC RR-YR-LR standard and SIGMA-ALDRICH 32539 as NOD standard.

Results: Among microscopically identified cyanobacteria, *Phormidium, Oscillatoria*, *Anabaena* and *Merismopedia* are potential MC producers, while *Nostoc* produces both MC and NOD. Except for tube-well samples, HPLC chromatograms showed the presence of one or more MC variants, in 44.4% CKD, 40% CKDu, 41.6% healthy individuals' well water samples, one from each category of water samples collected from reservoirs, springs and the water treatment plant. The presence of NOD was observed in 12% CKDu patients' well water, one from reservoirs and tube-well samples. Water samples collected from CKD and healthy individuals' wells, springs and the water treatment plant did not show a peak for NOD. 32% of tested rice samples showed the presence of one or more MC variants while none showed the presence of NOD.

Conclusion: Results indicate the presence of cyanotoxins in water sources and rice, particularly in CKDu endemic areas. It highlights the importance of quantifying cyanotoxins to investigate the ability of posing a human health risk. The research study is in progress, to find the possibility of cyanotoxins to be a CKDu risk factor.

Keywords: *CKDu, Cyanotoxins, Drinking water, Rice*

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Evaluating the scenic beauty of the Southern expressway landscape using GIS and remote sensing and suggestions to improve the landscape

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Background: Occurrence of landslides, frequent accidents and negative impacts on environmentally sensitive areas are some of the issues associated with the Southern Expressway in Sri Lanka. Most of these issues could be resolved through proper landscape designing along the highway.

Objectives: This study intended to assess the existing landscape and land cover/use types of the Southern Expressway using Geographic Information System (GIS) and remote sensing, and to suggest different landscape models for selected sites which can be repeated along the expressway.

Methods: Study area boundary of 1 km buffer zone along the expressway was demarcated. Existing land cover/ use types and environmental sensitive areas were identified using ArcGIS 10 and Google Earth software. Using Landsat 8 imageries, a map was developed based on Normal Difference Vegetative Index (NDVI) within the buffer zone to validate the acquired land use map. Landscape models were developed using the Real Time Landscaping Architect software on nine selected photographs after field observations. A visual preference survey was conducted using a focus group of 30 participants to determine the best options of landscape design models to be implemented.

Results: Results revealed that the Expressway is surrounded by different land cover/use types, environmental sensitive areas, archaeological reserves and ancient protected monuments, landslide-prone areas, hydrological areas, forests and wildlife reserves, and its greenness varied throughout the buffer zone. In the visual preference survey, the respondents preferred more natural landscape designs which fully or partially cover the residential areas and natural designs that thoroughly screen the religious sites along the Expressway. Respondents mostly preferred to have landscape designs which express the importance of the area with labelling directly with words.

Conclusion: Visual preference survey suggests the need for area-specific landscape designs for the Southern Expressway and the importance of human perception-based methods in designing landscapes.

Keywords: *GIS, Land use, Greenness, Visual preference survey*

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The role of probiotics in enhancing the nutrition absorption- A review

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Background: Undernutrition continues to be a major concern in health and development. In 2016, 15.1% wasting, 17.3% stunting and 20.5% of underweight were reported in Sri Lanka. Even though how much consumption does, the amount of nutrients absorbed from the diet affects the malnutrition conditions. Probiotics are one of the sources which improve the beneficial microbiome density in the gut through the correct diet plan.

Objectives: Study the role of probiotics in enhancing nutrition absorption.

Methods: Influences of different probiotics through diet in nutrition absorption were reviewed with research findings using meta-analysis. The 45 research papers were used to review from indexed and peer-reviewed journals.

Results: According to my reviewing, 27 research concludes that probiotics enhance nutrition absorption. Literature evidence shows that different kinds of microorganisms affect different types of nutrient absorption and also having different foods in a diet gives different probiotics. Around 20 to 30% of energy from indigestible carbohydrates and proteins is captured by colon absorption. Enzymes produced by the microbiome improve the digestion and absorption of macromolecules. Probiotics increase the bioavailability of calcium by almost 100% in some fortified foods. And complex plant carbohydrates/prebiotics contribute to increasing nutrient absorption through the gut epithelium by increasing the gut probiotic microbiome.

Conclusion: Literature evidence shows that probiotics positively influence nutrition absorption in the gut. So consuming enough amount of probiotic-rich foods increases nutritional status and prebiotics support the functional properties.

Keywords: *Probiotics, Nutrient absorption, Utilization, Probiotic food*

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arsM gene abundance in Sri Lankan paddy soils

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Background: Rice is one of the major sources of arsenic (As) in humans. Inorganic As is a type I carcinogen, whereas organic As is less toxic for humans. Methylation of As is a key step of the As biogeochemical cycle and methylated As is the only source of organic As species in rice. Soil microorganisms harbour *arsM* gene that encodes As (III) S-adenosylmethionine methyltransferase enzyme, mediating the As methylation. However, the abundance of the *arsM* gene in Sri Lankan paddy soils has not been studied before.

Objectives: Analysing the *asrM* copy numbers in paddy soils and the factors that affect the abundance of the *arsM* gene in Sri Lankan paddy soils is the objective of the present study.

Methods: Paddy soils were collected from wet, intermediate, and dry zones of Sri Lanka. Soils were incubated under controlled conditions, and porewater and soil samples were collected after two weeks. Bacterial DNA was isolated from incubated soil samples, and log2 *arsM* copy number was quantified using qPCR. Additionally, soil pH, Eh, soil organic carbon (SOC) and total organic carbon in porewater (TOC) were also measured. Total As was analysed using ICP-MS, and As speciation was detected using IC-ICP-MS.

Results: *arsM* copy number was well correlated with soil pH, Eh, SOC, TOC and soil As. However, there was no significant difference between the abundance of *arsM* gene copy numbers across different climatic zones in Sri Lanka. Porewater DMA (organic As) was not correlated with $\log_2$ *arsM* copy number.

Conclusion: The abundance of *arsM* gene depends on soil chemical parameters. The results suggested that the *arsM* copy number in the soil is not an indicator for the As methylation capacity in Sri Lankan paddy soils.

Keywords: *Sri Lanka, Paddy soils, arsM gene*

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Phytochemical screening, antioxidant activity and total phenolic content of plant extracts in *Polyscias scutellaria* in Sri Lanka

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Background: *Polyscias scutellaria* is an underutilized plant available in Sri Lanka which is locally known as "Koppa kola". Even though this species has been used traditionally for different purposes, consumption of this plant has been reduced drastically in modern society due to the poor awareness and unrecognized nutrient values.

Objectives: Present study was carried out to screen the different extracts of *P. scutellaria* tender leaves to determine phytochemicals, antioxidant activity and total phenolic content.

Methods: Qualitative *in vitro* phytochemical screening was done in three different solvent extractions of *P. scutellaria*, namely ethanol, methanol and chloroform (0.1 mg/mL). After adding different regents, phytochemical availability was identified using colour variations and precipitations in each extract. Moreover, each extract was tested for antioxidant activity using DPPH and ABTS assays while total phenolic content was estimated using Folin – Ciocalteu procedure.

Results: *In vitro* phytochemical screening confirmed the presence of alkaloids, phenols, flavonoids and saponins in all three extracts, while quinine was presented in ethanol and chloroform extracts. Moreover, tannins and terpenoids were identified in hexane extract and steroids were presented in ethanol extract. The highest antioxidant activity for both DPPH (IC_{50} 2.20 mg/mL) and ABTS (342.50 mg TEAC/g) assays were found in ethanol extract followed by chloroform and hexane extracts. The highest total phenolic content was also observed in ethanol extract (9.91 GAE mg/100 g) followed by chloroform (1.52 GAE mg/100 g) and hexane (1.24 GAE mg/100 g) extracts.

Conclusion: The results provide evidence to the presence of antioxidant secondary metabolites, phenolic compounds and important phytochemicals in *P. scutellaria* extracts. This study has shown the potential application of this plant as a good source of antioxidant/dietary supplement.

Keywords: *Polyscias scutellaria, Phytochemicals, Antioxidants, Phenols*

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One-Health approach: Colonization prevalence of *Staphylococcus aureus* and MRSA in farm personnel, livestock and livestock products in Southern Sri Lanka

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Background: *Staphylococcus aureus* is a pathogenic bacterium that causes both minor and severe infections in humans and animals. Methicillin-resistant *S. aureus* (MRSA) more often causes life-threatening infections. MRSA strains can be transmitted to humans via direct contact with animals, environmental contamination, and eating or handling contaminated livestock products. MRSA colonization prevalence in farm personnel, livestock, and livestock products in southern Sri Lanka is unknown.

Objectives: This study describes the prevalence of *S. aureus* and MRSA isolated from nasal swabs of both farm personnel and livestock, and of livestock products in the southern province of Sri Lanka.

Methods: From November 2020 to May 2021, nasal swabs were collected from farm personnel who had direct contact with livestock, as well as from randomly selected livestock (cattle, buffalo, pig, goat, and poultry). At least one livestock product (dairy products, meat, or egg) was collected from each farm/ retail shop. *S. aureus* and MRSA isolates were identified using standard microbial and antibiotic susceptibility testing based on cefoxitin resistance as in CLSI, 2018.

Results: A total of 136 nasal swabs were collected from farm personnel working at 46 farms (large scale-28.3%, medium scale-30.4% and small scale-41.3%). Personnel were mostly male (75.7%) and had a median age of 44 (17-76) years. Of them, 38 (27.9%) had *S. aureus* and 9 (6.6%) had MRSA. Of 142 nasal swabs collected from livestock (cattle/buffalo-38.7%, pig-30.2%, goat-20.6% and poultry-6.3%), 22 (15%) had *S. aureus* and 1 (0.7%) had MRSA (cattle/buffalo-1.8%). Among 78 livestock products tested (dairy products-69.2%, meat-10.2% and egg-20.5%), 15 (19%) showed *S. aureus* and 2 (3%) had MRSA (meat-25%), respectively.

Conclusion: MRSA was isolated from farm personnel, livestock, and livestock products. The presence of *S. aureus* at a considerable level in livestock and livestock products may increase potential transmission to humans. Continued surveillance of farmers and livestock is needed to describe zoonotic transmission.

Keywords: *MRSA, One-Health, Prevalence, Staphylococcus aureus, Southern-Sri Lanka*

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Assessment of fatty acid profile of some selected edible oils available in the Jaffna district

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Background: Lipids play a vital role in human health in different ways; they serve as an energy source, a component of cell membranes, hormones and carrier for lipid-soluble bioactives. Edible oils are the major source of lipids in the human diet. However, their quality is a serious concern due to adulteration with poor quality oils.

Objectives: This study aimed to assess the quality of three edible oils available in Jaffna district emphasizing on their fatty acid profile.

Methods: Triplicate samples of branded oils; sunflower oil (SO) (n=3), palm oil (palm olein) (PO) (n=4), and olive oil (OO) (n=2) were collected from markets in the Jaffna district. Fatty acid methyl esters prepared by BF_3-methanol method were analyzed using gas chromatography. Values were compared with the standard values specified by the Codex Alimentarius Commission.

Results: All SO samples had the fatty acid composition within the standard ranges with the total unsaturated fatty acid content and saturated fatty acid content ranging from 92.21 to 92.24% and 7.01 to 7.74%, respectively. The saturated and unsaturated fatty acid contents of PO samples were 38.96 - 44.81% and 55.09 - 61.5%, respectively. In all the PO samples, the lauric acid content was higher (0.83-1.61%) than the standard (0.1-0.5%) and in brand 3, palmitic acid content (35.68%) was less than the standard (38.0-43.5%). The ranges of saturated and unsaturated fatty contents of OO samples were 10.55-13.1% and 89.61-87.62%, respectively. The fatty acid composition of brand 1 OO was in line with the standards. However, brand 2 of the OO had much less oleic acid content (49.45±0.01) than standard (55-83%) whereas linoleic acid content (38.17±0.00) was higher than the standard (3.5-21%).

Conclusion: PO and OO samples are suspected to be adulterated with other types of oil. Further studies are needed to confirm the adulteration of suspected samples.

Keywords: *Adulteration, Fatty acid composition, Olive oil, Palm oil, Sunflower oil*

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Developmental duration of immature *Spodoptera frugiperda* (Lepidoptera: Noctuidae): an important dimension for sex-based pest control

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Background: The Fall Armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae) is a polyphagous pest that causes yield loss in a wide range of crops resulting a great economic impact to the agriculture sector, worldwide. The extensive use of insecticides to mitigate FAW has driven to the development of pest resistance; therefore, a sustainable and effective approach is required for pest mitigation. Understanding the durations of immature stage development, leading to male and female insects, can support the development of sex-based pest management measures.

Objectives: The study intends to examine the development durations of FAW immature stage, to support the development of sex-based pest management of FAW.

Methods: Different larval stages of *S. frugiperda* were collected from ten highly infested Maize fields in the North-Central, North-Western and Uva provinces of Sri Lanka, representing dry and intermediate climatic zones. They were reared under controlled environmental conditions (28±2 °C, 80 % RH & 12 h:12 h light:dark natural photoperiod). Over six successive generations of laboratory rearing, a total of 201 live FAW (females = 114, males = 87) were observed for their immature stage developmental duration: the total duration of larval stage, prepupal and pupal stages (upon hatching to eclosion).

Results: One-way Analysis of Variance (ANOVA) was conducted to determine the significant variation in immature stage growth between sexes. A significant difference of total immature stage duration was found in relation to male and female FAW. The mean duration (mean±SE) for male was 26.0 ± 0.5 days, and that for females was 24.4 ± 0.5 days (df=1, $F_{x,y}$=30.06, p=0.000). This represents sex specific fitness benefits and survival strategies for sexes as early emergence of females increases early fecundity, whereas delayed eclosion in males avoid mortality risks in nature.

Conclusion: The study suggests that development duration of immature *S. frugiperda* depends on the sex.

Keywords: *Spodoptera frugiperda, Immature stage, Developmental duration*

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Biomonitoring $HgCl_2$ with *Dracaena sanderiana* under two different irradiance levels: effects on the photosynthetic apparatus

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Background: Heavy metals such as Hg are phytotoxic. Interference of heavy metals with photosynthesis has been a topic of intensive research during the last few decades. Some plants can be used in biomonitoring and the remediation of such pollutants. It is important to test the biomonitoring potential in ornamental plants as they do not enter into the food chain.

Objectives: This experiment was conducted to examine the effect of $HgCl_2$ on the photosynthetic apparatus in *Dracaena sanderiana* to assess its potential to use in biomonitoring.

Methods: *D. sanderiana* cuttings were subjected to heavy metal stress (100 µM $HgCl_2$ solution), along with control (distilled water) under two contrasting irradiance levels (High light-22,500±2,000 and Low light-750±200 lux). Treatments were laid out in a Completely Randomized Design with three replicates. The measurements were recorded four times a day (9am, 12noon, 3pm and 6pm) continuously for four days. OJIP chlorophyll fluorescence transient analysis was done using a fluorometer (FluorPen, FP-110). Specific energy fluxes per reaction centre, flux ratios and Performance Index (PI) were recorded.

Results: There was a significant reduction in PI, maximum quantum yield of primary photochemistry (φPo) and quantum yield of electron transport (φEo) in $HgCl_2$ treatment compared to control. This indicates the negative effects of Hg^+ on the photosystem II. However, visual rating of the foliage quality was at a satisfactory level. Moreover, there was a significant increment in absorption per reaction centre (ABS/RC) and maximum quantum yield of non-photochemical de-excitation (φDo) in $HgCl_2$ treatment with time. Except in electron transport efficiency (ψ_o), a clear unimodal circadian variation was observed in all OJIP parameters under high light conditions.

Conclusion: Photosynthetic apparatus of *D. sanderiana* is affected by the Hg^+. However, the plant can cope up with the heavy metal stress indicating that it can successfully be employed in short-term biomonitoring of $HgCl_2$.

Keywords: *Biomonitoring, Chlorophyll fluorescence, Dracaena sanderiana, Mercury*

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A simple and effective method for quantifying the leaf variegation in red-pigmented *Aglaonema* cultivars

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Background: *Aglaonema* cultivars, the red-series in particular, have gained attention in the recent past with a high demand in the floriculture trade as a foliage ornamental plant. *Aglaonema* plants are valued based on their foliar variegation trait which is placed as the second most important consideration in the purchase decision at commercial scale. In quantifying the amount of variegated colour on leaves, a simple and efficient technique is required, specially for the export market.

Objectives: In this study, we attempted to develop a simple and effective method to quantify the amount of variegated colour on leaves.

Methods: Image colour analysis was performed using thirteen red-pigmented *Aglaonema* cultivars. Using a digital camera, the images of the variegated leaves were imported into a computer. Pixel value of each colour within the selected leaf area was determined using MatLab software and respective RGB measurement graphs were generated for each sample. RGB histograms were built on the colour values 0-255 (x-axis) and relative numbers of pixels at each of the 255 colour values (y-axis). The dendrogram for the selected 13 newly introduced red pigmented *Aglaonema* cultivars was derived through cluster analysis using Minitab 17 software, from the RGB peak colour values.

Results: All the cultivars used, generally have red-pink colour and yellow colour patches on leaf blade. Three main clusters were observed at the similarity percentage of 66%. Leaf samples under each cluster show similar graph patterns in RGB measurement. In most of the samples, dark red colour was observed and all the leaf samples indicated having dark green colour variegations. Blue colour was not visible in the leaves.

Conclusion: Image colour analysis qualifies as a valuable new tool for accurate, reproducible detailed and objective quantitative assessment for monitoring changes in colours and variegation patterns of plants like *Aglaonema.*

Keywords: *Aglaonema, Araceae, Dendrogram, Foliar variegation, Foliage plants*

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Evaluation of prebiotic activity and dietary fiber content of raw and processed *Artocarpus nobilis* (Ceylon breadfruit) seeds

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Background: *Artocarpus nobilis* (Ceylon breadfruit) is an underutilized native tree in Sri Lanka. The nutritional and functional properties of the seeds of that tree are yet to be explored. These seeds may contain potential prebiotic compounds, and processing may alter their functionality.

Objectives: To investigate the *in vitro* prebiotic activity and dietary fiber content of raw and processed: roasted, boiled and microwaved *A. nobilis* seeds.

Methods: Dietary fiber content was determined according to the enzymatic gravimetric method specified in AOAC (2012)-991.42, using a dietary fibre assay kit. Seeds were subjected to simulated *in vitro* digestion using synthetic gastrointestinal enzymes and the non-digestible portion was used as the carbon source for probiotic bacteria: *Bifidobacterium animalis* Subsp. *lactis* (BB-12) and *Lacobacillus acidophilus* (LA-5). Prebiotic activity of *Artocarpus nobilis* was determined in comparison with the commercially available prebiotic, inulin, after 24-hour incubation.

Results: The total dietary fiber (TDF) content of *A. nobilis* seed ranged from 27.72- 30.08% in dry matter. Raw seeds had significantly higher ($p < 0.05$) TDF content than the processed samples. Nevertheless, TDF content did not significantly ($p > 0.05$) vary among roasted, boiled and microwaved samples. The insoluble dietary fiber content of the raw and processed samples ranged from 25.23-27.58 % DM, where soluble dietary fiber content accounted for less than 3.2 %. When considering the prebiotic activity, both raw and processed *A. nobilis* seeds showed significantly higher ($p < 0.05$) *Lactobacillus* proliferation ability than the positive control inulin, where boiled seeds showed the highest (2.466 log CFU/ml) activity. When compared to inulin, both raw and processed *Artocarpus* seeds showed significantly lower ($p < 0.05$) *Bifidobacterium* proliferation ability. However, there was no correlation between dietary fiber composition and prebiotic activity of the studied samples.

Conclusion: According to the findings of this study *A. nobilis* seeds could be considered as a good source of dietary fiber with greater prebiotic potential.

Keywords: *Artocarpus nobilis, Bifidobacterium, Dietary fiber, Lactobacillus, Prebiotic activity*

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Probing the effect of salicylic acid on the post-harvest changes in *Cordyline fruticosa* using OJIP chlorophyll fluorescence transient analysis

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Background: Postharvest management is important to maintain the cut-foliage quality. Although Salicylic Acid (SA) is a promising postharvest treatment, its direct impact, and increment of net photosynthesis on the photosynthetic process has debatable outcomes as reported by various researchers. Chlorophyll fluorescence (ChlF) transient analysis (OJIP analysis), a non-invasive technique in measuring the performance of photosynthetic apparatus, can be used for early-detection in postharvest changes in the leaves.

Objectives: In this study, we attempted to investigate the effect of SA on the post-harvest performance in cut foliage using OJIP analysis.

Methods: Two concentrations of SA (100 and 300 mg/L) with a water-control were tested with cut-leaves of *Cordyline fruticosa* at room temperature (25±2°C). OJIP parameters, i.e., specific energy fluxes (ABS/RC, TR/RC, ET/RC, and DI/RC), flux ratios (maximum quantum yield of primary photochemistry-φPo), electron transport efficiency (ψo), and quantum yield of electron transport (φEo), and performance index (PI) were recorded every other day, using a fluorometer (FluorPen FP-100). Leaf chlorophyll content was determined spectrophotometrically by 80% acetone extraction method. Data were subjected to ANOVA in a completely randomized design (CRD). Mean separation was done by DMRT.

Results: The PI increased in both SA treatments up to 7th day of treatment. SA at 300 mg/L had a significant effect on most of the OJIP parameters, specific fluxes in particular. SA has an effect on the retention of chlorophyll in leaves which proves the results of many past studies. All flux ratios except φPo were significantly affected by the SA treatment which indicates that the effect of SA could be on the photosynthetic apparatus but most probably in retarding the ethylene biosynthesis as reported elsewhere.

Conclusion: SA extends the postharvest life of *Cordyline fruticosa* cut-leaves. Moreover, there is an effect of SA on the photosynthetic machinery proved in the OJIP results. The underlying mechanism in photosynthetic apparatus warrants further studies.

Keywords: *Chlorophyll fluorescence, OJIP transient analysis, Photosynthesis, Postharvest, Salicylic acid*

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Correlation between in-vitro starch digestibility and in-vivo glycaemic index of selected rice varieties

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Background: The glycaemic index (GI) ranks carbohydrate-containing foods based on their postprandial blood glucose concentration relative to a referent carbohydrate, generally pure glucose. However, testing GI is an in-vivo process which is costly and consumes much time compared to the in-vitro starch digestion (hydrolysis index – HI) method.

Objectives: The objective of this study was to determine the correlation between in-vivo GI and in-vitro starch digestion HI of seven rice varieties namely "*Sudu Suduru", "Fragrant Red", "Rathu Suduru", "White Basmati", "Suwandel", "Black 02"* and "*Red Nadu"*.

Methods: Proximate composition of rice was determined using AOAC-2000 methods. The colorimetric phenol sulfuric acid method and the iodine colorimetric method were used to determine the available carbohydrate and the amylose content of all varieties, respectively. Thirteen healthy individuals (aged between 20-27 years and BMI between 18-23 kg/m^2) voluntarily consented to participate in the in-vivo GI study. The in-vitro HI was performed using non-restricted incubation with the α-amylase enzyme followed by the colorimetric analysis for glucose.

Results: Rice variety "*Rathu Suduru*" recorded a high GI value (72.9±5.6). *"Black-02*" (48.3±1.9) and "*Fragrant Red"* (54.8±1.5) recorded low GI values. All other tested rice varieties: "*Sudu Suduru", "Rathu Suduru", "White Basmati", "Suwandel"* and "*Red Nadu*" had medium GI values. Amylose (R^2= 0.7897) and fibre content (R^2 =0.9024) were significantly (p<0.05) correlated with GI values. An inverse relationship was observed between fibre content and GI values of rice varieties. Based on the procedures followed in this study, GI values showed a significant correlation with HI values of starch digestion time120 minutes (R^2=0.8003, p<0.05).

Conclusion: There is a significant correlation between GI values and HI values of the tested rice varieties. In-vitro studies can be used as a prediction tool for GI values of rice. Further extended studies on range of rice varieties are warranted to develop a standard correlation equation between GI and HI.

Keywords: *In-vitro study, Glycaemic index, Hydrolysis index, GI prediction*

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Spatial variation of soil available nitrogen and phosphorus concentrations in tropical Mangrove ecosystem at Erukulampiddy of Mannar region, Sri Lanka

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Background: Erukulampiddy consists of mangroves (*Avicenia marina*, *Rhizophora mucronata* and *Soneratia alba*) with intermittently spread saltmarsh species. The tidal creek and the mudflats of Erululampiddy tend to accumulate more sediments due to its location in the Palk bay and the specific shape, compared to the adjacent mangroves in the coastal fringe. However, the available nitrogen (N) and phosphorous (P) concentrations in mangrove soils of many tropical and subtropical mangrove ecosystems are reported as low and limited for the growth of mangrove plants.

Objectives: Spatial heterogeneity of soil N and P concentrations in Erukulampiddy was intended to be studied while correlating to other soil parameters (pH, electrical conductivity (EC) soil moisture content (SMC) and microbial biomass carbon (MBC)).

Methods: Adhered to grid method, thirty-five soil samples were collected from the surface depth (0-15 cm) at randomly chosen 10m×10m plots during the dry span of the site, and subsequently analysed for nitrate, phosphate, ammonium and for above parameters. Principal component (PC) analysis and agglomerative hierarchical clustering were performed using Minitab 17.

Results: The PCs made significance (accounting 62% of data variability) for the variables; PC1: EC (+) and phosphate (+), PC2: nitrate (-) and pH (+) and PC3: ammonium (+) and MBC (-). Both score plots based on PCs and the dendogram indicated that plant communities occur in a wide but overlapping range of ammonium and P availability. The concentrations of soil N ($N\text{-}NO_3^-$= 1.6- 9.9 mg kg^{-1} and $N\text{-}NH_4^+$= 5.6- 66.5 mg kg^{-1}) and P (42.1- 92.1 mg kg^{-1}) varied over space irrespective of the type of plant community, except at the woodland plant community where it revealed high nitrate (4.1- 9.9 mg kg^{-1}) and low ammonium (5.6- 9.8 mg kg^{-1}) and P (42.6- 62.2 mg kg^{-1}) concentrations.

Conclusion: High spatial heterogeneity of available N and P was revealed in the studied mangrove ecosystem, and soil EC and pH affect the formation of gradients in available P and N concentrations.

Keywords: *Electrical conductivity and soil pH, Nutrient availability, Spatial heterogeneity, Soil conservation and management*

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Evaluation of expression patterns of senescence and stemness in the epithelium of oral submucous fibrosis

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Background: Recent studies have shown that senescence and stemness plays a crucial role in the pathogenesis and malignant transformation of oral submucous fibrosis (OSF). Traditionally, it is believed that senescence and stemness in cells are two phenotypes that cannot occur at the same time. However, "senescence induced stemness" has become a novel concept in the field of oncology research.

Objectives: To evaluate the expression patterns of novel senescent marker DEP-1 and cancer stem cell marker Bmi-1 in the epithelium of OSF.

Method: Five micrometer thick sections from 106 OSF tissue blocks with and without dysplasia were stained with anti-DEP-1 and anti-Bmi-1 antibodies separately according to the manufacturers' instructions. Membranous and cytoplasmic positivity of DEP-1 and nuclear positivity of Bmi-1 were considered as true positivity. The extent of DEP-1 expression was recorded as 0%, 1-50% and more than 50% of the epithelium. Extent of Bmi-1 expression was recorded as less than 10%, 10%-50% and more than 50% positivity. Statistical analysis (Chi square) was performed considering $p<0.05$ as significant.

Results: In approximately 30% (32/106) of the cases, both senescence and stemness like properties were observed in the epithelium while in 26% (28/106) of the cases both markers were negative. 33% (35/106) of the cases expressed only senescence while only stemness like properties were expressed in 10% (11/106) of the cases. Majority of cases with significantly higher expression of senescence resulted in lower expression of stemness like properties ($X^2=9.764^a$, $p=0.043$).

Conclusion: Expression of senescence and stemness can occur together in OSF epithelium. Stemness in the epithelium could be induced by senescence or by a different mechanism which should be explored further to elucidate the malignant transformation mechanism of OSF. Expression of both senescent and stemness markers could indicate a transient period of epithelial cells escaping senescence and entering into the tumourogenic proliferative state.

Keywords: *Oral submucous fibrosis, Senescence, Stemness*

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A preliminary investigation on genetic affinities of *Aedes albopictus* in Sri Lanka using unweighted pair-group mean analysis (UPGMA) dendrogram method

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Background: The secondary dengue vector, *Ae. albopictus*, is found all over Sri Lanka including North and East, which has become endemic to dengue at a relatively later period. Considering its highly invasive nature and vectorial capacity, understanding the spatio-genetic relationships of local *Ae. albopictus* populations, would be of immense importance in designing effective dengue control strategies.

Objectives: This pilot study was aimed to investigate the genetic relationships among *Ae. albopictus* mosquitoes distributed throughout Sri Lanka.

Methods: *Ae. albopictus* larval samples were collected from all districts except from Mannar, Nuwara Eliya and Moneragala using the dipping method. A total of 109 samples were analysed ranging from 2 to 14 larvae per district. Samples were genotyped using six microsatellite markers (Albtri-3, Albtri-18, Albtri-20, Albtri-25, Albtri-44 and Albtri-45). Allelic data were used to construct the UPGMA dendrogram based on Nei's genetic distance using POPGENE 1.32.

Results: In the dendrogram, samples from northern and eastern regions were clustered with those from southern, western, and central parts of the country. For example, samples from Kilinochchi (northern), Matale (central) and Kalamulla (western) were grouped together in one cluster, while samples from Matara (southern) and Batticaloa (eastern) were clustered together in another. Similarly, samples from Palinagar and Vavuniya (northern) were grouped with those from Kandy (central) and Colombo (western), while samples from Trincomalee (northeastern) were grouped with those of Galle and Hambantota (southern).

Conclusion: The observed long distance gene flow, out of the mosquito flight range, suggests possible passive migrations that had occurred across different geographical areas. Clustering of samples of northern and eastern areas of Sri Lanka, along with those of southern, western and central parts of the country in multiple separate clusters, suggests that multiple invasions of *Ae. albopictus* had occurred towards the former regions from the latter. Further studies with substantial sample numbers are required to confirm these inferences.

Keywords: *Microsatellites, Dengue vector, Gene flow, Passive mosquito migrations, Spatial genetic structure*

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An innovative hybrid teaching model to make hands-on experience in electronics by using smart phones.

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Background: This is an action study. An innovative and simple Hybrid teaching model was constructed and implemented to prospective science teacher training regarding physics electronic experiments to deliver the hands-on experiences among participants and how to assessment model and evaluation technique also built up by using a proper arrangement of a Smartphone via zoom conferencing. 24 small electronics experiments were done by using a bread board and evaluated among 58 science prospective teachers of Jaffna National College of Education. 47 participants' level of achievement was at a very satisfied level. It is an essential and urgent need to bring attention on teaching Physics practical to promote hands-on experience to the students and to assess the students' performance of experimental skills to evaluate the teaching learning process in this COVID 19 pandemic. An innovative and simple Hybrid teaching model was constructed and implemented for prospective science teacher training.

Objectives: The objectives are to construct an innovative and simple blended teaching model, to bring 12 twenty-first century skills and to evaluate, assess and feedback the experiments by using smart phones.

Methods: Every participant was asked to buy necessary electronic components by WhatsApp group. In each class, students' participated demonstration with two-way communication was used via zoom video. The model was demonstrated to keep the smart phone in such a way the back camera was focused to an A4 sheet. Along with circuit diagram drawing on the A4 sheet and circuit was built up under the camera such that it was clearly seen on screen. At this stage the student's performances were assessed via video conferencing. The outcomes were evaluated by proper tools such as checklist and observation schedule via analysing uploaded video clips along with proper voice recording in WhatsApp group.

Results: Among the 58 participated prospective teachers, regular participated prospective teachers (47) reached the competency level. Others reached near competency level. So, this is an efficient model.

Conclusion: A simple and easy Hybrid model that can be used to construct hands-on experience among students was constructed by using smart phones in a proper arrangement. This study will contribute to teacher trainers, teachers and curriculum practitioners for 21st century teaching.

Keywords: *Hybrid teaching methodology, Hands on experience, Video conferencing, Smart phone, Proper arrangement.*

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Statistical machine learning for medicinal plant leaves classification

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Background: Medicinal plant identification involves years of experience through sensory and olfactory senses, laboratory-based testing, and automatic ways useful for those lacking knowledge.

Objectives: The main objective is to introduce an automatic approach based on statistical machine learning to classify medicinal plants using leaves.

Methods: MEDIPI is our medicinal plant classification algorithm which is divided into offline and online phases. The classification algorithm is trained in the offline phase, whereas the pre-trained classification model is used for real-time leaf image classification for general users in the online phase. Features extracted from the leaf images (MedLEA, Flavia, Swedish, and Kaggle) are used to operate our classification algorithm. First, leaf images are followed by a sequence of image processing steps. The main image processing steps consist of converting the original image to an RGB image, gray scaling, Gaussian smoothing, binary thresholding, removing the stalk, closing holes, and resizing the image used to remove undesired distortion. Extracting features from plant leaf images is the second stage. Next, we trained our algorithm using random forest, gradient boosting, and extreme gradient boosting. We trained by following two methods as training (80%) and test (20%) from the same dataset and training (80%) and test (20%) from different datasets. Furthermore, our algorithm works as a hierarchical classification system that contains three levels. The level classifies images according to the shape, edge types, and plant species accordingly. We used high dimensional visualization approaches to visualize what is happening inside the trained algorithm and provide transparency to our black-box model. We established an open-source repository in R software, MedLEA.

Results: We introduced 52 computationally efficient features to classify plant species which are mainly classified into four groups as shape, colour, texture, and scagnostics. Length, area are shape features whereas monotonicity is one of scagnostics features. The model trained with random forest algorithm provides the accuracy with 100% while gradient boosting, and extreme gradient boosting have 99%.

Conclusion: The MEDIPI algorithm yields accurate results to the state-of-the-existing techniques in the field for medicinal plants classification.

Keywords*: Image processing, Feature extraction, Statistical machine learning, Hierarchy, Reproducibility*

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Enhancement of photoactive properties of CZTS/Cu_2O solar cell by annealing

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Background: Cu_2ZnSnS_4 (CZTS) and Cu_2O are two environmentally-friendly low-cost potential materials for applications in thin film solar cells. Electrodeposition is an attractive technique because of its simplicity, low-cost and easy to control the properties of the deposits.

Objectives: Fabrication of CZTS/Cu_2O heterojunction solar cell

Methods: In order to grow CZTS on Mo substrate, Cu thin film was electrodeposited on Mo substrate at -0.89 V vs Ag/AgCl in an electrochemical cell containing 0.4 M $CuSO_4$, 3 M lactic acid. Bath pH was adjusted to 11 by using NaOH. Deposition of Sn thin film on Mo/Cu electrodes was carried out at -1.2 V vs Ag/AgCl in an electrochemical cell containing 0.055 M $SnCl_2$, 2.25 M NaOH and 8 ml of sorbitol. Zn thin film was electrodeposited on Mo/Cu/Sn at -1.2 V vs Ag/AgCl in an electrochemical cell containing 0.2 M $ZnSO_4$. In order to obtain CZTS thin film on Mo substrate, Mo/Cu/Sn/Zn thin film electrodes were annealed at 550 ^oC for 60 min in H_2S. To fabricate CZTS/Cu_2O heterojunction, n-Cu_2O thin film was potentiostatically electrodeposited on Mo/CZTS electrode at -0.52 V vs Ag/AgCl in electrochemical cell containing 0.45 M $CuSO_4$, 3.0 M lactic acid and 4.0 M NaOH. pH of the bath was adjusted to 9.3 by adding NaOH and the temperature of the bath was maintained at 60 °C. In order to make front contact to the device, thin Au spots (2×2 mm^2) were deposited on Cu_2O by using the sputtering technique. CZTS/Cu_2O heterojunction devices were annealed at different temperatures (125 ^oC, 150 ^oC and 175 ^oC) for 10 min in air. Materials and devices were characterized using XRD, SEM, spectral response, C-V and J-V measurements.

Results: As fabricated CZTS/Cu_2O device exhibited open circuit voltage (V_{oc}) of 200 mV and short circuit current density (J_{sc}) of 0.75 mA cm^{-2}. However, V_{oc} and J_{sc} improved to 350 mV and 1.125 mA/cm^2 respectively with annealing the device at 150 ^oC for 10 min.

Conclusion: It was clearly observed that V_{oc} and J_{sc} of the device have significantly improved with the annealing at 150 ^oC for 10 min. Further, the spectral response has confirmed this optimum annealing condition. This result is encouraging since CZTS/Cu_2O heterojunction have not been reported in the literature.

Keywords: *CZTS, Cu_2O, Electrodeposition, I-V characteristics, Solar cell*

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Low-grade glioma tumour segmentation and area calculation using convolutional neural networks

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Background: Low-grade Glioma is a type of brain tumour. Segmentation of these brain tumours is a critical and complex challenge in medical image processing for prognosis and diagnosis.

Objectives: This study was done to extract low-grade glioma tumour segmentations from magnetic resonance brain images with standard classifiers and Convolutional Neural Network (CNN), and to calculate the area of the segmented tumours.

Methods: The experiment was carried out using a "The Cancer Imaging Archive (TCIA)" dataset with image intensities of lower-grade glioma patients (3929 images). It was initiated with conventional classifiers, namely the Resnet Deep Neural Network (RDNN), CNN, and implemented in Google Colab. The image set was arbitrarily split for training, test, and validation in the ratio of 70:15:15. Numerical scores of segmented tumour areas are obtained using the Intersection over Union (IoU) and Sørensen dice coefficient scores, where the tumour segments were extracted for the process of area calculation by counting the number of pixels in the segmented region.

Results: The model was trained using four distinct epochs (1, 10, 20 and 50) and it was eventually able to achieve the highest accuracy of training and validation for 50 epochs. Neural Network achieved an accuracy of 99.92% and validation accuracy of 92.64% for the epoch 50 to detect low-grade glioma tumours.

Conclusion: Low-grade Glioma tumour segmentation and area calculation are achieved by applying convolutional neural networks for brain MRI images. The proposed approach achieved high performance levels as same as the other brain segmentation methods available. Low-grade Glioma tumour segmentation process can be automated by utilizing the developed algorithm.

Keywords: *Glioma tumor, Brain tumor, Convolutional neural network, Magnetic resonance imaging, Image processing.*

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An accurate deep learning model for classification of cancer types

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Background: Cancer is one of the most threatening diseases in the world. According to the molecular structure, cancers differ from one type to another. Gene expression data can be used for cancer type classification which is publicly available in TCGA (The Cancer Genome Atlas). However, gene expression data is high-dimensional. Recently machine learning and deep learning models use those data for cancer type classification. However, their accuracies were not enough. This research proposes how transfer learning can be used to perform the cancer classification process effectively.

Objectives: The objective of this research is to implement a deep learning model to perform the classification of cancer types and subtypes using gene expression data more accurately.

Methods: Gene expression data from TCGA was used for this research. Gene expression data related to Kidney Renal Cell Carcinoma (KIRC), Breast Invasive Carcinoma (BRCA), Lung Squamous Cell Carcinoma (LUSC), Lung Adenocarcinoma (LUAD), and Uterine Corpus Endometrial Carcinoma (UCEC) was used in this research based on the availability of the data. Before inputting it into a deep learning model, the dataset was pre-processed using an equation. Each sample consists of 20533 genes. Gene expression data related to each sample was then represented in a 3D space. Using available different Convolutional Neural Network architectures, cancer types were classified. Among the Resnet50, Resnet101, VGG16, VGG19 and Densenet121 CNN architectures Densenet121 architecture showed the best classification results.

Results: The proposed Deep learning model has obtained higher accuracies than the other models. Training Accuracy is 99.948% and validation accuracy is 98.926%.

Conclusion: Densenet121 can be used for cancer type classification using transfer learning. In future work, other CNN models can experiment with this problem.

Keywords: *Gene expression data, Cancer classification*

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Can deep learning restore the fast particle dynamics from noisy fluorescent images?

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Background: Single Molecule Tracking (SMT) is an imaging-based experiment to trace the motion of a molecule/particle under a microscope and knowing the exact position of the molecule bears answers to fundamental research questions in cell biology and molecular biology. To track these fast-moving molecules, one needs to go for higher frame rates – which in-turn reduces exposure time of the camera and thereby reduces signal to noise ratio (SNR) in the images. This makes the tracking impossible.

Objectives: Recent advancements in Deep Learning have shown great progress in restoring noisy fluorescent images, but it wasn't clear if it is applicable on SMT movies. We intend to evaluate the performance of two Deep Learning packages – one that uses a supervised approach and the other, an unsupervised approach, on the SMT experiment.

Methods: We applied them on the following examples: 1. A synthetic bead model which follows Brownian Motion where SNR can be reduced artificially 2. Experimentally we applied these techniques on nucleosomes and chromatin microdomains taken at low exposure times, to verify if deep learning can restore stationary and dynamic data.

Results: For the synthetic data we were able to restore low SNR movies and restore their individual trajectories by both supervised and unsupervised methods. Statistical comparisons showed no significance ($P>0.99$). Experimentally, we found that, while both supervised and unsupervised approaches improved tracking results compared with the original noisy images, supervised learning generally outperformed the unsupervised approach.

Conclusion: It was noted that the supervised approach delivered better results. However, there are instances where these algorithms produce deceiving results, despite 'looking good' to the naked eye. We anticipate broad application of this approach to critically evaluate artificial intelligence solutions for quantitative microscopy.

Keywords: *Deep learning, Chromatin, Nucleosome*

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Comparing the effect of P3HT and Spiro-OMeTAD as hole transport material in Sb_2S_3-based solar cells

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Background: The n-i-p structured Sb_2S_3 solar cells are widely developed based on various conditions of fabrication. Generally, these types of solar cells consist of different layers. Even though a high quality of the absorber layer (Sb_2S_3) is synthesized, the compactness of each layer is beneficial to enhance the performance. In this solid-state solar cells, the Hole Transport Material (HTM) is an attractive factor due to the commercialization difficulty of liquid electrolyte solar cells.

Objectives: In this study, Sb_2S_3 solar cells were fabricated with P3HT and Spiro, which were used as HTMs to extract the holes from the absorber to find the effect of HTMs in our system.

Methods: To fabricate the device configuration of FTO/TiO_2/Sb_2S_3/HTM/Ag, a mixture of titanium isopropoxide, butan-1-ol, and 2-ethanolamine and a mixture of $SbCl_3$, thiourea, and 2-methoxyethanol used to deposit TiO_2 and Sb_2S_3 layers respectively. The P3HT and Spiro solutions were prepared by dissolving 2 mg of P3HT in 100 µl of chlorobenzene and 3.6 mg of spiro-OMeTAD, 1.4 µl of 4-tert-butyl pyridine (tBP), and 0.8 µl LiTFSI solution (520 mg LiTFSI in 1 ml of acetonitrile) in 100 µl of chlorobenzene respectively. The prepared HTM precursors were spin-coated separately on Sb_2S_3/TiO_2 at 3000 rpm for 30 s and heated on the hotplate at 100 ^oC for 15 mins.

Results: The power conversion efficiency (PCE) was obtained as $4.11 \pm 0.2\%$ and $4.01 \pm 0.18\%$ for the cell with spiro and P3HT respectively, by the current density (J)-voltage (V) measurements. A good current density (J) was received by Spiro (15.6 mA/cm^2) than P3HT (14.05 mA/cm^2), which enhanced the PCE. The EQE exhibited a wide range of spectrum for spiro-OMeTAD than P3HT, which was in good agreement with J.

Conclusion: In our system, the photo-generated electron-hole pairs are effectively separated by Spiro-OMeTAD than P3HT. The HTM plays a significant role to improve the PCE of solar device.

Keywords: *Efficiency, P3HT, Sb_2S_3, Solid-state, Spiro-OMeTAD*

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Colour enhancement of opaque corundum by heat treatment

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Background: Among blue sapphire, several types of non-gem quality opaque corundums are abundantly found in Sri Lanka. They are usually discarded, instead of being value-added by heat treatment.

Objectives: To identify types of opaque corundum which could produce blue colour by heat treatment.

Methods: The corundum samples collected from the Kolonna area in Rathnapura district were categorized into four types based on their colour and lustre. Five samples from each type were selected for the treatment. A representative sample from each type was sliced into two for reference. The heat-treatment was performed in a Lakmini gas furnace at 1800 ºC under reducing conditions with a soaking period of 40 minutes. Both the unheated (reference) and the heated portions of the colour-produced sample were then analyzed with the Jasco V-760 UV-Vis spectrophotometer. Further, the samples were placed in a piece of pendant jewellery to confirm the stability of the stone.

Results: It was identified that only one type out of the four was able to improve the colour. This type shows a light blue hue, dark tone, and slightly greyish saturation before treatment. According to the Gemmological Institute of America colour grading, the type can be named B7/2. A prominent peak was observed at 450 nm of the UV-Vis spectrum on the unheated portion that accounts for Fe^{3+}. The broad peak at around 550 nm was found in both heated and unheated portions that correspond to the $(Fe.\ Ti)^{6+}$ complex. This confirms that the colour-producing mechanism in B7/2 type and blue sapphire are the same. This affirms that the enhanced colour is permanent. Further, the B7/2 type is durable enough to mount on jewellery.

Conclusion: The B7/2 type opaque corundum which is thrown away by gem miners can be treated effectively under controlled heating conditions to obtain a permanent blue color.

Keywords: *Corundum, Non-gem quality, Colour, Heat treatment*

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Improving cycle life through fast formation in lithium metal batteries using phosphonium based ionic liquid electrolytes

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Background: Cell formation of lithium-ion cells impacts the evolution of the solid electrolyte interphase (SEI) and the cell cycle stability. However, most lithium metal battery research has used a conventional lithium-ion formation protocol; this is time consuming, costly and does not account for the different properties of the lithium metal electrode.

Objectives: In this work we aim to understand, how the formation step affects lithium metal long-term cycling at a reasonable current density (1.75 mA/cm^2) and commercially relevant areal capacity (3.5 mAh/cm^2), while utilising an ionic liquid electrolyte (lithium bis(fluorosulfonyl)imide in triethyl(methyl)phosphonium bis(fluorosulfonyl)imide/ 3.2 m LiFSI in P_{1222}FSI) in Li|NMC 622 full cells (1C current density corresponds to 3.5 mA/cm^2).

Method: Three different formation conditions (C/20, C/4, 1.25C pulse at 50 °C, Biologic VMP3), which varied from slow to a high pulsed current regime, were chosen. The cells were then cycled for 100 cycles at a moderate current density (C/2 at 50 °C, Biologic VMP3). The morphology (JSM IT300 SEM) of the lithium deposit and the cell impedance (at 100 % SOC, Biologic VMP3) were analysed after formation and long-term cycling. In addition, MD simulations were utilised to further understand the electrode-electrolyte interface.

Results: A faster formation protocol comprised of a pulsed 1.25C current decreased the formation time by 56% and gave a 26% greater capacity retention after 100 cycles compared to the formation at slow rate. A lower resistance SEI and column-like lithium deposits underline the excellent performance of these high energy density cells; a 56% greater stack specific energy was achieved compared to the analogous graphite-based lithium-ion cell chemistries.

Conclusions: Use of a high current density pulse formation promotes a favourable SEI, thus enhancing cyclability and capacity retention for long-term cycling while reducing the formation time.

Keywords*: Lithium metal batteries, Ionic liquid, Formation, Energy storage*

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Towards an approximation for the n^{th} prime number

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Background: The prime number theorem is a method for estimating the number of primes that are less than or equal to a positive integer. Gauss and Legendre first conjectured it in 1798. After nearly a century had passed, in 1896, Hadamard and Charles Jean de la Vallée Poussin proved this independently. As a result of the prime number theorem, one can obtain an approximation for the n^{th} prime number which is $n \log_e n$.

Objectives: In the present study, we introduced a new approximation for the n^{th} prime number which is a better approximation than the existing one. As far as the literature is concerned, there is no efficiently computable formula for predicting consecutive prime numbers. Mathematicians have inferred that anything so fundamental must have a pattern, but such a pattern has yet to be found for prime numbers.

Methods: We have found the exact n^{th} prime number using a program in python. We tried an expression for the n^{th} prime number of the form $\frac{n}{a}\log_b n$, where a is a positive integer and b is an irrational number.

Results: In the existing approximation, the base of the logarithm is e. The number e is an irrational number. We tried a multiple of π as the base of the logarithm, which is an irrational number as well. We observed that the base $\frac{\pi}{2}$ gives a better approximation than all the existing ones. This approximation is obtained by setting $a = 2$ and $b = \frac{\pi}{2}$.

Conclusion: The error in the suggested approximation is less than that of in the existing approximations.

Keywords: *Prime number theorem, n^{th} prime number.*

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Study of optoelectronic motion capture systems to analyze sit-to-stand human body movements of paraplegic patients.

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Background: Optoelectronic motion capture system is a system used to analyze human body motion for a specific work using video cameras and reflective markers. It helps to identify the correct body movement during sit-to-stand task of paraplegia patients.

Objectives: Study the best way to collect information about movements of the body joints and segments of a paraplegic human body.

Methods: Selected four different optoelectronic motion capture systems named Optotrak, Vicon, PaseSpace, and Motion-Analysis™ were used to capture reflecting marker movements. The infrared reflecting makers of each system were fixed on the ankle, knee, hip, and arm joints of the right side of the paraplegic and healthy human bodies separately. The human body sit-to-stand process kinematic raw data were collected by considering the human body as a 5-bar link rigid body model. Then raw data is filtered and amplified to compute dynamic parameters.

Results: The system with higher frames per second gives quality output. It was found that active markers have higher accuracy than passive markers and, Butterworth (low-pass), high-pass filters are used to amplify raw signals of motion capture systems. The higher-order and low cut-off frequency arrangement of the Butterworth filter gave increased gain output signal. Lower order and high cut-off frequency arrangement of high-pass filter gave more accurate increased gain. Butterworth filter was used mostly, as it amplified no ripple maximum flat output. Dynamic parameters of the human body were calculated using identified kinematic parameters. Each method calculated the torques, moments, and forces acting on the ankle, knee and hip joints. The inverse dynamics method gave center-of-mass, center-of-pressure coordinates, and trajectory details. Lagrange's and inverse dynamic methods computed more details than Newton-Euler's method.

Conclusion: Sit-to-stand movement analysis is done with an accuracy of around 0.1mm with optoelectronic motion capture systems. The PhaseSpace motion capture system shows more qualities than other systems for STS. Butterworth filter is suitable as it gives no ripple output.

Keywords: S*it-to-stand, STS, Paraplegia, Assistive, Movement*

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Study of designing a sit to stand transfer assistive robot device for paraplegic patients.

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Background: Independent movement of paraplegic patients is a dream as their lower body segments do not work as they wish. The primary step to being independent is to stand up straight with own not working legs. A literature survey collected details of sit-to-stand lower limb movement analysis of paraplegia patients.

Objectives: Collect information about designing a boarding from back assistive robot device for stand-up paraplegic patients.

Methods: First, required human body kinetic and kinematic data were collected from the literature survey. Then system workflow was suggested. Concluded to design a boarding from back device to make it easy to operate by patients themselves. Mathematical calculations were done by taking the human body as a 5-bar link rigid body model, to find suitable physical specifications for the device. The main parts were the base, handle, linear actuator, control system, and safety belts. The electric linear actuator was selected as the lifting mechanism by comparing other actuators after calculations. The prototype device idea was designed with SolidWorks software. And stability was calculated mathematically with complete weights.

Results: Four phases in the sit-to-stand process were configured as initiation, seat unloading, ascending, and stabilization. From the calculations, we found the movement of the center of mass of the patient during the sit-to-stand task and found the trunk moves horizontally forward when the patient starts to stand up. We found that minimum sit-to-stand time is good for health. Calculations implemented that arm support was essential until the stabilization phase to reduce the pressure on the legs and linear actuator. Dimensions of the device were suitable to use as a household device satisfying ergonomics. The prototype system's center of gravity with the patient was led to be on the device base premises to maintain stability.

Conclusion: A prototype of the sit-to-stand assistive robot device was designed in SolidWorks software in virtual. It will be fabricated with suitable materials to function sit-to-stand for paraplegic patients and motorize movable ability in the household as future work.

Keywords: *Sit-to-stand, STS, Paraplegia, Prototype, Movement*

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Graphite purification: Importance of acid volume by volume percentage for scale-up the acid leaching process

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Background: Laboratory and bench-scale systems are important early-stage tools for assessing and scaling methods prior to industrial-scale pilot plants. The choice of the right scale for the scale-up is crucial when a scale-up is performed and to include scenario analyses for the most important steps before designing the industrial-scale pilot plant.

Objectives: This study aims to find optimum laboratory-level scale-up conditions for graphite purification using Hydrochloric acid.

Methods: Therefore, in the present study, the patented acid leaching purification method was used for scaling-up of purifying vein graphite. Accordingly, two volume by volume (v/v) percentages 10% v/v HCl (HCl-10) and 20% v/v HCl (HCl-20) were investigated. For laboratory-level scaling-up, the arithmetic general formula used both v/v percentages to prepare samples with different weight ratios of graphite:acid.

Results: The Carbon Content (CC) of the raw graphite used for the study was 99.24% and the resultant CC of HCl-10 and HCl-20 samples after initial purification were 99.94% and 99.96%, respectively. Scaled-up samples from both v/v percentages showed slightly different low CC from the initial purified CC. X-ray diffractogram obtained on the purified scaled-up graphite samples show successful elimination of impurities such as pyrite, feldspar, and calcite. Electrochemical characterization was conducted by assembling the anode fabricated from the developed graphite/LiPF6/Li cell configuration with CR 2032-coin cell type. Galvanostatic charge-discharge study revealed the absence of any obvious reversible capacity fading after purification and cycling behaviour was similar to initial purified samples.

Conclusion: The Lithium-ion battery coin cells assembled with HCl-20 graphite sample showed better electrochemical performances than the HCl-10 graphite sample. But, these both samples are showing better electrochemical performances despite the significant volumetric scale-up. Therefore, HCl-10 method can be proposed for further studies in order to minimize the environmental risk in the industrial-scale pilot plant.

Keywords: *Graphite, Purification, Scale-up, Optimization*

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Investigation of using lotus (*Nymphaea nouchali*) petiole as the electrolyte for Zn/Cu vegetative batteries

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Background: Fabricating vegetative batteries using natural biodegradable materials to use as an alternative power source has drawn a large amount of attention. In this project, suitability of using lotus petiole as a biodegradable and environmentally friendly electrolyte was comparatively studied.

Objectives: To test lotus (*Nymphaea nouchali)* petiole as a possible candidate to use as an electrolyte in a galvanic cell. Plantain (*Musa paradisiaca*) pith has been used as the reference material. Selecting the material was done by comparing its ionic content with Plantain pith.

Methods: An experimental setup was made using acrylic plastic sheets with dimensions of 4.5 cm × 5 cm × 12.5 cm. Fresh plantain pith and lotus petiole samples were collected and suitable electrolyte samples were obtained by chopping the samples. Samples were boiled by varying temperature as the main treating method. Open circuit voltage, current and the discharge voltage were recorded for 6 hours using relevant current and voltage sensors with two devices programmed using the Arduino platform. Anionic and cationic concentrations were determined by ion chromatography and atomic absorption spectroscopy, respectively.

Results: The voltages obtained for untreated samples were: 0.877 V and 0.852 V for plantain pith and lotus petiole, respectively. In heat treating, the maximum voltage obtained for plantain pith was 1.032 V when the sample was boiled for 30 minutes. For Lotus petiole, 1.009 V was obtained as the maximum voltage when the sample was boiled for 35 minutes. The galvanic apparent internal impedance of the two cells were found as 158.98 Ω and 148.60 Ω for plantain pith and lotus petiole, respectively. Experimental efficiencies of the samples were calculated using Gibbs energy of the reaction. At untreated state, the experimental efficiencies were obtained as 9.25% for plantain pith and 8.98% for lotus petiole. Highest experimental efficiency of 10.89% was recorded for treated plantain pith and 10.64% was recorded for treated lotus petiole. Highest values for battery capacity and energy were obtained for untreated samples. In terms of ionic concentration, Zn^{2+} was found to be the most abundant cation in both samples while nitrate, sulfate and phosphate contribute to the anion concentration. The decay rate of Zn plate was 3.29 kg/hr and 6.82 kg/hr for plantain pith and lotus petiole respectively.

Conclusion: It can be concluded that lotus petiole shows promising results compared to the plantain pith. Considering the wide availability, lotus petiole can be considered as a good candidate for biodegradable vegetative batteries for further improvements.

Keywords: *Biodegradable galvanic cells, Vegetative batteries, Biodegradable electrolytes, Plantain pith, Lotus petiole*

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Comparison of geothermal exploration techniques applied in Sri Lanka with those used globally: A review

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Background: Geothermal energy has a significant economic impact globally as a renewable energy resource. For proper investment on geothermal projects, it is mandatory to carry out factual geothermal resources explorations. Despite the fact that geothermal energy is economically used in many parts of the world, Sri Lanka is yet to exploit geothermal resources as renewable energy.

Objectives: This study focuses on the previous studies on geothermal resources in Sri Lanka to compare them with international exploration techniques and to identify the most suitable techniques and gaps that need to be filled in order to exploit them.

Methods: Research papers from 2015 to 2021 published across the world were reviewed and compared with those from Sri Lanka.

Results: Initial studies have been done by Dissanayake and Jayasena (1988) following geochemical studies on Kapurella, Padiyathalawa, Nelumwewa, Kinnniyai, Mahaoya, Marangala, Mahapelessa, Rankihiriya and Kiwulegama. Gravity anomaly map of Fonseka (1995) and seismic catalogue of Peiris (2007) have been used to interpret the gravity anomalies and seismic activities in geothermal areas by some researchers. During the last 10 years electromagnetic and electrical surveys have been carried out around seven geothermal springs. The structural details of the geothermal areas have been interpreted using satellite images and contour maps. No seismic or gravity surveys have been conducted in the field (except for the gravity anomaly map (Fonseka, 1995) and the seismic catalogue (Peiris, 2007) in any of the geothermal springs in recent years. No direct temperature measurements using boreholes have been conducted to determine the geothermal gradient. There are models built up globally, using remote sensing, geophysical and geochemical data, which are yet to be developed in Sri Lanka.

Conclusion: Combined geochemical, geophysical, and remote sensing investigations and models are essential to understand the nature of the geothermal systems in Sri Lanka and to develop them for power generation.

Keywords: *Geothermal, Explorations, Geophysical, Geochemical, Techniques*

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Creating an on-orbit magnetic simulation for ground testing of attitude determination and control system of nanosatellites using the helmholtz cage

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Background: A Helmholtz cage is capable of providing a uniform magnetic field over a cuboid-shaped volume. The magnetic field components in each 3-axes of this field can be varied independently by controlling the current supplied to each of the respective coil pairs.

Objectives: The aim is to design a dynamically driven ground testing facility for the Attitude Determination and Control System (ADCS) for testing the stability of nano-satellites. This is achieved by designing a Helmholtz cage.

Method: Using a Two-Line Element (TLE) dataset, the orbital positions (Latitude, Longitude and Altitude/ LLA) for a period of the selected satellite are calculated by implementing algorithms. 3-axes magnetic field in that certain orbit is modelled using the World Magnetic Model (WMM) in MATLAB giving calculated LLAs as the inputs. To emulate these magnetic fields, the Helmholtz cage is calibrated using the supplied current controlled by a current driver capable of providing the desired current by a Pulse Width Modulation. The magnetic fields generated by a coil pair were obtained. A relationship between the pulse width given to the driver and the generated magnetic field is acquired. Using that relationship, the pulse widths required to create the orbital magnetic fields calculated by the algorithm are obtained. Those pulse widths are supplied to the driver to generate the orbital magnetic field inside the Helmholtz cage. Finally, the generated magnetic fields are recorded and compared with the theoretical values.

Results: The generated magnetic fields and the expected magnetic fields variations were compared and found that fairly similar to each other and lie within the limits of the Earth Magnetic Field (EMF). The ranges of the theoretical and experimental are from 1.014×104 to 3.228×104 nanotesla and from 0.901×104 to 2.968×104 nanotesla respectively. The total EMF of this orbit ranges from 2.103×104 to 4.419×104 nanotesla. The previous studies on EMF show it varies from the average of 2.5×104 to 6.5×104 nanotesla.

Conclusion: By computing on-orbit magnetic fields experienced by a Nanosatellite using an implemented algorithm by reading a TLE dataset is a fitting method for Helmholtz cage modelling.

Keywords: *ADCS, Helmholtz cage, Nanosatellites, TLE, WMM*

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Framework of computer display to tactile Sinhala braille embossed display converter

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Background: There are many visually impaired in our country with less education knowledge due to the limitation in our education and support system, which also creates difficulties for them to learn or teach computer screens. Therefore, they do not have any platform to interact with the latest technology. This project is to overcome the above problems and to make a cheap Braille embossed displayer.

Objectives: To convert computer display to the tactile Sinhala Braille embossed displayer.

Methods: Characters on the scanned computer screen were identified by the system with the use of W3C software. The identified characters were converted into the relevant number pattern with the help of the Python program. Signals of specific number patterns were sent by the system to the Braille embossed displayer through the controller. The prototype of the Braille embossed displayer consisted of six dots that were embossed by tiny electromagnets made using the magnetic levitation theory.

Results: The system is tested with a wide variety of computer screens. The output of the system is a tactile Braille embosser with up and down six pins. The response time of lifted pins is 0.5 seconds, and the embossed system can display three characters, each one by one. A magnetic levitation system makes the system light weighted. After the user touches the tactile, a buzzer associated with the system will sound and the next character will appear.

Conclusion: Through this system, the visually impaired can interact with technology and gain knowledge in many subjects, and the gap between the ordinary and the visually impaired is also reduced. The system is useful for the government and education system.

Keywords: *Embosser, Screen, Computer, Tactile*

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Framework for Sinhala braille characters to audio signals using convolutional neural network

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Background: In Sri Lanka, blind people read their Braille documents and books manually and if there was a system to read Braille documents and translate them to voice it would save more time and effort. Visually impaired face many difficulties in communicating with others. Also, the government has to pay more salary to Braille paper markings due to the lack of Braille expert teachers and lecturers. This project is carried out to overcome the above problems.

Objectives: To design Sinhala Braille characters to speech audio signals system using Convolutional Neural Network.

Methods: The system platform was divided mainly into three parts. Braille image was processed in a convenient way to read using methods in the OpenCV library. Mathematical formulas of the Convolutional Neural Network were used for the extraction and identification of the Braille characters. The Braille images were read and identified as relevant Sinhala letters by the system. Finally, audio signals were generated by extracted Braille letters with the help of an auto-correction algorithm and the Convolutional Neural Network.

Results: The system is tested for multiple single-sided, scanned, printed, and typed Sinhala documents. Character translation is achieved up to 94% success rate. The conversion of recognized braille letters to speech is straightforward and performed letter by letter. The system is tested with different browsers and operating systems and it runs on any platform.

Conclusion: Through this system, the visually impaired can interact with each other, and the communication obstacles between the regular and visually impaired are reduced. The system is useful for the government and education system. Through this proposed system, every teacher can mark the papers of blind students.

Keywords: *Braille, Sinhala, Audio, Neural*

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Concept for a framework of machine vision-based human following smart travelling bag

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Background: Where people travel, they carry luggage, especially through airports, dragging out their heavy luggage. Perhaps trailing the bag is a very difficult task for older adults. If a bag follows passengers with intelligence by utilizing the human following concept, the entire problem vanishes. The major issue of person-following is how to localize the target person by tracking.

Objectives: To design a framework of machine vision-based human following smart traveling bag.

Methods: The embedded robot platform is divided into the user identification part and navigation part. The user identification is made by onboard image processing implemented on Raspberry Pi using Python with OpenCV. Once identified the user system will extract the feature of the user and start to track the user path avoiding the obstacles in the surrounding. The speed of the robot platform will change with the speed of the user's walking pattern.

Results: A python program allows the detection of a human fulfills human body in live stream video content. An object to be tracked is usually selected by a rectangular bounding box. The task of a tracker is to follow the object in the video by updating the bounding box parameters with the help of correlation filters. The infinite loop is used so the web camera captures the frames in every instance. Safe distance Ultrasonic sensor maintains the safe distance between the bag and person. The commercial smart bag is working with GPS technology, but this is based on image processing techniques. It has more accuracy than GPS systems.

Conclusion: A real-time personalized human-following approach for mobile robots is proposed in this paper. The proposed model is able to detect the gap between the motion of the human and the mobile robot. It was shown that various following patterns are possible in the proposed control algorithm.

Keywords: *Smart travelling bag, Image processing*

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Development of hydrophobic self-cleaning coatings with antimicrobial properties on clay roofing tiles using modified TiO_2 nanoparticles

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Background: As a result of exposure to rainfall and humidity, clay roofing tiles develop favourable surface conditions for microorganism growth. This results in physical and chemical deterioration of the tiles, thus decreasing their durability and aesthetic appeal.

Objectives: The study was focused on developing a hydrophobic coating on clay roof tile surfaces using modified TiO_2 nanoparticles, investigating the photocatalytic and antimicrobial properties of the coating, and aiming towards industrial manufacturing

Methods: TiO_2 was synthesized hydrothermally using HNO_3, Titanium Isopropoxide and Isopropnaol. The obtained nanoparticles were modified using Ethanol and Stearic Acid (>99.5%). A photocatalytic solution was prepared using 0.08g of modified TiO_2, 0.04g of Polyethylene glycol of molecular weights 600 or 4000 or 20000 and 0.15g of Expanded Polystyrene of 3 types. Six samples were made by varying the PEG and EPS types, the solution was spray coated onto tile samples from Samson Rajarata Tiles (Pvt) Ltd, heated at 290°C or 200°C. The tile surface was inclined at 20° and subjected to a slight water stream and the contact angle was measured using ImageJ 1.53j.

Results: XRD results indicated that hydrothermally synthesized TiO_2 nanoparticles contained 97.3% Anatase phase, and the measured water contact angle was 118.93°. However, after exposure to ambient conditions, the WCA decreased to 112.00° after 7 days.

Conclusion: The coating displayed successful hydrophobicity. The decrease in the contact angle and the possibility of obtaining the result at a lower temperature needs to be further investigated.

Keywords: *Hydrophobicity, Clay roof tiles, Photocatalytic, TiO_2, Stearic acid*

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Fabrication and characterization of dye-sensitized solar cells based on vein graphite /Lead sulfide nanoparticles composite counter electrode

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Background: As a potential candidate of low-cost, third generation photovoltaic device, dye-sensitized solar cells (DSSCs) have attracted increasing attention. The counter electrode (CE) is one of the major components of a DSSC. The role of the CE is to collect electrons from the external circuit and then transfer them into the redox electrolyte by catalysing the reduction of oxidized species in the electrolyte. The ideal CE materials should exhibit high electrocatalytic activity toward electrolyte regeneration, excellent electronic conductivity, good chemical stability, and low production costs. Considering the above properties, carbonaceous materials would be promising candidates for CE materials compared to other types of CE materials.

Objectives: In this study, we have used Sri Lankan vein graphite to investigate the electro catalytic activity and replace the expensive Pt CE in DSSC applications with low cost material.

Methods: Sri Lankan vein graphite based CEs were prepared using a simple spray technique. To improve the power conversion efficiency, we have introduced lead sulphide (PbS) nanoparticles as a transition metal sulphide into the graphite matrix. To assemble PbS nanoparticles on graphite CEs, successive ionic layer adsorption and reaction (SILAR) method was used. Prepared composite material was characterized using scanning electron microscopy and the cyclic voltammetry (CV) was performed to study the electrochemical performance of CEs.

Results: The photovoltaic performance of composite CE based DSSCs were optimized by varying the number of SILAR cycles from 1 to 4. With the increasing number of SILAR cycles, the power conversion efficiency was increased up to 2 SILAR cycles, but further increasing the number of SILAR cycles from 3 to 4, the performance was reduced.

Conclusion: The best power conversion efficiency of 6.42 % can be obtained for 2 SILAR cycles, which is higher than the pristine graphite based device (5.01 %) but lower than the Pt-based device (8.12 %), fabricated under similar conditions.

Keywords: *Graphite counter electrode, PbS nanoparticles, Dye-sensitized solar cells.*

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Electrochemical performance of thermally oxidized graphite as the anode material in Lithium-ion rechargeable batteries

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Background: The development of natural graphite for the anode application in rechargeable Lithium-Ion Batteries (LIB) has brought about excellent cycle capability with increased power and energy densities. The thermal oxidation method is a low cost and single-step solid-gas phase reaction technique used for graphite modification.

Objectives: Investigating an effective, simple and low cost method to improve the electrochemical performance in the graphite electrode.

Methods: In the present study, Purified Natural Vein Graphite (PNVG) was thermally oxidized under air at 550 °C. The thermally oxidized (TO) graphite were then investigated by X-ray diffraction, scanning electron microscopy, Raman microscopy, BET surface area and Fourier Transform Infrared spectroscopy. Electrochemical characterization was performed with CR 2032 coin cells assembled with the anode fabricated with TO graphite/LiPF6/Li cell configuration.

Results: The results revealed that the TO graphite has a better crystalline structure, higher surface area and improved surface functionalization than the PNVG. The initial discharge capacity of the TO anode is 375 mA h g^{-1}. Compared to PNVG, high discharge capacity is observed for TO. After 50 cycles, the Coulombic efficiency of TO improved from 84% to 99.9%. Electrochemical impedance analysis revealed smooth diffusion and lithiation-delithiation of Li-ions during charging and recharging while showing five transition stages of intercalation of Li-ions into the graphite. During phase transition stages I and III, a continuous drop in voltage was observed while other II, IV and V stages show voltage plateaus, indicating that these transitions may occur via two-phase electrochemical reactions.

Conclusion: Surfaces of PNVG have modified during oxidation hence improving graphite structure for higher Lithium-ion intercalation. Simultaneously, it has also improved the reversible capacity and cycling behavior of PNVG, considerably. As a result, it can be concluded that these considerable modifications in graphite surfaces have caused the enhancement of the electrochemical performance of the TO graphite anode.

Keywords: *Graphite, Thermal oxidation, Electrochemical performance, Li-ion rechargeable battery*

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Investigating the phenomenon of electricity generation by flowing water over a graphene sheet

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Background: Recently published studies show that an electric voltage is generated when a flow of water passes over a graphene layer.

Objective: The objective is to understand the mechanism in which the process generates electricity. Since some researchers hypothesized that this phenomenon might have been caused by the presence of ions in water, in this study, we test and present a novel hypothesis by using de-ionized (DI) water.

Method: We deposited a few layers of graphene on to a silicon dioxide substrate using a thermal evaporation technique. The graphene thin-film system was characterized by means of UV-Visible, X-ray diffraction, and Raman spectroscopy. Then DI water was allowed to flow on the graphene thin film at a constant flow rate. The generated voltage was measured using a digital voltmeter connected to a computer. We changed the water flow rate and measured the corresponding voltages.

Results: We observed a voltage of 0.2 μV for a flow rate of 13.9 mm/s. Consequently, we observed that a higher voltage is generated with a higher flow rate. Our experiment using DI water confirms that this phenomenon of electric voltage generation is not caused by the presence of ions in water as suggested by some of the previous researchers. However, ions may enhance the magnitude of the voltage generated. Moreover, we observed that with changing the direction of the water flow, the polarity of the generated voltage gets changed. Hence, the momentum transfer theory cannot be used to fully explain this phenomenon.

Conclusion: We believe that the dipolar properties of the water molecule generate the voltage observed. Since H_2O is a dipolar molecule, when the DI water flows over the graphene sheet, Pi-cloud of graphene sheet could generate a charge imbalance on nearby water molecules, leading to a flow of electric charges. Further studies are being conducted to test this hypothesis by changing the dipolar property of water flow by applying a strong electric field.

Keywords: *Renewable energy, Graphene, Dipolar property, Energy harvesting*

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CHEMICAL SCIENCES

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In vitro acetylcholinesterase inhibitory activity of *Walidda antidysenterica*, *Centratherum punctatum* and *Vernonia cinerea*

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Background: Acetylcholinesterase (AChE) inhibition is a well-accepted therapeutic strategy for Alzheimer's disease and many types of dementia. Natural products are promising sources of useful AChE inhibitors and have been used for the treatment of Alzheimer's disease and other memory-related disorders for years in various parts of the world. *Walidda antidysenterica*, *Vernonia cinerea* and *Centratherum punctatum* have been used in traditional medicine to treat various diseases including cognitive disorders.

Objectives: This study was carried out to evaluate AChE inhibitory properties of the organic extracts of *W. antidysenterica*, *C. punctatum* and *V. cinerea*.

Methods: Air dried, powdered samples from different plant parts (leaves, stem bark, roots, flowers and seeds) were sequentially extracted with 3 solvent systems (CH_2Cl_2, Methanol: CH_2Cl_2-1:1 and Methanol) and mixed together to yield a total extract of the individual plant part. Next, the organic extracts were evaporated to dryness and redissolved in a methanol-water mixture (7:3). These mixtures were tested for AChE inhibiting activity using Ellman's method in 96-well microplates. Donepezil (AChE IC_{50} value = 34 nM) was used as the standard acetylcholinesterase inhibitor and all the tests were done in triplicates.

Results: Potent AChE inhibitory activities were shown by the flower extract of *C. punctatum* and the leaf extract of *W. antidysenterica* with IC_{50} values of 60 ±0.2 µg/mL and 64 ±0.5 µg/mL, respectively. Furthermore, *V. cinerea* leaves extract and *W. antidysenterica* root extract exhibited AChE inhibiting activities with IC_{50} values of 128±1.2 µg/mL and 240 ±0.4 µg/mL, respectively.

Conclusion: Based on the results it can be concluded that these plants possess anti-cholinesterase activity and can be used to isolate drug leads with anti-acetylcholinesterase activity.

Keywords: *Acetylcholinesterase, Centratherum punctatum, Ellman's method, Vernonia cinerea, Walidda antidysenterica*

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An indexical evaluation of heavy metal pollution in drinking water in Rideemaliyadda-South village, a CKDu hotspot of Sri Lanka

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Background: For about two decades, Sri Lanka has been facing the pressing health issue known as Chronic Kidney Disease of uncertain etiology (CKDu). The disease is believed to be associated with toxic trace elements present in drinking water of affected areas.

Objectives: This study was conducted to assess the potential health risk due to nephrotoxic trace metals in drinking water through calculation of Water Quality Index (WQI), Heavy Metal Pollution Index (HMPI), Heavy Metal Evaluation Index (HMEI) and Environmental Water Quality Index (EWQI) in an emerging CKDu area, Rideemaliyadda-South village in Uva Province of Sri Lanka.

Methods: Thirty (30) drinking water samples were collected from the study area, and concentrations of nephrotoxic heavy metals Cu, Cr, Cd, As, and Pb were measured using the ICP-MS (Agilent 7800). From the mean values of the metal concentrations, WQI, HMPI, HMEI, and EWQI were calculated.

Results: The mean nephrotoxic heavy metal concentrations for Cu, Cr, Cd, As, and Pb were recorded (in µg/L) as 1.95(±1.17), 0.16(±0.04), 0.12(±0.02), 0.24(±0.05) and 0.45(±0.07) respectively. They were under the maximum permissible levels recommended by WHO (2004). The WQI (4.02±0.15) showed excellent water quality (0-25), HMPI (2.76±0.33) showed low contamination (<15), HMEI (0.09±0.007) resulted as fit for consumption (<1), and EWQI ($1.3\times10^{-3}\pm0.2\times10^{-3}$) resulted in excellent water quality (<50) of the study area.

Conclusions: According to indexical evaluation, the water quality of Rideemaliyadda-South village has lower contamination of nephrotoxic trace metals and is suitable to use for drinking purposes. Further investigations can be done in these areas as water is free from trace metals. Even though the concentrations of these trace metals are lower than the WHO standards, chronic exposure could pose a threat to human health. Therefore, usage of proper filtration methods when utilizing those waters for drinking purposes can be recommended.

Keywords: *CKDu, heavy metal indices, nephrotoxic heavy metals, water quality indices*

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Bio-mediated synthesis of TiO_2 nanoparticles and its photocatalytic degradation of methyl orange

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Background: Investigation of an environmentally friendly method to remediate the organic dyes in the industrial effluents.

Objectives: To investigate a green method to synthesise TiO_2 nanoparticles using *Azadirachta indica* flowers extract and to use these nanoparticles in photocatalytic degradation of methyl orange.

Methods: *Azadirachta indica* flowers were washed with deionized water, shadow dried for 1 week and then flowers were ground to powder. Extract was prepared by adding 5.00 g of the above powder to 100.0 mL of ethanol using soxhault apparatus. 0.50 mL of titanium tetraisopropoxide was added to 50.0 mL of extract and shaken for 24 hours in a shaker, at room temperature. Formation of TiO_2 nanoparticles was confirmed by UV-Visible spectrophotometer. TiO_2 nanoparticles were collected and calcinated at 500 ˚C. 0.05 g of TiO_2 nanoparticles were added separately to 100.0 mL of methyl orange (10 ppm) at pH of 5, 7 and 8. Then the mixtures were kept under sunlight and analysed using UV-Visible spectrophotometer.

Results: UV-Visible spectrum band at 296 nm confirms the presence of TiO_2 nanoparticles. Tauc plot gave the band gap energy of 3.2 eV, which belongs to the anatase phase of TiO_2. XRD peaks at 2θ = 25.41˚, 38.14˚, 48.22˚, 54.34˚, 55.29˚, 63.08˚, 69.34˚, 70.58˚, 75.57˚ and 83.17˚ corresponding to the planes (101), (004), (200), (105), (211), (204), (116), (220), (215) and (224) respectively indicate anatase phase of TiO_2 nanoparticles. FT-IR absorption bands at 3343 and 1649 cm^{-1} indicate the secondary amide group and the band at 619 cm^{-1} shows the presence of C-Cl. These functional groups functioned as a stabilizing agent. Degradation percentages 99.17 %, 96.87 % and 78.16 % were attained for methyl orange at pH 5, 7 and 8 respectively in 330 minutes.

Conclusion: Secondary amide in flower extract of *Azadirachta indica* acts as a stabilizing agent for the synthesised nanoparticles. XRD peaks confirm the formation of anatase phase of TiO_2. Highest degradation percentage of methyl orange was attained at pH 5. Degradation percentage was decreased with increasing pH within the pH range studied.

Keywords: *Methyl orange, Photocatalytic degradation, Titanium dioxide, XRD*

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Effect of hydroxyapatite nanoparticles on serum proteins

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Background: Bone grafting is a global technology that uses the transplanted bone to repair and rebuild diseased or damaged bones. Nanoscale hydroxyapatite (HA) has displayed important properties such as osseointegration when compared with microscale HA. Nanoparticles (NPs) can interact with proteins present in biological fluids such as blood. Therefore, protein adsorption onto NPs in a biological medium is an important factor for the assessment of biological responses to NPs. In human plasma, a typical protein corona formed on NPs consists of proteins such as serum albumin, immunoglobulins, fibrinogen, and apolipoproteins.

Objectives: The objectives of the study are to synthesize HANPs by facile one-pot methods using Ca and phosphate sources only and to determine the effect of HANPs on serum total protein and serum albumin.

Methods: A novel, low-cost surfactant facilitated (Triton X 100) HANPs were synthesised by a simple one-pot method using $Ca(OH)_2$ and $Na_2HPO_4.12H_2O$ only and it was characterized using Powder X-ray Diffraction (XRD) method, Scanning Electron Microscopy (SEM) and particle size analysis. In this study serum total protein (STP) and serum albumin (SA) concentrations were measured according to the guidelines provided along with the kits with different masses of HANPs. Data were analyzed using SPSS (Version 23 for Windows).

Results: XRD pattern, SEM images and particle size analysis revealed the formation of HA nanoparticles. After adding HANPs, the STP concentrations of serum samples decreased significantly ($p<0.05$) than the serum samples without HANPs and SA concentrations were comparable with HANPs added samples and in those without HANPs.

Conclusion: A simple, novel, surfactant-mediated, one-pot method can be used to synthesize pure HANP. The tested concentrations of HANPs significantly affect the STP concentrations and do not significantly affect the SA concentrations.

Keywords: *Hydroxyapatite Nanoparticles, Serum total protein, Serum albumin, Bone grafting*

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Comparative study of different extraction techniques on phytochemical extraction of *Psidium guajava* leaves

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Background: Precision and legitimacy of qualitative and quantitative measurements of plant-based phytochemical materials are heavily reliant on the choice of an appropriate extraction method. Selection of efficient yet simple method, has a critical impact on the diversity of bioactive compounds extracted without damage.

Objectives: The current study aimed at evaluating effect of different extraction techniques on the Total Phenolics (TPC), Total Flavonoids (TFC), Total Tannins (TTC), Terpenoid (TC), Saponins (SC), and Alkaloids (AC) Contents of *Psidium guajava* (Guava) leaves.

Methods: Four extraction techniques were selected and used to extract phytochemicals from guava leaves: sonication (E1, one-hour at RT), Soxhlet (E2, six-hours at 105 ºC), maceration with agitation (E3, six-hours at RT), and maceration with agitation upon heating (E4, six-hours at 60 ºC), all of which used water as the solvent. All aqueous extracts were screened for phytochemicals using standard methods and quantified using standard spectrophotometric methods. All parametric and non-parametric data were statistically analysed at a 5% significance level using statistical software SAS and R-Studio.

Results: According to the extracted yields, E2 has the greatest yield percentage at 5 % significant level, followed by E4, E3, and lastly E1. Though, extraction yields differ from each technique, none of the four methods showed statistically significant differences in phytochemicals availability. TPC, TTC, and TC levels were significantly high in E4 (279.07±0.23 mg GAE/g, 276.27±0.23 mg TAE/g, and 28.61±0.06 mM LE/g, respectively). TFC and SC were found significantly high concentrations in E2 (38.17±0.03 mg QE/g and 575.29±2.86 mg SE/g, respectively). AC, on the other hand, was significantly high in E3 (2.92±0.20 mg AE/g) and low in E2.

Conclusion: Phytochemicals were recovered in large quantities using heat extraction methods. The E2 extraction approach is highly recommended for extracting flavonoids and saponins, whereas the E4 extraction technique is appropriate for extracting a wide range of phytochemicals such as polyphenols, tannins, and terpenoids.

Keywords: *Extraction methods, Psidiumguajava, Phytochemicals, Spectrophotometric methods*

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Synthesis of a chitosan based mucoadhesive nano drug delivery system for amoxicillin

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Background: Nanoencapsulation is a promising avenue that has garnered much attention in the field of medicine because of its potential to increase bioavailability of poorly soluble drugs, improve the specific targeting ability of drugs and provide protection from the harsh environment of the gastric fluid. Furthermore, their versatility and capacity for modification allows them to be used for a variety of other medicinal applications including controlled release formulations.

Objectives: This study aimed to develop an oral mucoadhesive formulation for the controlled release of the antibiotic amoxicillin using the ionic gelation technique. Amoxicillin is a cornerstone in the treatment of gastric ulcers caused by *Helicobacter pylori* and currently requires multiple daily doses due to its short gastric retention time.

Methods: The polymer chitosan was chosen for the nanoencapsulation process due to its biocompatibility, mucoadhesive properties and inherent antibacterial activity. The encapsulation was done using the ionic gelation technique with sodium tripolyphosphate as the crosslinker. The resulting nanoparticles were characterized by FT-IR, XRD and SEM, and were evaluated for their mucoadhesive properties in simulated gastric fluid using bovine mucin.

Results: The synthesized nanoparticles exhibited a yield of 82.3% and loading and encapsulation efficiencies of 58.94% and 96.20% respectively. The optimum chitosan concentration was 2.0 mg/mL, and the drug was found to lose its crystallinity upon encapsulation. The nanoparticle formulation showed a 67.76% increase in mucin binding efficiency compared to the conventional formulation demonstrating its potential as a controlled release vehicle. The size range of the nanoparticles was between 100 nm to 1 µm, and they were found to exist as an amorphous nanodispersion.

Conclusion: The results clearly show that our developed formulation shows promise as a controlled release vehicle for the delivery of amoxicillin and can be used to develop more effective oral drug delivery platforms in the future.

Keywords: *Nanoencapsulation, Drug delivery, Mucoadhesive, Amoxicillin*

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In silico binding energetics of Carvacrol from *Ocimum sanctum* against BACE-1 target in Alzheimer's Disease

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Background: Neurotoxic aggregation of amyloid β peptide (Aβ) is a major factor causing Alzheimer's Disease (AD). Beta-site amyloid precursor protein (APP) Cleaving Enzyme-1 (BACE-1) is a rate-limiting enzyme in the production of Aβ. Phytochemicals are widely studied for their BACE-1 inhibitory behaviour. *Ocimum sanctum*, commonly known as Holy Basil, has been used in traditional medicine due to its pharmacological actions.

Objectives: Molecular-level binding of carvacrol, a phenolic monoterpenoid from *O. sanctum* against BACE-1 receptor was computationally investigated for its energetics associated with docking. There is not adequate information on anti-Alzheimer activity of carvacrol. The present study profiled docking conformations and residual interactions at the BACE-1 sites including binding energetics that can provide guidance to laboratory experiments.

Methods: BACE-1 target preparation, carvacrol ligand preparation, drug-likeness analysis employing Lipinski's rule of five and variable nearest neighbour method-based Adsorption, Distribution, Metabolism, Excretion and Toxicity (vNN ADMET) predictions and docking pocket grid identification were performed prior to molecular docking. The binding affinity of carvacrol was investigated against the BACE-1 target using molecular docking tools. The molecular interactions were studied using python molecular visualization.

Results: Carvacrol shows no violations to Lipinski's rule of five. ADMET predictions confirm that the drug has no cytotoxic and mutagenic effects. Nine different ligand poses were obtained among which the most stable conformation accounts for a binding affinity of -5.6 kcal/ mol. Tyrosine (TYR71) and phenylalanine (PHE108) of chain A of BACE-1 protein were found to have π-π stacked and π-alkyl interactions with the ligand at receptor sites.

Conclusion: Carvacrol from *O. sanctum* shows potential drug-likeness with stable docking pose, which will be useful in the inhibition of the BACE-1 activity, preventing the accumulation of Aβ. This can be further verified using *in vitro* and *in vivo* studies.

Keywords: *Alzheimer's Disease, BACE-1, Carvacrol, Molecular docking, Ocimum sanctum*

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Evaluating three metal organic frameworks to adsorb nitrates and fluorides

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Background: Water pollution is the alteration of physical, chemical and biological properties of water to the extent it is hazardous to humans and the environment. Excess nitrate in water causes eutrophication, and methemoglobinemia, and excess fluoride causes dental fluorosis, skeletal fluorosis, reproductive and developmental effects. Adsorption is one among diverse approaches for removing hazardous anions from water due to its high performance.

Objectives: To determine the removal of anions by the process of adsorption using three synthesized Metal Organic Frameworks (MOF): – MIL53(Fe), MIL53(Al) and MOF 71(Co).

Methods: The MOF's were synthesized by using the respective metals Fe, Al and Co and 1,4-benzenedicarboxylic acid by microwave digestion and characterization was done by using P – XRD and FTIR. After determining the adsorption of nitrate and fluoride, Optimization, Kinetic study, Isotherm study and Thermodynamic study were also performed

Results: In the adsorption experiments, nitrate could not be adsorbed by any of the MOF's; all of the MOF's were able to adsorb fluoride: 96.42% by MIL53(Fe), 89.87% by MIL53(Al) and 24.73% by MOF71(Co). Optimization experiments were performed with MI53(Fe) and the optimum shaking time for the adsorption process was 30 mins, optimum pH was 7 – 9, and optimum shaking speed was 100 rpm. Removal of fluoride in the aqueous medium by MIL53(Fe) followed pseudo second order kinetic model and isotherm studies showed that this process followed the Langmuir isotherm model. Thermodynamic studies concluded that removal of fluoride in an aqueous medium by MIL53(Fe) is a spontaneous process at 300 K and 310 K.

Conclusion: The MOF - MIL53(Fe) is a good adsorbent for chemical treatment of wastewater and merits further investigation.

Keywords: *Adsorption, Fluoride, Nitrate, Aqueous, Metal organic framework*

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Adsorption kinetics of fluoride on to γ- Fe_2O_3 coated laterite sand

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Background: Out of many causes of water pollution, the contamination by fluoride (F^-) has been recognized as one of the pragmatic problems by the World Health Organization (WHO), which causes detrimental health problems. It has been estimated that more than 200 million people worldwide rely on drinking water with fluoride that exceeds the WHO guideline of 1.5 mg/L.

Objectives: Keeping the view of toxic effects of fluoride on human health, there is an urgent need to find out an effective technique for the removal of excess fluoride from drinking water.

Methods: This study focused on a new adsorbent made by the coating of γ- Fe_2O_3 on the natural laterite sand (mixture of Al_2O_3 - 21%, Fe_2O_3 - 47%, SiO_2 - 28%) substrate using chemical co-precipitation methodology. The prepared material was characterized by RAMAN Spectroscopy and Scanning Electron Microscopy (SEM) and the adsorption of F^- has been studied.

Results: The SEM image of the substrate showed the presence of a porous and rough surface. The adsorption data fit with the Freundlich isotherm at higher concentrations, revealing the multilayer adsorption. The adsorption kinetics fit more toward a pseudo-first-order for initial 30 min with R^2 value of 0.95 and the pseudo-second-order of kinetics can have applied for the rest of the reaction with R^2 value of 0.96.

Conclusion: The RAMAN spectra revealed the presence of common peaks for the γ- Fe_2O_3 and laterite sand while proving the adsorption which happens through replacing the bending and stretching –OH groups of the absorbent substrate by the F^- ions efficiently (up to 85% removal). Kinetic studies concluded that at initial 30 min, chemisorption (-OH groups at the absorbent surface replace with F^- ions by forming covalent bonds.) will take place, while multilayer adsorption takes place with increasing the time with other fluoride ions by forming weak van der Waals interactions with already adsorbed species.

Keywords: *Chemisorption, Adsorbent, Contamination, Removal-capacity*

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Variability of the total and exchangeable phosphorus concentrations in paddy cultivated soils of Sri Lanka

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Background: Total and exchangeable phosphorus (P) concentrations and the ratio of those concentrations are important in sustainable soil management in agriculture. However, this has not been tested recently for soil types used for rice cultivation in Sri Lanka.

Objectives: The objective of this study was to calculate the variation of soil total and exchangeable P concentrations and their ratio of the soils used to cultivate paddy in Sri Lanka.

Methods: Total of 200 soil samples representing three climatic zones and 25 districts in Sri Lanka were collected. Available P and total P concentrations were measured using Olsen and colorimetric methods, respectively. Eventually, the ratio of total and exchangeable P concentrations was calculated

Results: Soil total P concentration ranged between 24-4,929 mg kg^{-1} while the exchangeable P concentration varied between 5-77 mg kg^{-1}. Therefore, the ratio of total to exchangeable P concentration in tested soil samples varied from 2 to 416. The ratio of soil groups used to cultivate rice varied from 11 to 106. Rock knob plain soil had the highest total P concentration (2,295 mg kg^{-1}), and lowest in Noncalcic Brown soils on old alluvium and Solonetz (NB_S) (152 mg kg^{-1}). The highest available P concentration was recorded in Reddish Brown Earths & Immature Brown Loams (RBE_IBL) (34 mg kg^{-1}) and lowest in Red-Yellow Latosols (RYL) (12 mg kg^{-1}). The highest P ratio was recorded in Red-Yellow Podzolic soil with soft or hard laterite (RYP) and lowest in NB_S. Moreover, NB_S and Solodized Solonetz and Solonchaks soils (SSS) had ratio less than 20. The highest ratio was recorded in Wet zone soils while the lowest in Intermediate zone soils.

Conclusion: Soils with lower P ratios require external P application to sustain crop productivity. This information would be crucial for sustainable P fertilizer application and sustainability in paddy cultivation in Sri Lanka.

Keywords: *Exchangeable phosphorus, Paddy, Soil categories, Total phosphorus*

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Proximate and phytochemical composition of *Eryngium foetidum* extracts under two different extraction techniques

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Background: *Eryngium foetidum* (Long coriander) grows in the wet zone of Sri Lanka. Though this herb is popular in healthcare application and as a culinary spice in tropical regions, very limited scientific studies are available in Sri Lanka.

Objectives: The present study aimed on investigation of phytochemicals and proximate composition of leaves of *E. foetidum* extracted into methanol using two different techniques, i.e., maceration and sonication.

Methods: Dried plant powder was macerated for 48 hours at RT whereas sonication was done for one hour at RT. Phytochemical qualitative analysis was performed using standard methods described in the literature. The Total Phenolic Content (TPC) and Total Tannin Content (TTC) were determined by Folin-Ciocalteu method, Total Flavonoid Content (TFC) was determined by $AlCl_3$ method and Terpenoid Content (TC) was determined by phosphomolybdic acid method of macerated methanolic extract. The standard AOAC protocols were followed for the estimation of proximate compositions of the dried leaves powder. All the data were statistically analysed using SAS and R-Studio.

Results: Even though, extraction yield was significantly high in sonication (14.72 ± 0.92 %), phytochemicals qualitative analysis showed that there were no significance differences in presence of phytochemicals in both extracts. Phytochemical quantitative analysis revealed that the TPC, TFC, TTC and TC of macerated methanolic extracts of *E. foetidum* were 66.78 ± 2.50 mg GAE/g, 28.41 ± 0.10 mg QE/g, 61.70 ± 1.31 mg TAE/g and 14.51 ± 0.14 mg LE/g, respectively. Energy content of dried leaves is 303.54 ± 1.39 kcal/100g.

Conclusion: The phytochemical screening confirmed similar phytochemical composition in the dried leaves samples of *E. foetidum* both under maceration and sonication methods. Considering the yield and time factor, sonication is a faster method. As quantitative data from macerated samples evidenced an adequate amount of phytochemicals, this extraction process is ideally suited for functional food production because it is easily accessible to the general public.

Keywords: *E. foetidum, Phytochemicals, Total phenolics, Proximate composition, Sonication*

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Status of registration and quality of metformin products in Sri Lanka: A case study

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Background: According to the product recalls and withhold reports published on the website of the National Medicines Regulatory Authority (NMRA) of Sri Lanka, metformin is one of the most commonly reported medicines with poor quality. Pharmacopieas provide methods of assaying specific pharmaceutical products.

Objectives: This study aimed to identify quality failures of metformin products in post-marketing samples.

Methods: A sample of 30 metformin 500mg tablets were purchased from 25 selected pharmacies representing 5 districts of Sri Lanka. Registration status of the products was checked with the data available on the NMRA website. Visual inspection of the products was performed according to the visual inspection tool developed by the International Pharmaceutical Federation. The assays were performed using 20 tablets of each product using UV- Vis spectrophotometric method according to the British pharmacopoeia 2019.

Results: Of the collected 25 different metformin samples, 8 were generics and 17 were branded generics. It was observed that 10 out of 25 products (40%) dispensed by the pharmacies were not available in the list of NMRA registered pharmaceuticals. According to the results of the assay, 3 out of 25 products (12%) obtained from Colombo, Badulla and Jaffna districts failed to meet pharmacopoeial assay limits. However, the products without proper registration status showed compliance to assay limits. Surface chipping was observed with one of the products failing the assay. The pharmacy which dispensed metformin product which failed the assay, did not have air conditioning facilities. Also, black dust particles were observed with one metformin product that had metformin within pharmacopoeial assay limits.

Conclusion: A relatively high assay failure rate (12%) of metformin products was reflected in the study sample along with other quality and registration status related issues indicating the need for a stringent quality assurance scheme to ensure the quality of metformin products in Sri Lanka.

Keywords: *Metformin, Quality of medicines, Assay failures, Post-marketing quality surveillance*

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Investigation of *in vitro* antidiabetic activity of chitosan-tripolyphosphate nanoparticles encapsulated with *Gmelina arborea* aqueous extract

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Background: Enhancing bioavailability of antidiabetic principles via encapsulation in a chitosan-tripolyphosphate (CS-TPP) matrix could improve their antidiabetic potential. *Gmelina arborea* Roxb. (Family: Verbenaceae) stem bark decoctions are used in Sri Lankan traditional medicine to treat diabetes mellitus. The aqueous extract (AE) of *G. arborea* has been found to significantly inhibit carbohydrate-digesting enzymes. In the present study, the AE-encapsulated CS-TPP nanoparticles were screened for their *in vitro* antidiabetic properties.

Objectives: To encapsulate the aqueous extract of *G. arborea* in CS-TPP nanoparticles and investigate the *in vitro* antidiabetic activity of the nanoparticles using α- glucosidase inhibitory, glucose uptake and glucose adsorption assays.

Methods: Dried and powdered stem bark of *G. arborea* was extracted using distilled water under ultrasonication (40 kHz, 37 °C, 30 min). The AE-encapsulated CS-TPP nanoparticles were synthesized (0.375% w/v, encapsulation efficiency 57.64±2.38%) using ionic gelation method and were screened for antidiabetic activity using α-glucosidase inhibitory, glucose uptake and glucose adsorption assays. Acarbose and metronidazole were used as the positive controls. The results were analysed using ANOVA, followed by Tukey post hoc test.

Results: The AE-encapsulated CS-TPP nanoparticles displayed significantly high ($p<0.05$) α-glucosidase inhibitory activity (IC_{50}, 8.09±0.99 mg/mL) compared with the AE (IC_{50}, 31.48±1.34 mg/mL). The AE-encapsulated CS-TPP nanoparticles also showed significant ($p<0.05$) glucose adsorption (1.20±0.24 mmol/g at 100 mM glucose concentration) compared with the AE (−1.11±0.14 mmol/g at 50 mM glucose concentration). However, with respect to the glucose uptake, the AE-encapsulated nanoparticles did not show any significant difference compared to the AE ($p>0.05$). Negligible matrix effect [α-glucosidase inhibitory activity (0.06±0.33 %)], increase of matrix effect [glucose adsorption assay (22.50%)] and decrease of matrix effect [glucose uptake (4.00%, 5.56% and 22.37% at 5, 7.5, 10 mM glucose)] were exerted by void nanoparticles.

Conclusion: The AE-encapsulated CS-TPP nanoparticles have high α-glucosidase inhibitory activity and glucose adsorption compared to the free AE.

Keywords: *Gmelina arborea, α-glucosidase, Glucose uptake, Glucose adsorption, Chitosan-tripolyphosphate nanoparticles*

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Metabolomic profiling of fluorosis patients using mass spectrometry tools

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Background: Fluoride consumption helps decrease dental caries up to the permissible limits but excessive consumption causes a fluorosis disease. Studies related to fluorosis disease are limited and therefore, there is no fundamental cure available for fluorosis till now.

Objectives: This work describes the metabolic profiling of serum obtained from fluorosis patients to study metabolic changes in response to chronic consumption of fluoride.

Methods: Serum samples of fluorosis patients (n=39) and healthy control (n=20) were collected from Tharparkar, Sindh, Pakistan. Estimation of fluoride in serum was done through ion selective electrode (ISE). Metabolomic analysis of disease and healthy control was carried out using UPLC-QTOF-MS in positive ionization mode.

Results: Fluoride concentration was found to be in the range of 0.16-1.25 ppm and 0.007–0.038 ppm in disease and healthy groups, respectively. Total 49 compounds were identified through a different available database and annotation. Among all identified metabolites, intensities of eleven differential identified metabolites have been found altered in disease samples as compared to healthy controls. Different statistical tools, such as PCA, heatmap and OPLS-DA have been generated for the discrimination of groups.

Conclusion: Pathway analysis of identified compounds revealed that 5 important pathways are disturbed with the most affected purine metabolism. This study can be helpful to understand the progression of fluorosis disease at the molecular level, and the patient's diagnosis, the prognosis could be improved.

Keywords: *Fluorosis; Ion-selective electrode (ISE), Metabolomics, Serum, UPLC-QTOF-MS/MS,*

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Enzyme assisted extraction of oleoresin from Cinnamon (*Cinnamomum zeylanicum*) and its effect on trans-cinnamaldehyde content and yield

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Background: The Cinnamon Oleoresin (CO) represents a concentrated form of cinnamon (*Cinnamomum zeylanicum*) and it is becoming progressively more significant in the processed food industry. Enzyme Assisted extraction (EAE) is found to be more advantageous for the extraction of oleoresins over traditional methods such as solvent extraction, maceration.

Objectives: To study the effects of enzymatic pre-treatment and concentrations on extraction yield and trans-cinnamaldehyde content (TCC) of cinnamon.

Methods: Aqueous Enzyme solution of viscozyme and α-amylase were prepared in different concentrations of 0.25%, 0.5%, 1.0% (adjusted pH to 4.5-5.0 with citric acid). The crushed plant materials were sprayed with them and incubated at 45+2 ^{0}C for 90 min. Pre-treated and control samples were extracted by soxhlet extraction for 18 h using ethyl acetate and acetone (1:1). The yield of CO was determined and TCC was analysed by HPLC using a reversed-phase C18 column and mixture of methanol:acetonitrile:water (35:20:45).

Results: The CO yield and the TCC of the pre-treated samples with enzymes were significantly higher ($P < 0.05$ at 95% confidence level) compared to the control. Further, viscozyme (composed of Cellulase and Pectinase) treated sample showed significantly higher CO yields of 3.62±0.04% and 3.73±0.08% at 0.5% and 0.1% concentrations respectively. TCC was significantly higher in the same concentrations of viscozyme; 46.04±0.99% at 0.5% and 46.09±0.33 at 1.0%. The comparison of yields and TCC revealed that there is no significance difference between 0.5% and 1% ($P < 0.05$).

Conclusion: The study demonstrated that the 0.5% viscozyme concentration is the optimum concentration for EAE of CO. Further, the overall study reveals that EAE could be an effective and economical method for increasing the yield and quality of CO as enzymes facilitate the loosening of the structural integrity of plant cells and enhances the extraction of the desired flavour components.

Keywords: *Cinnamon oleoresin, Enzyme assisted extraction, trans-cinnamaldehyde, Viscozyme*

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Physicochemical and functional properties of seed flour obtained from *Mucuna pruriens* and *Phaseolus lunatus*

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Background: *Mucuna pruriens* and *Phaseolus lunatus* are underutilized pulse varieties in Sri Lanka, which are considered as dietary protein sources in rural areas.

Objectives: The study was carried out to investigate the physicochemical and functional properties of seed flour obtained from aforementioned varieties.

Methods: Moisture, ash, crude protein, crude fat and crude fiber contents of seed flour were evaluated. The water (WHC) and oil holding capacities (OHC), swelling power (SP), solubility, emulsifying activity (EA), emulsion stability (ES), foaming capacity (FC), foam stability (FS) and least gelation concentration (LGC) were also analyzed.

Results: The highest moisture content (6.26 ± 0.08 %) and crude fiber (1.89 ± 0.08 %) were reported for *P. lunatus* flour. *M. pruriens* flour had 5.79 ± 0.04 % moisture and 0.47 ± 0.04 % crude fiber content. *M. pruriens* flour had the highest crude protein content (24.31 ± 1.09 %) and crude fat (2.59 ± 0.71 %) when compared to crude protein (19.66 ± 0.02 %) and crude fat (1.43 ± 0.08 %) of *P. lunatus* flour. There was no significant difference ($p>0.05$) in SP of flours at 60 °C, 70 °C and 80 °C. The solubility of two flours at 80 °C were significantly different ($p<0.05$) and the highest solubility was shown by *M. pruriens*. The highest SP for both flours were observed at 90 °C. Significantly higher levels ($p<0.05$) of WHC (2.11 ± 0.10 mL/g) and OHC (1.17 ± 0.08 mL/g) were recorded for *P. lunatus* flour compared to *M. pruriens*. In both flours there was no significant difference ($p>0.05$) among the FC, FS, EA and ES. LGC of both flours was in the range of 15-18 % (w/v).

Conclusion: Above pulse flours may have potential for food applications with functionalities attributed to high protein content and also carbohydrate content, which should be further evaluated.

Keywords: *Crude protein, Flour, Pulse, Underutilized crops, Value addition.*

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Application of reusable magnetic nanoferrites

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Background: Industrialization has unwittingly caused degradation of environmental sources and harmful effects on human health. The addition of dyes to the water resources, without any proper pre-treatment, is a major threat to the ecosystem and human health.

Objectives: This study considered synthesize of separable and reusable methods that alleviate the treating of azo dye contaminated wastewater as conventional methods are ineffective for the removal of these dyes.

Methods: In the present study, $Zn_{0.5}Co_{0.5}Fe_4O_7$ nanoparticles (ZnCF) were synthesized by using a co-precipitation method. Then, followed by standard procedures at ambient conditions surface modified, polyaniline (PANi)/ZnCF nanocomposite was obtained. Colour removal studies proceed with a definite amount of dye solutions which keep contacting surface coated/non-surface coated magnetic nanoparticles.

Results: The as-prepared sample structures were characterized by using X-Ray diffraction (XRD) and Fourier-transform infrared (FTIR) spectroscopy techniques. UV-VIS spectroscopy was used to monitor the colour degrading in the dye solution. It indicates the composite can remove at least 100 ppm dye solutions effectively from water samples. An effective dye removal is identified when in contact with surface modified nanocomposite, whereas non-surface modified nanoparticles are not that effective in dye removal. Also surface coated nanocomposite can be reused effectively at least for three times.

Conclusion: The study, based on different concentrations, was limited to specific time intervals and the effectiveness of the dye to be in contact with both surface coated and with non-surface coated magnetic nanocomposite. Thus, the approach in this work could lead to facile synthesis of highly activated composite for efficient removal of hazardous dye pollutants from wastewater.

Keywords: *Dye, Magnetic, Modified, Nanocomposite, Removal*

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Spatial and seasonal variations in mud quality of the Jaffna lagoon in Northern Sri Lanka

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Background: The Jaffna lagoon is one of the key marine resources in the Jaffna Peninsula, which provides habitat for a number of fauna and flora, livelihood support for fishing communities in the area and seafood for the local population. However, a comprehensive study on its mud quality has not been reported so far.

Objectives: The present study assessed the spatial and seasonal variations in mud quality of the Jaffna lagoon to support the upcoming development efforts in the region while ensuring the sustainability and resilience of the Jaffna lagoon ecosystem.

Methods: Mud samples were collected at 30 different geographical locations in the Jaffna lagoon along the coastline from Ponnalai to Kilaly during the period from December 2018 - June 2019, covering both dry and wet seasons, and the selected physicochemical parameters were determined adopting the standard analytical methods. The obtained data were statistically analysed by t-test and correlation coefficient analysis using SPSS software.

Results: The lagoon mud samples analysed during the study period covering both seasons revealed the following range of variation for each physicochemical parameter studied: lagoon depth 13-127 cm; pH 6.96-8.82; EC 11.90-108.05 mS/cm; salinity 6.35-65.60 g/kg; sulfate 793-6,250 mg/kg; phosphate 0.00-10.95 mg/kg; alkalinity 825-3,300 mg/kg; and hardness 1,750-14,000 mg/kg. Though some degree of seasonal variation was witnessed for each quality parameter, EC, salinity and sulfate showed significant differences between the wet and dry seasons ($P < 0.05$) while an insignificant difference was observed with respect to pH, phosphate, alkalinity and hardness. In the dry season, all parameters, except phosphate, negatively correlated with lagoon depth while a positive correlation was found with respect to pH and phosphate in the wet season. In terms of spatial variation in the mud quality, a high concentration of phosphate was detected in locations where the stormwater carrying detergents and agrochemicals drains into the lagoon.

Conclusion: The study reveals the patterns of spatial and seasonal variations in mud quality of the Jaffna lagoon and helps to understand how the resourceful lagoon could be efficiently utilized for various economic development activities based on these findings without compromising its productivity, biodiversity and sustainability.

Keywords: *Jaffna lagoon, Mud quality, Phosphate, Spatial and seasonal variations*

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Phytotoxic properties of an endophytic fungus from *Centella asiatica*

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Background: Endophytic fungi are recognized as a new source of bioactive substances with their capacity to produce a wide variety of enzymes and secondary metabolites with various biological activities.

Objectives: This study investigated phytotoxic properties of an endophytic fungus isolated from *Centella asiatica* (Apiaceae).

Methods: Triple sterilized leaf segments of *Centella asiatica* were placed on potato dextrose agar (PDA) and incubated in the dark to isolate an endophytic fungus. Large scale culturing of the pure fungal strain was carried out in potato dextrose broth (PDB) medium for 5 weeks. Culture broth was filtered, and broth and mycelium were separately extracted with EtOAc. Three phytotoxicity assays were conducted: freshly filtered broth was sprayed on 3 weeks old cucumber (*Cucumis sativus*) plants and the plants were observed for 7 days; two EtOAc extracts were combined based on thin-layer chromatography, and the combined extract, after concentrating, was screened for phytotoxicity using lettuce (*Lactuca sativa*) seed germination inhibition assay and leaf puncture assay using 2 weeks old cucumber leaves.

Results: Broth spraying assay showed an increase in wilting symptoms of leaves from day 1 to day 7. No wilting symptoms were observed in plants sprayed with un-inoculated PDB medium. In leaf puncture assay, leaf necrosis was observed after 24 h with increased necrosis by 72 h with the EtOAc extract at 1000 mg l^{-1}. In lettuce seed germination assay, EtOAc extract showed ~100% root inhibition at 1000, 500 and 250 mg l^{-1} and IC_{50} values of 23.7 and 55.8 mg l^{-1} for root and shoot inhibition, respectively. Molecular identification of the fungus and isolation of pure compounds are in progress.

Conclusion: Since synthetic weedicides lead to major environmental and health issues, results of the present study suggest that secondary metabolites from this endophytic fungus can lead to the discovery of eco-friendly weedicides.

Keywords*: Centella asiatica, Phytotoxicity, Secondary metabolites*

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Luminescent properties of Eu^{3+} and Tb^{3+} doped hydroxyapatite particles functionalized with dipicolinic acid in the presence of heavy metals

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Background: Luminescence of europium and terbium is hardly affected by ligands or other outer sphere environmental factors. However, sharp narrow emission bands and longer luminescent lifetimes of these ions makes them suitable candidates for luminescent probes. On the other hand, excited states of organic chromophores are easily affected by the surrounding environment. For instance, excited state of organic chromophores can be easily quenched by heavy metal effect. Organic chromophores are often used as sensitizers for lanthanides and if the excited state of the sensitizer is quenched, emission from lanthanide is also affected. This phenomenon enables designing effective luminescent probes. Hydroxyapatite is considered as a material with a remarkable ability to adsorb heavy metal ions such as Pb^{2+}, Zn^{2+}, and Cd^{2+}. Consequently, $Eu^{3+}$and Tb^{3+} doped hydroxyapatite particles functionalized with dipicolinic acid (EuTb-DPA-HAp) can be used as a potential luminescent probe for detection of these heavy metals.

Objectives: The primary goal of this research project is to determine the effect of Pb^{2+}, Zn^{2+} and Cd^{2+} ions on luminescent properties of EuTb-DPA-HAp

Methods: EuTb-DPA-HAp was synthesized using coprecipitation method. A mass of 10 mg of EuTb-DPA-Hap was mixed with 10 ml aliquots of 0.1 mol dm^{-3} Cd^{2+}, Zn^{2+}, and Pb^{2+} solutions, separately. The suspensions were incubated for 16 h at room temperature. Luminescence spectra of the particles after incubation were collected at excitation wavelength of 272 nm.

Results: EuTb-DPA-HAps incubated in Cd^{2+} and Zn^{2+} showed reduction in intensity of luminescence peaks (490, 590, 620 nm). Luminescent profile obtained for Cd^{2+} has barely visible peaks compared to Zn^{2+}. In the case of $Pb^{2+,}$ some luminescence peaks enhanced (545 nm) while simultaneously some declined (490, 590, 620 nm).

Conclusion: Since, luminescence of EuTb-DPA-HAps showed changes with respect to heavy metal species that were present in the medium. Eu^{3+} and Tb^{3+} doped dipicolinic acid functionalized hydroxyapatite particles can be used as a potential candidate to detect heavy metals.

Keywords: *EuTb-DPA-HAps, Heavy metals, Hydroxyapatite, Luminescence, Quenching.*

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Plant-extract based synthesis of zinc oxide particles and evaluation of their antioxidant effect

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Background: Reactive oxygen species (ROS) could react with cellular components resulting in serious diseases such as neurodegeneration and cancer. When the concentration of ROS inside the body increases, the level of endogenous antioxidants is inadequate to effectively neutralize ROS. Various naturally occurring and chemically synthesized antioxidants are currently used to treat ROS-related diseases. However, the long-term therapy of these medicines is known to cause some serious side effects and drug resistance.

Objectives: The objective of the study is to incorporate natural compounds of plant extracts into ZnO particles with a simple plant extract-based synthesis to find if there is a synergistic improvement of the efficacy of antioxidant property of plant extracts or ZnO particles.

Methods: Plant-extract based ZnO particles were synthesized by mixing zinc acetate dihydrate with *Adenanthera pavonina* and *Passiflora foetida* fresh leaf extracts, separately. In addition, ZnO particles without plant extracts were also prepared. Then, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay was conducted to determine the effectiveness of antioxidant activity using ascorbic acid as the standard and under dark conditions. The percentage of radical scavenging activity (RSA) was calculated for plant-based ZnO particles and compared with the results of chemically synthesized ZnO particles without plant extracts.

Results: The synthesized particles were characterized using UV/visible spectroscopy. In comparison, *P. foetida* fresh extract showed a higher RSA (90.58% / 50 µl) than *A. pavonina* fresh extracts (57.29% / 50 µl). However, *P. foetida* extract-based ZnO particles showed a lower RSA (55.96% / 200 ppm) than *A. pavonina* extract-based ZnO particles (62.63% / 100 ppm). The RSA shown by fresh leaf extract is greater than their respective extract-based ZnO particles for both plant species. Leaf extracts studied had to be freshly prepared, while plant extract-based ZnO particles can be stored for at least three months under ambient conditions. Further, the plant extract-based ZnO particles have higher RSA than chemically synthesized ZnO particles.

Conclusion: The plant extract-based ZnO particles of both plants, *P. foetida* and *A. pavonina*, exhibited a considerable DPPH-radical scavenging activity. Although the antioxidant activity (measured by DPPH-radical scavenging assay) of plant extract-based ZnO particles is lower than their respective fresh plant leaf extracts, it is greater than ZnO particles made without plant extracts.

Keywords: *A. pavonina, Antioxidants, P. foetida, RSA, ZnO*

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Validation of a HPLC-UV method to determine benzoic and sorbic acid preservatives in yoghurt and curd products

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Background: Benzoic and Sorbic acids are the most commonly found preservatives in yoghurt and curd. There are no scientific reports on preservatives and their levels of addition in Sri Lankan dairy products. Validating a method to determine the levels of preservatives could bring accurate determination of them in yoghurt and curd.

Objectives: The current study validated ISO 22855:2008 HPLC method in determining the levels of benzoic and sorbic acid in yoghurt and curd.

Methods: HPLC-UV method was validated according to International Conference on Harmonization (ICH) guidelines. Using the validated method, 32 random samples of yoghurt and curd were used to determine the levels of benzoic and sorbic acids in yoghurt and curd products present commercially available in the Colombo district of Sri Lanka.

Results: Both benzoic and sorbic acid gave recoveries within the range 98.16- 109.92% and 92.82-109.34% respectively with a precision less than 2%. Limit of detection (LOD) were 0.027 mgl^{-1} and 0.001mgl^{-1} while limit of quantitation (LOQ) were 0.082 mgl^{-1} and 0.003 mgl^{-1} for benzoic and sorbic acids respectively. Calibration curves plotted for both preservatives within the range of (0.5- 50) mgl^{-1} gave correlation coefficients higher than 0.997. Out of the analysed samples, 80% contained benzoic acid within the range of 1.27-13.94 $mgkg^{-1}$ even though it is not permitted for addition. Sorbic acid was present within the range of 10.79- 292 $mgkg^{-1}$

Conclusion: The validated method demonstrated to be suitable for routine monitoring of benzoic and sorbic acids in yoghurt and curd, as the method presented adequate linearity, sensitivity, accuracy and precision. Presence of benzoic acid could be due to its indigenous origin from the dairy products as it was present in small amounts. Sorbic acid is present below the nationally regulated maximum permitted level of addition (300 $mgkg^{-1}$) in yoghurt and curd products of Sri Lanka.

Keywords: *Benzoic acid, HPLC, ISO 22855, Sorbic acid*

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Implications for vector transport of polyethylene microplastics bound Pb^{2+}: Adsorption capacity and interaction mechanism

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Background: Microplastics are lightweight materials, and found ubiquitously in the aquatic environment due to the discharge of primary and secondary plastics. Pb^{2+} is a common micropollutant found in water discharged from wastewater from industries, service stations, and landfill leachate. Thus, microplastics are considered as a vector to transport Pb^{2+} ions influencing their migration through the water.
Objectives: The present study is to evaluate the interactions of polyethylene (PE) microplastics (MPs) with Pb^{2+} and to assess mechanisms in between them at different environmental conditions and competing ions.
Methods: The adsorption behaviour of Pb^{2+}on PE-MPs was investigated through batch adsorption experiments under various conditions, i.e., ionic strengths (0.001-0.1 M NaNO3), pH (2-8), reaction time, Pb^{2+} loading, and the presence of dissolved organic matter (DOM) (0.5-2.5 ppm) at a PE-MPs loading of 1.0 g/L. PE-MPs were characterized by Scanning Electron Microscopy (SEM) and Fourier Transform Infrared Spectroscopic (FTIR) analysis, respectively. Surface titrations were conducted to determine the pH zero point charge of PE-MPs.
Results: The adsorption of Pb^{2+} showed a gradual increase with increasing pH, reaching the maximum adsorption at pH 5.0–6.0 and > pH 6.0 demonstrated Pb^{2+} precipitation. The overall Pb^{2+} adsorption of PE-MPs decreased at higher ionic strengths, while enhanced with increasing DOM concentration, revealing the hydrophobic and electrostatic interactions. FTIR spectra exhibited non-polar hydrophobic properties of PE-MPs. Pb^{2+} adsorption kinetic data were well described by Elovich and Fractional power models, suggesting that adsorption was assisted through diffusion-controlled and time-dependent processes. The isotherm equilibrium data fitted well for Freundlich and Hill isotherm models, implying multilayer adsorption.
Conclusion: The findings demonstrated the possibility of PE-MPs to act as a vector for Pb^{2+} ions, impacting their migration and destination in water systems where the adsorption was significantly dependent on the pH, ionic strength, and DOM of the water column.

Keywords: *Emerging contaminants, Heavy metals, Lead (II), Polyethylene microplastics, Adorption*

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Full keratin hair growth oil portion: increasing the hair thickness, strongness and depth of the follicles with peppermint extract

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Background: Untimely falling of hair is a widespread burning issue among all men and women. This could partly be due to the busy lifestyle that everybody must go through. However continuous hair treatment with care and reducing the stress-absolutely can control the falling of hair. Therefore, hair oil with peppermint extract was prepared as a good solution to restore the dermal thickness of the hair.

Objectives: Current research focused on the factors that affect hair falling, including the stress, less care, and Chemicals to damage the follicle. Experiment undergoes the activity with follicle thickness and follicle count, depending on age, gender, scalp, and diet.

Method: A random sample of 30 people living in Central province, Sri Lanka was investigated. The results were collected within 60 days by considering age, gender, scalp type and diet. Furthermore, the thickness, follicle count and the nature of the scalp after the use of the oil were experimentally analyzed using microscopic data.

Results: There was a significant increase in the follicle thickness and follicle count in men and women (66.6%) between the ages of 20–50 (T=87.8%) than to ages between 51–60 year-olds. 90.5% had high growth rates, who continue to eat vegetables and herbs daily. All data were obtained from a single part of the island. Therefore, the climatic effects were negligible. Individuals with dry scalp had higher hair growth (T=98.79%) and increasing the peppermint percentage in the oil showed further hair growth. However, men who eat protein-rich foods had a relatively low growth rate. Although most men's scalp oily nature showed rapid hair growth.

Conclusion: It appears that the peppermint essence contained a fatty soluble compound which leads to a high growth rate and thickness of hair follicles. As a future study the compound in the oil extract will be studied.

Keywords: *Follicle, Growth, Microscopic*

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Bioactivity of compounds from *Diploclisia glaucescens*

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Background: *Diploclisia glaucescens* ("Ata thiththa wel") belongs to the family Menispermaceae, is a creeper which grows in the mid-country regions of South India and Sri Lanka. The leaves have been used in the treatment of biliousness and venereal diseases.

Objectives: To study the chemistry and bioactivity of secondary metabolites isolated from the stem of *D. glaucescens.*

Methods: 50g of Methanol extract of dry mature stem of *D. glaucescens* was chromatographed over silica gel (*n*-hexane-EtOAc-MeOH) followed by HPLC. All the isolates were screened for antioxidant activity using DPPH, antifungal activity against *Cladosporium cladosporioides*, phytotoxicity (lettuce seed germination assay), brine shrimp toxicity (*Artemia salina*) and enzyme inhibitory assays on α-amylase, α-glucosidase, acetylcholinesterase and lipase.

Results: The methanol extract furnished six compounds 3-deoxy-1β-20-hydroxyecdysone (**1**), abutasterone (**2**), 20-hydroxyecdysone (**3**), makisterone (**4**), diploclisin (**5**), 20-hydroxyecdysone 2,3,22-triacetate (**6**). Compounds **1**, **2** and **3** showed moderate brine shrimp lethality at 98.69 ppm, 46.39 ppm and 54.94 ppm, respectively. Strong antioxidant activity was observed for compounds **1** and **6** against DPPH at 30.18 ppm and 0.12 ppm, respectively. Compound **3** showed shoot inhibition of lettuce seedlings at 135.65 ppm while compound **2** showed root inhibition of lettuce seedlings at 330.29 ppm. Moderate α-glucosidase inhibitory activity was observed for compounds **3** at 16.19 ppm and **6** at 9.69 ppm. None of the compounds exhibited α-amylase, lipase and acetylcholinesterase inhibitory activities and antifungal activity against *C. cladosporioedes*.

Conclusion: *Diploclisia glaucescens* can be considered as a potential source for the isolation of new therapeutic agents.

Keywords: *Antioxidant, Brine shrimp lethality, Diploclisia glaucescens, Enzyme inhibitory activities*

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Bioactivity of aerial parts of *Mussaenda frondosa*

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Background: Natural products are metabolic compounds which are produced by living organisms such as plants, or micro-organisms which possess vast diversity and involve in vital biochemical pathways, help to continue life on the earth. *Mussaenda frondosa* ("Mussanda") is a tropical shrub belonging to family Rubiaceae and distributed in South Asia. It is commonly used in traditional medicinal practices such as for treatment of asthma, ulcers, leprosy, diuretic, wounds, swells and eye infections.

Objectives: To determine the bioactivity of *M. frondosa*.

Methods: Samples were collected from Central Province Sri Lanka. Aerial parts of *M. frondosa* (15g) were air dried and powdered using grinder and then sequentially extracted into ethylacetate (EtOAc) and methanol (MeOH) using sonicator. Crude extracts were screened for antioxidant activity using DPPH radical scavenging method, antifungal activity against *Cladosporium cladosporioides*, phytotoxicity by lettuce seed germination assay, brine shrimp toxicity against *Artemia salina*, and enzyme inhibitory assays for α-amylase, α-glucosidase, acetylcholinesterase and lipase.

Results: After solvent evaporation it resulted 0.57g of EtOAc and 1.33g of MeOH extracts. Both EtOAc and MeOH extracts showed moderate brine shrimp lethality with IC_{50} 6.0 ppm and 17.0 ppm respectively. Strong antioxidant activity was observed for EtOAc extract against DPPH radical with IC_{50} 0.58 ppm and MeOH extract at 0.67 ppm. Strong α-glucosidase inhibition was observed for both EtOAc and MeOH crude extract with IC_{50} 0.56 ppm and 1.88 ppm respectively. None of above crude extracts exhibited antifungal property against *C.cladosporioides* and phytotoxicity against lettuce seed germination assay. Both EtOAc and MeOH extracts did not exhibit α-amylase, lipase and acetylcholinesterase inhibitory activity.

Conclusion: *Mussaenda frondosa* can be considered as a potential source for isolation of new therapeutic agents especially for cancer and diabetes mellitus.

Keywords: *Antioxidant activity, Bioassay, α-glucosidase, Mussaenda frondosa*

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Bioactivity of some endophytic fungi in *Acalypha indica*

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Background: Secondary metabolites of endophytic fungi are vital source of bioactive compounds. *Acalypha indica* is a promising medicinal herb used in traditional medicine with wide variety of endophytic fungi.

Objectives: This study was focused on bioactivity of fungal extracts obtained from four endophytic fungi isolated from *Acalypha indica.*

Methods: Surface sterilized parts of leaf, flower and petiole of the plant were cultured on Potato Dextrose Agar. Four types of fungi were isolated JK/AI/C, JK/AI/D, JK/AI/G and JK/AI/K. They were cultured large scale on Potato Dextrose Broth for 21 days and it was extracted with ethyl acetate (EtOAc). Mycelia were extracted sequentially with EtOAc and methanol (MeOH). The two EtOAc extracts were combined after analysing patterns of their Thin Layer Chromatography. Crude extracts were screened for antifungal activity against *Cladosporium cladosporiodies*, phytotoxicity activity against lettuce seed germination, cytotoxicity activity against brine shrimps, antioxidant activity against DPPH (2.2`-diphenyl-1-picrylhydrazyl) and α-amylase enzyme inhibitory activity.

Results: EtOAc extracts of JK/AI/D (73.29% shoot inhibition; 68.5% root inhibition) and JK/AI/G (65.47% shoot inhibition; 95.81% root inhibition) gave good phytotoxic effects than other extracts. EtOAc extracts of JK/AI/K and JK/AI/G resulted in 93.33% and 96.67% of Brine shrimp mortality respectively. The EtOAc extracts of JK/AI/C, JK/AI/D and JK/AI/G showed antifungal activity. The EtOAc extracts of JK/AI/G, JK/AI/C and JK/AI/D gave IC_{50} of 2.14 mg L^{-1}, 5.12 mg L^{-1} and 14.41 mg L^{-1} against DPPH radical scavenging assay respectively. The MeOH extracts of JK/AI/K and JK/AI/C gave IC_{50} of 40.42 mg L^{-1} and 52.04 mg L^{-1} against DPPH radical scavenging assay respectively. EtOAc extract of JK/AI/G showed inhibition of α-amylase enzyme with IC_{50} value of 441.15mg L^{-1} and MeOH extract of JK/AI/C with IC_{50} value of 100.56mg L^{-1}. Molecular level identification of these four fungi and isolation of pure compounds from these extracts are in progress.

Conclusion: The extracts of endophytes of *A. indica* is a promising source for isolation of bioactive compounds.

Keywords: *Acalypha indica, bioactivity, endophytic fungi*

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Bioactive extracts from endophytic fungi associated with Cardiospermum halicacabum

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Background: Endophytic fungi are capable of colonizing, in living plant tissues. They are known to produce vast number of compounds that are used in pharmaceutical and agricultural industries.

Objective: This study investigated the bioactivity of secondary metabolites produced by endophytic fungi, associated with *Cardiospermum halicacabum.*

Methods: Surface sterilized plant segments were incubated at room temperature on Potato Dextrose Agar plates. The pure fungal strains of the emerged fungi were cultured in Potato Dextrose Broth medium, and incubated at room temperature for 21 days. After completion, the broth was filtered and extracted with ethyl acetate (EtOAc). The mycelia were extracted with EtOAc and methanol (MeOH). The crude extracts were screened for antioxidant activity against DPPH (2,2′-diphenyl-1- picrylhydrazyl) , phytotoxic activity against lettuce seed germination, antifungal activity against *Cladosporium cladosporioides,* cytotoxic activity against *Artemia salina* and α-amylase enzyme inhibitory activity.

Results: Four different fungi were isolated and labelled as US/CH/B, US/CH/E, US/CH/H, and US/CH/L. All broth extracts showed antioxidant activity where, lowest and highest activity (IC_{50}) were shown by US/CH/H (742.34 mg L^{-1}) and US/CH/E (113.18 mg L^{-1}) respectively. EtOAc extracts of mycelia US/CH/B (509.02 mg L^{-1}), US/CH/E (101.70 mg L^{-1}), US/CH/L (4.03 mg L^{-1}) and mycelium MeOH extract of US/CH/L (417.73 mg L^{-1}) also showed antioxidant activity. Broth extracts of US/CH/E, US/CH/L and US/CH/H showed phytotoxicity, whereas highest root and shoot inhibitions (98.8% and 95.3%) were shown by US/CH/L and US/CH/E extracts (1000 ppm) respectively. Broth extracts (US/CH/B, US/CH/H and US/CH/L) showed 100% cytotoxicity at 1000 ppm. Only US/CH/B mycelium EtOAc and MeOH extracts showed antifungal activity. None of the extracts showed α-amylase enzyme inhibitory activity. Molecular identification of fungi and isolation of pure compounds from the crude extracts are in progress.

Conclusion: Endophytic fungi associated with *Cardiospermum halicacabum* can be used to isolate bioactive compounds.

Keywords: *Cardiospermum halicacabum, Cytotoxicity, Endophytic fungi, Phytotoxicity, Secondary metabolites*

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Amino-functionalized biochars for sorptive removal of hexavalent chromium in aqueous media

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Background: A variety of novel biochar modification methods have been recently used to improve its remediation efficacy, however, lack of attention is given to improve amino modification for the invasive plant derived biochar in removing anionic heavy metals.

Objectives: This study was aimed at investigating and comparing the effectiveness of Cr(VI) removal by amino-modified and pristine biochar derived from the local invasive plant *Mimosa pigra* and determining the conditions and governing mechanisms of Cr(VI) removal.

Methods: *Mimosa pigra* biomass was pyrolyzed at 350°C for 2 hours and produced biochar (MPBC) was amino functionalized via surface introduced amino groups by treating with Hexamethylenediamine maintaining the ratio at 1:2 (Hexamethylenediamine: biochar) (HDA-MPBC). The pristine and modified biochar were characterized by proximate and ultimate analysis, Brunauer-Emmett-Teller surface area, Scanning Electron Microscopy, X-Ray Diffraction and Fourier- Transform Infrared spectroscopy. Batch experiments were conducted at various pH values (pH 3–10), mixing times (up to 24 h), and initial Cr(VI) concentration (2–25 mg L^{-1}). The effects of coexisting anions on removal of Cr(VI) were investigated in presence of Cl^-, SO_4^{2-} and PO_4^{3-}.

Results: Characteristic analysis indicated that the surfaces of pristine and modified biochars are covered by abundant active groups, among which amino groups act as major functional groups for Cr(VI) sorption. The highest Cr(VI) removal from solution occurred at pH 3 with an adsorption capacity of 3.10 mg g^{-1} for MPBC and 3.80 mg g^{-1} for HDA-MPBC, supported by the electrostatic attractions of Cr(VI) with positively charged biochar surface. The experimental data were well-fitted to the pseudo-second-order and intra particle diffusion models and Freundlich isotherm model which suggested that the Cr(VI) sorption is governed by chemisorption and physisorption.

Conclusion: Results conclude that modification significantly improved the adsorption performance of pristine biochar and a low pH was favourable for the Cr(VI) removal.

Keywords: *Adsorption, Amino-functionalization, Invasive plants, Heavy metals*

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Hydrothermal co-pyrolysis of food and fish waste for nutrient recovery

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Background: Food waste and fish offal account for a considerable percentage of the municipal solid organic waste. These nutrient-rich waste sources are currently mismanaged despite the fact that it could be successfully recycled back into the environment. Hydrothermal conversion (HTC) is a thermal treatment method to convert wet biomass into solid (hydrochar), liquid, and gaseous products.

Objectives: Food and fish waste were hydrothermally converted to nutrient enriched hydrochar while recovering nutrients from vaporous products.

Methods: A laboratory-scale HTC reactor was fabricated and operated at temperature of 490±40 °C with a self-generated pressure maintained at 0.5±0.2MPa. Three different feedstock retention times (30, 60 and 90 minutes) were tested with six different food: fish wastes ratios of 1:0, 3:1, 1:1, 1:2, 1:3 and 0:1. Two bubbling scrubbers were integrated to condense vaporous products in water as a nutrient rich liquid. Characteristics of produced hydrochar, liquid products and synthetic gases were analysed. Seed germination bioassays were conducted to assess the potential toxicity of hydrochar water suspension.

Results: The hydrochar with food: fish wastes ratio of 1:3 has the highest available nitrogen (709 mg/kg), while the 1:2 ratio showed the highest available phosphorus (5,040 mg/kg) content. Produced hydrochar with 1:2 ratio had the highest biochar recovery of 31.2% (wb). The proximate analysis of hydrochar showed a decreasing pattern of fixed carbon with increasing fish waste. The highest available nitrogen (6 mg/L) and phosphorus (4 mg/L) contents in scrubber liquid products were obtained by 1:2 ratio mixture. The produced syngas consisted of CO_2, H_2, CO, CH_4, and hydrocarbon. The toxicity assessment showed higher germination and seedlings growth in hydrochar water suspension compared to the control with distilled water.

Conclusion: The finding revealed that HTP is a feasible way of recovering nutrients in problematic food and fish wastes and converting them into a toxin-free stable fertilizer.

Keywords: *Food waste, Hydrochar, Nitrogen, Phosphorus, Pyrolysis*

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Antioxidant activity and total phenolic content of some underutilized vegetables in Sri Lanka

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Background: Underutilized vegetables in Sri Lanka have many nutritional and medicinal values. Most of these properties are due to the chemical profile of the plants including both primary and secondary metabolites. Phenolic compounds are secondary metabolites with physiological functions such as antioxidants, anti-carcinogens and as anti-inflammatory agents. Antioxidants reduce the oxidative stress in cells and are useful in treating many human diseases including cancer, cardiovascular and inflammatory diseases.

Objectives: To determine antioxidant activity and total phenolic content of pod with seeds in *Phaseolus lunatus* (Lima bean), *Momordica dioica* (Spiny gourd) and *Psophocarpus tetragonolobus* (Wing bean).

Methods: The samples were collected at matured stage and air dried. Dried samples were ground with a domestic blender and extracted with Ethyl acetate and Methanol successively. The extracts were evaporated using a rotary evaporator (<40℃) to obtain crude extracts. The antioxidant properties were studied using 2,2 Diphenyl-1-picrylhydrazyl (DDPH) assay with ascorbic acid as the reference and the polyphenol content was measured as gallic acid equivalents using Folin-Ciocalteu method. The experiment was design with 3 replicates.

Results: According to this study, the phenolic content of ethyl acetate extract of lima bean, spiny gourd and wing bean showed high total phenolic contents 42.83 mg /g GAE (Gallic acid equivalent), 29.36 mg/g GAE and 66.32 mg/g GAE respectively. In methanol extract of lima bean, spiny gourd and wing bean were found at 41.93 mg/g GAE, 26.70 mg/g GAE, 35.02 mg/g GAE respectively. Spiny gourd of methanol extract showed high IC_{50} value (3347.96 ppm) compared to lima bean and wing bean of antioxidant activity. The total phenolic content is relatively high in wing bean and lima bean compared to spiny gourd in both ethyl acetate and methanol extracts.

Conclusion: These results prove the importance of these vegetables as a food commodity in relieving oxidative stress.

Keywords: *Antioxidant, Medicinal, Phenolic content, Plant extract, Vegetables*

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Antioxidant property and total phenolic content of selected underutilized fruits in Sri Lanka

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Background: *Cynometra cauliflora* (Namnam), *Morus rubra* (Red mulberry) and *Psidium cattleionum* (Cherry guava) are commonly found fruits in Sri Lanka. However, the nutritional and biochemical properties of these fruits have not been studied extensively.

Objectives: This study was designed to evaluate the antioxidant activity and total phenolic content of these fruits.

Methods: The samples were collected at a matured stage from wild and air-dried fruits, in order to get rid of moisture. Dried samples were ground and extracted with Ethyl acetate and Methanol successively. The extracts were evaporated using a rotary evaporator <40℃ to obtain crude extracts. The antioxidant properties of all extracts were studied using 2,2 Diphenyl-1-picrylhydrazyl DPPH assay with ascorbic acid as the standard and the polyphenol content was measured in terms of gallic acid equivalents using Folin-Ciocalteu method. The experiment was conducted using a Complete Randomized Design (CRD) with 3 replicates.

Results: IC_{50} values in terms of DPPH radical scavenging activity were recorded and all three fruits consisted with comparable activities with the standard. All species were reported high IC_{50} values in MeOH extraction compared to EtOAc extraction. Out of three species namnam MeOH extract reported the highest 51.74 mg/ galic acid and the lowest was in namnam EtOAc extract:22.02 mg of galic acid equivalent per 1g.

Conclusion: All three fruits are rich in antioxidants which can scavenge DPPH free radicals as well as with high levels of polyphenols, thereby the greater potential to be used as antioxidant sources in functional foods.

Keywords*:* *Antioxidant, Free radical, Gallic acid, Total phenolic content, Underutilized fruits*

SOCIAL SCIENCES

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Acceptance of mobile banking services offered by Sri Lankan commercial banks

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Background: Mobile banking services enable customers to conveniently patronage financial services using smart mobile devices. Present research analyses the impact of subjective norms (SN) and security of e-services (SoES) on mobile banking adoption (AoMB).

Objectives: Formulated objectives to identify the significance of security of SoES, SN and interaction effect of SN and reason (R) towards AoMB (R = perceived ease of use or perceived usefulness).

Methods: University students participating for the week-end study programs and are using mobile banking services of private commercial banks, have been considered for sample selection and 287 duly completed self-administered questionnaires were utilized for data analysis. Technology acceptance model has been adapted by incorporating the SN and SoES variables.

Results: AoMB has been significantly predicted by SN as per ANOVA. Later, developed a Hierarchical Linear Model (HLM) and final model demonstrated that, SN is significant (p = .034), SoES too is significant (p = .000), reason (R) also significant (p = .049), interaction of SN and R is also significant, (p = .000). Interaction effect noted that AoMB (after controlling for SoES) was lower for those who have SN in view of perceived usefulness than those who had subjective norm in view of perceived ease of use.

Conclusion: As shown in empirical results, final model along with the incorporation of all the aforesaid variables, significantly predict AoMB. In accordance with final HLM, it is possible to note that AoMB, was comparatively lower for the respondents who had SN considering perceived usefulness as against perceived ease of use. Accordingly, it could suppose that, easy to use, peer-recommended, secured mobile banking acceptance may drive greater financial inclusion whilst improving considerable profitability and performance expectations of the banking sector alongside mutually rewarding banking relationships.

Keywords: *E-Services, Mobile banking, Online banking, Subjective norms, Technology adoption*

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Readiness of farmers for organic farming: Factors that inhibit transition from chemical fertilisers to organic fertilisers

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Background: Agriculture as a domestic industry has a great potential in increasing GDP in Asian countries due to favourable climate conditions bestowed upon them. According to Sri Lankan environmentalists, prolonged and unsubstantiated use of agrochemicals since the green revolution has inflicted serious repercussions on personal health, soil health, food security and environment. Popularisation of organic fertiliser among farmers has been identified as a remedial measure, this research aims to understand the factors that prevent farmers from switching to organic fertiliser.

Objectives: To identify the factors that influence farmers' conversion from chemical to organic fertilisers.

Methods: A simple data analysis was carried out using 1+1 interview data obtained from a stratified sample of 121 farmers (Paddy, Tea, Coconut, Cinnamon, Rubber), of Welipitiya Divisional Secretariat, Matara District, who use chemical and organic fertilisers.

Results: Out of 121 farmers 78.5% use only chemical fertilisers, 16.5% use both organic and chemical fertilisers, only 5% use organic fertilisers; Crop wise organic fertilizer use is Coconut (36.4%), Cinnamon (19.4%), Rubber (9.5%) and Tea (0%). 69.5% of the farmers who use only chemical fertilisers are willing to switch to organic fertilisers; crop wise willingness is Paddy (81.9%) Tea (66.7%), Cinnamon (77.2%), Coconut (90.0%), and Rubber (42.1%). 30.5% are unwilling or unsure to switch. Out of all farmers 53.7% and 57% are respectively aware of negative health and environmental impacts caused by chemical fertilisers.

Conclusion: Majority of the farmers who use only chemical fertilizers have expressed their willingness for organic transformation. Main reasons why farmers are unwilling to switch are; unavailability of organic fertilizers in acceptable quality and quantity; lack of knowledge on household organic fertiliser preparation; yield insecurity; difficulties in application of organic fertilizers in large farmlands; unawareness of environmental and health hazards caused by chemical fertilizers and certain chemical fertilizer propagandas that promise higher yields.

Keywords: *Organic fertilizers, Chemical fertilizers*

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Youth opinions on effect of lack of sex education on underage pregnancies in Sri Lanka

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Background: Although the statistics provided by the health.gov.lk based on the years 2015-2020 shows a slight reduction of the number of registered underage pregnancies, the issue is still considerably present and thereby must be addressed. underage pregnancy is generally defined as reaching motherhood by a female individual below the age of 18.

Objectives: This study is aimed to observe youth's views on whether there can be an effect of lack of proper sex education on underage pregnancies in Sri Lanka.

Methods: The research was done mainly focusing students and undergraduates in different fields (Science, Engineering, Business, Law) under the age of 15-30 in Sri Lanka from 8 provinces within the month of July 2021.The research was formulated as a questioner that the volunteers answered online via google forms. Furthermore, the student views on topics such as, Is sex taboo? Should abortion be legalized? Would you wait till marriage to engage in sex? Which sexual activities can and cannot result in conceiving? And how accurately is sex represented in porn? were collected. Information of a total of 111 students both male (30.63%) and female (69.36%) and of different sexualities were obtained and summarized within a time span of 20 days to see outcome results.

Results: Only 53.15% of the volunteers stated that they have at least basic conversations on sex education and only 32.43% of them happened at school, with an individual who was educated in the subject (science teacher, biology teacher) while the remaining 20.72% were casual conversations among friends. 60.36% of volunteers used pornography as a source of sex education and most of them were exposed to porn at the age range of 10-15(47.76%). Only 63.96% of the volunteers confirmed to have an average knowledge (5 and above in a scale of 1-10) on safe sex and contraceptives. 54.16% of the volunteers did not have a clear idea on the sexual acts that can and cannot lead to conceiving.94.59% of the volunteers confirmed that having proper sex education as a part of school curriculum would have a large impact on reducing underage pregnancies in the island.90.09% of the volunteers stated that kids should receive sex education from age 10 onwards. 93.69% stated that sex should not be a taboo topic in the society.

Conclusion: majority of the youth states that the lack of sex education to school students might have had a huge impact on underage pregnancies in Sri Lanka. They also agreed that addition of sex education to the school curriculum, promoting better knowledge on menstruation health, safe sex and having sex a less taboo topic in the society could help individuals have a better awareness on safety and thereby can have an overall effect on reducing the rate of underage pregnancies in Sri Lanka

Keywords: *Underage, Sexual education, Contraception, Abortion*

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Multiclass classification for optimizing job satisfaction of work from home employees during COVID-19: A cross-sectional study in Sri Lanka

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Background: With the outbreak of COVID-19, the Sri Lankan government and many organizations encouraged employees to work from home (WFH) and it represents a significant effect on employee job satisfaction.

Objectives: This study is undertaken to investigate the influencing factors on job satisfaction of WFH employees during Covid-19 pandemic and to propose a classifier which optimizes job satisfaction based on influencing factors.

Methods: A detailed online survey is conducted on a sample of 500 WFH employees in Central and Western provinces from January 2021 to June 2021 using stratified sampling by sector (bank, government, IT/software, other).

Results: Job satisfaction of WFH employees relies on the neutral state and results of correlation analysis rectify that working environment (ρ=0.748), technical environment (ρ=0.473), salary and benefits (ρ=0.565) and workload (ρ=0.648) factors have a significant impact on job satisfaction at 5% significance level. Multiclass classification is performed on job satisfaction based on influencing factors using supervised learning classifiers, namely Support Vector Machine (SVM), Gradient Boosting (GB), Naive Bayes (NB) and Random Forest (RF) and the fitted models are performed with accuracies of 69.35%, 70.16%, 67.74% and 73.39% respectively. Thereby, RF classifier is illustrated significant performance with the highest accuracy of 73.39%.

Conclusion: Aforementioned factors have a significant impact on job satisfaction of WFH employees during COVID-19 pandemic and RF classifier can be used to optimize the job satisfaction of WFH employees from any sectors such as bank, government, software, etc.

Keywords: *COVID-19 pandemic, Job satisfaction, Multiclass classification, Random forest*

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Investigation of the preferred music styles, singers, and instruments in Sri Lanka: A basic study

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Background: Music preference has correlated with sociological and psychological aspects of humankind. Thus, age, economic status and type of music are some key attributes linked with the music choice of people.

Objectives: This study was undertaken to investigate the orientation of preferred music styles, artists and instruments with regards to two mainstream categories namely Eastern and Western Music across five social classes representing three age categories.

Methods: A total of seventy-five individuals were selected from urban and suburban areas of Sri Lanka. Five social classes were selected based on the average household income namely, upper class, upper-middle class, middle class, working-class, and poor class while three different age groups namely Gen-Y (age 39 or younger), Gen-X (age 40-55) and Baby boomers (age 56-74) have represented the adult population within each social classes. The participants were provided with an open-ended questionnaire. The responses were screened and classified into three main categories Eastern, Western and not Categorized. The data were analyzed using a multinomial logistic regression model using SPSS 16.0 (USA) software.

Results: There was a significant difference in the preference of artists across the different economic classes and age categories whereas music styles and instruments were not recorded statistically significant ($p<0.05$). Seventy-four participants reported that they follow Music as a hobby.

Conclusion: The data suggested that economic class and age have imparted an effect on individual music preference based on artists lying in Eastern or Western categories. Further investigations are required for the music preference and music choices with different music genres. This study warrants future studies with a higher number of participants to ensure better outcomes.

Keywords: *Music preference, Music instruments, Music choices, Music styles, Artists*

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The need for multidisciplinary social sciences within the Sr Lankan academia: Some reflections from Sociology and Anthropology

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Background: The two stark polarities of Natural Sciences and Humanities and Social Sciences in educational imagination is evident among scholars in Sri Lanka. Although this divide is justifiable in terms of their disciplinary uniqueness and mastery, policymakers, politicians, and natural science scholars claim that Natural Science and Engineering fields are job market-oriented disciplines than Humanities and Social Sciences. However, many global universities have made certain Social Science disciplines like Sociology and Anthropology as prerequisites for undergraduate programmes as multidisciplinary Social Sciences do not refer to a discipline, but instead relates to teamwork or collaborative learning.

Objectives: This study discusses why multidisciplinary Social Sciences are essential to enrich the final objectives of the Sri Lankan academia in empowering people in the country; what multidisciplinary Social Sciences propose to be practiced; and how the knowledge of Social Sciences would be useful and valuable for national development and the benefit of diverse organizations.

Methods: This reflective study has used data from the Open University of Sri Lanka where I belong as an academic and critically discussed how multidisciplinary Social Science education would empower people and included data from relevant academics and students who provided stimulating examples and case studies during the conversations.

Results: Multidisciplinary Social Science training would enable students to perceive global issues through a cross-cultural comparison and cultivate a spirit of collaborative learning and teamwork among the students.

Conclusion: Knowledge of Social Sciences is required more because the country needs experts inspired by a multidisciplinary framework to address problems connected to conflict, war-torn and natural disaster (tsunami) areas, made complicated by problems relating to internally displaced people, war-affected people, refugees, Covid-19 global pandemic and other social issues.

Keywords: *Multidisciplinary social sciences, Sociology, Anthropology, Cross-cultural comparison, Collaborative learning*

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The reading habits of university students in Sri Lanka

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Background: The university period, which is the most productive stage of a student's formal education, plays a critical role in shaping our society's future. However, university students' reading habits, which is crucial in building a robust individual, are affected by various factors.

Objectives: This study was aimed to investigate the reading habits of university students in Sri Lanka in terms of gender, preferences, purpose of reading, reading frequency and reasons distracting them from reading.

Methods: The data were collected using questionnaires that included 14 open-ended and multiple-choice questions from 333 students of 3 state universities in Sri Lanka. A random sampling procedure was followed, and descriptive statistics (frequency and percentage) were performed to analyse the data.

Results: Based on the analysis, a solid number of students (71.8%) enjoyed reading books, and female students (71.2%) read more than males. The majority of the students read novels (34.8%), while poems were read by the least respondents (12%). Education (47%) was the most preferred genre, followed by history (38.4%), romantic (36.3%) and psychology (31.2 %). Most students read once a week (27%), while 1.5% of them never read. This reading frequency is not enough compared to their age and needs. Most of the students responded that personal satisfaction (57.4%) was the main reason to read, followed by relaxation (49.2%). They further agreed that their habits towards reading were positively changed after starting studies at university. Social networks (52.7%) and preparation for exams (51.7%) were the main barriers preventing students from reading.

Conclusion: According to the study, most university students in Sri Lanka enjoyed reading, though their reading frequency is insufficient to develop them as intellectuals. Hence, it is recommended to introduce new plans and strategies to promote reading among university students in Sri Lanka.

Keywords: *Reading habits, Reading frequency, Social networks, University students*

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Association between depression and addiction to video games (gaming disorder) among young adults in Sri Lanka: A cross-sectional study

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Background: The underlying pathophysiological basis of depression is the depletion of the monoamine neurotransmitters serotonin, norepinephrine, or dopamine. Video games have the reverse effect of depression in that they deliver positive feedback to the brain's reward center. However, the technological advancements in video games have achieved their pinnacle in attracting young adults, and depression is prevalent among them.

Objective: To assess the association between addiction to video games and depression among young adults in Sri Lanka.

Methodology: A pre-tested questionnaire was used to conduct a cross-sectional study of 401 Sri Lankan young adults who play video games. The sample was obtained using the snowball sampling approach. There were four sections in the questionnaire: demographic information, game type, validated game addiction scale (seven-item game addiction scale) and validated Depression scale (Patient Health Questionnaire/PHQ-9). Ethical approval was obtained from KIU (KIU/ERC/21/106). Data were analyzed using descriptive statistics in SPSS version 25 using percentage, chi-square test, and prevalence ratio.

Results: The participants' mean age was 23.71 ± 4.69 years. The majority were reported from Colombo (31.4%) and the least from (0.2%) Jaffna. More than half were females (55.4%). Among the participants, 22.9% were educated up to GCE A/L. According to the seven-item game addiction scale and PHQ-9, 48% were reported under game addiction in the depressed population who played video games. Among video game players, depressed individuals were 4.5 times likely to get addicted to video games (Prevalence ratio = 4.5). Based on the chi-square results, there was a significant association between depression and game addiction ($p < 0.00001$, CI 95%).

Conclusion: An association was identified between video game addiction, also known as gaming disorder and depression. Future studies are suggested to enhance the clinical significance of the study on a broader level.

Keywords: *Addiction, Depression, Association, Video games, Gaming disorder*

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Evaluation of cephalic index of the Henanigala indigenous people in Sri Lanka

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Background: Veddas; the indigenous people of Sri Lanka are the descendants of pre-historic humans that populated in the Mesolithic Age of the country over 48,000 Years Before Present (YBP). They were the first anatomically modern human migrants to Sri Lanka dating to approximately 300,000 BP when compared with the more recent migration of the contemporary ethnic groups namely Sinhalese, Tamils and Muslims etc.; the later arrivals. Cephalometry is one of the four fields of Anthropometry and one of the commonly used indices in tracing population-based affinity and variation patterns. Cephalic parameters are important in the studies of population variations, ethnic, racial and sexual identifications etc.

Objectives: This research was carried out with the primary aim of evaluating the Cephalic Index (CI) of the Vedda people living in Henanigala area, in the Eastern Province.

Methods: A sample of one hundred and sixty-four (164) adult subjects comprising 106 females and 58 males were included in the study. They were divided into 5 age groups (19-29, 20-29, 30-39, 40-49, 50-59, 60yr+) and measured Cephalic Breadth (CB) and Cephalic Length (CL) individually. CI was calculated by dividing the CB by CL and multiplying by 100. Data were analysed using SPSS data analysing package and sexual differences were traced through t - test ($p<0.05$).

Results: CB, CL and CI of the females were 13.27 cm, 17.01 cm and 78.18 respectively. In males CB, CL and CI were reported as 13.51 cm, 17.48 cm and 77.30 respectively. Gender based statistically significant differences were found in all principal cephalic dimensions. Among females and males most dominant cephalic types recorded were mesocephalic and brachycephalic which account for 45% and 26% among females and 43% and 29% among males respectively.

Conclusion: Henanigala females significantly differ in CB, CL, and CI from males. Mesocephalic was the dominant cephalic type found among this indigenous population. Results of this study are significant for the anthropological, archaeological, forensic and clinical oriented fields of studies where data are scarce.

Keywords: *Cephalometry, Cephalic index, Vedda people, Sri Lanka*

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Awareness and perception of Sri Lankan undergraduate students on genetically modified foods

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Background: The demand for Genetically Modified (GM) foods has increased in recent times. However, the consumers have concerns in terms of their safety and hazardous nature to humans and environment.

Objectives: The present survey was aimed to evaluate the awareness and perception of undergraduates in Sri Lankan universities on GM foods.

Methods: Data were collected using random sampling technique from 200 undergraduates through a structured online questionnaire enquiring their awareness, perception and attitude towards GM foods. Frequencies, correlation and regression analysis were done using descriptive analysis, Pearson correlation and multinomial logistic regression respectively.

Results: The results showed that, 77.5% of the students have heard about GM foods and the primary source of awareness was university education (75%) followed by social media (17.5%). Half of the respondents were well-aware about the science behind the GM foods while the rest did not know. Moreover, 87.5% of the students had the tendency to learn more about GM foods. Majority of the students (40%) expressed their un-willingness in purchasing GM foods once it is introduced to the market while 30% were not sure about their decision. According to the students' perception, 25% of them believed that GM foods are not safe for consumption and 37.5% considered that producing foods using biotechnology is unethical, though majority of the undergraduates had favorable opinions towards GM foods. Pearson's correlation showed a positive correlation between the willingness of purchasing GM food with the factors including year and field of study, family income, knowledge about biotechnology and perception towards GM foods at 5% significance level. The perception about GM food had multinomial logistic regression (Nagelkerke pseudo R^2 = 0.349) with a tendency towards purchasing of GM foods (p<0.05).

Conclusion: Even though majority of the undergraduates believed that GM foods are safe, they were not ready to purchase them.

Keywords: *Awareness, Biotechnology, GM food, Perception, Undergraduates*

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The impacts of COVID-19 lockdowns on coastal fisheries in Sri Lanka

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Background: The marine fisheries sector remains a cornerstone of economic activity in Sri Lanka, accounting for 1.3% of the GDP in 2019 and supporting a workforce of over 2.7 million people. In response to the rise in COVID-19 cases, the Sri Lankan government announced an island-wide curfew on 20 March 2020, followed by lockdowns and travel restrictions of varying nature.

Objectives: The study seeks to critically reflect on the social and economic dimensions of COVID-19 related restrictions based on the impact on livelihood, support received, and adaptive capacities of SSF actors.

Methods: A purposive sampling approach was used to conduct surveys across the coast of Sri Lanka [North (80), East (120), South (80), West (120)]. Thirteen study sites were selected (Mannar, Mulativu, Kilinochchi, Jaffna, Trincomalee, Valachchenai, Batticaloa, Ampara, Tangalle, Galle, Beruwala, Negombo and Kalpitiya) based on pre-existing contacts. The surveys were conducted between 29 July to 29 August 2020, to understand the impacts prior to the study period. Questionnaires targeted 3 fisheries actors- fishers, processors and sellers/traders. Quantitative data were analysed using Microsoft Excel and RStudio using descriptive statistics. The qualitative data were extracted using text analysis, and themes were developed.

Results: Ninety percent (n=186) of fishers and 91% (n=95) of sellers/traders reported that they were negatively impacted by COVID-19 restrictions. Comparatively, 66% (n=66) of processors reported a negative impact on their work, which could be attributed to the longer shelf-life of dried seafood. The main factors that impacted respondents were limited accessibility, limited resources and impact on income. The most common adaptation strategies reported were utilising savings and credit services, and depending on the government allowance provided. Respondents reported that they would not be able to cope in the event of a future lockdown as their limited savings were exhausted. No clear gender-based difference in responses were reported.

Conclusion: Overall, this study showed that the inaccessibility to the ocean, and thereby fishing, negatively impacted SSF communities due to limited coping strategies and lack of alternative modes of income.

Keywords: *COVID-19, Small-scale fisheries, Vulnerability*

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Implementing the human library concept in the university libraries in Sri Lanka

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Background: Human Library (HL) is the same traditional library but the only difference is reading human books by listening to someone else's story. Listening and reading have become a primitive practice in the socio-cultural behaviour among university community due to the busy schedule, change of lifestyle, and especially global COVID pandemic. HL contributes to overcome this gap by creating an open platform for diversified social and ethnical groups to challenge prejudice, stereotypes, and discrimination; and as a way to learn, educate, and change attitudes; to encourage reading; to express and share own ideas, stories, and experiences and knowledge; and to establish intellectual freedom among the university community. Thus, execution as an interactive learning platform, will be an added value to the university system in Sri Lanka. Therefore, this research is at the initial stage and expect valuable comments to carry out the future research successfully.

Objectives: (1) Initiating physically available human library program, (2) Initiating virtually available human library program, (3) Creating a digital human library archive project, (4) Managing the HL through an online reservation system.

Methods: This study will utilize Mix methods. Sample of 370 students and 278 academic staff selected through stratified sampling technique will answer the questionnaires. The unstructured interviews with the academic staff of the library will collect qualitative data.

Conclusion: HL concept will be implemented focusing on the 1st dimension of Human Library Organization's (HLO) goals i.e. how HL concept contributes as a learning platform in the University system of Sri Lanka. By selecting University of Kelaniya to implement this HL concept as a new service to the traditional library scenario, this study expects to enhance the interactive learning process, knowledge sharing and research culture using process management theory implication

Keywords: *Human Library (HL), Learning platforms, University libraries*

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Conducting day-schools via ZOOM during COVID-19 pandemic lockdown: students' & facilitator's reflections.

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Background: Education institutes from schools to universities adopted online teaching mainly via zoom technology (ZT). During Covid-19 lockdown period, the Open University of Sri Lanka initiated conducting Day Schools (DS) via ZT and it was a novel experience for both students and facilitators.

Objectives: The objectives were to identify the positive and negative encounters of students when learning via ZT, the gaps and issues in the delivery of DS via ZT and the areas which need further improvement.

Methods: Of the total number of students registered for this module (N=364), only 35.7% (N=130) students completed online questionnaire survey among level four students of the BA Degree in Social Sciences Programme who undertook a compulsory academic module (N=364) and a Focus Group Discussion (FGD) (N=10) via ZT. Questionnaire based data were analyzed quantitatively via SPSS, and FGD based qualitative data through thematic analysis technique.

Results: Both employed and unemployed students attended zoom DS (ZDS). All employed students (64.6%, N=84) perceived ZDS as convenient, more interactive, and therefore effective and useful. Majority of students 70.8% (N=98) recommended ZT for future learning. Network failures, non-availability of devices, non-familiarity with ZT and lack of familiarity with the culture of "working from home" were common challenges reported. The facilitator endorses ZDS as an effective communication platform and the ability to interact with students from all regions as a positive experience.

Conclusion: By sufficiently providing necessary technical assistance to students, ZT can be further used as a viable option to conduct DS effectively.

Keywords: *Online learning, Day schools, Zoom technology,The Open University.*

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Parental relationship and responsive care for preschool-aged children: A qualitative study

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Background: Relationships with parents have a major impact on cognitive, linguistic, emotional, social, and moral development of children. Also, responsive caregiving has emerged as a key parenting domain that is linked to improved physical, cognitive and psychosocial health in children in both high and lower income countries. However, in Sri Lanka, there is a paucity of literature related to the exploration of parents' views, ideas and practices on responsive care and related assessment of parenting style.

Objectives: This study explores parental relationship and responsive care for preschool-aged children in Sri Lanka.

Methods: This qualitative cross sectional, exploratory study involved ten in-depth interviews and two focus group discussions with purposively selected 24 parents, in Kandy district. Interviews based on a systematically developed and pretested interviewer guide, were audio-recorded with permission, transcribed and thematically analysed by two independent researchers.

Results: 25 primary codes specific to "Parental relationship and responsive care for preschool-aged children" were classified under 05 subthemes; Devote the time, Participation in domestic chores, Parental roles, Physical support and Psychological support in child's needs. Identified codes have suggested the type of parenting; authoritative, authoritarian, permissive, or neglectful. Parents engagement with children's play and activities was expressed as *"I help her if she asks for...", "I get her to help in household chorus", " we don't force them ... but when they do creative things we appreciate", "we tolerate even if they scribble on the walls"*

Conclusion: Parents' commitment is admirable on relationship with their child and support given. However, care is limited to noticing, understanding, and providing feedback and support rather than real engagement in responsive care. This study recommends to examine predictors of parents' responsive caregiving and investigate how these interactions are associated with children's development.

Keywords: *Relationships, Responsive care, Qualitative study, Preschool age*

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The middle class voters' voting behaviour at 2015 and 2019 presidential elections: a study in Kurunegala district, Sri Lanka.

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Background: A citizen's voting decision at a presidential election is the broadest individual political step in Sri Lanka. Here, the voting behaviour of local middle class (whose daily expenditure falls in the range $2-$20 a day per person) is important as it represents the majority of the society.

Objectives: The objectives of this research are, to find out the major influence on middle class to make the voting decision, and to identify the nature and impact of repentance about their own voting decision.

Methods: Covering consecutive presidential elections held in 2015 and 2019, an ethnographic research was done, targeting a total of twenty individuals from a semi-urban area in Kurunegala district as the sample. The major data collection tool was Interviews. Additionally, a focused group discussion was done via "zoom" to clarify the data moreover.

Results: The influence of the voter's family, which consists the close family members' level of active politics, attributed party-based political identity of the family, cast and self decided social class, stood as the most crucial effect on selecting a political party than selecting a candidate. The decision of voting or not, for the particular candidate in spite of the candidate's party, is significantly influenced by the close peer company but the decision of voting for another candidate. Many repentances were the effects of peers which direct 'denying the vote' than 'thinking of an alternative'.

Conclusion: The voting decision of middle class of semi-urban dwellers are mostly permanent under the influence of family. Although changing of a rooted voting decision is generally low, denying of own vote is present at where the peers' strong company engages. The peer-based repentance and subsequent neutral response on own past voting behaviour produce an appeal for a national need of making a voters' mindset that must be more logical and critical than what exists.

Keywords: *Voter, Voting behaviour, Presidential election, Candidate*

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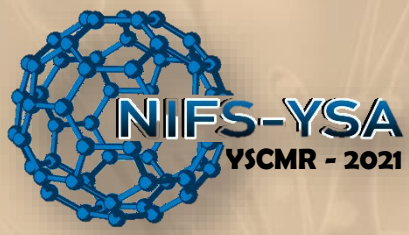

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