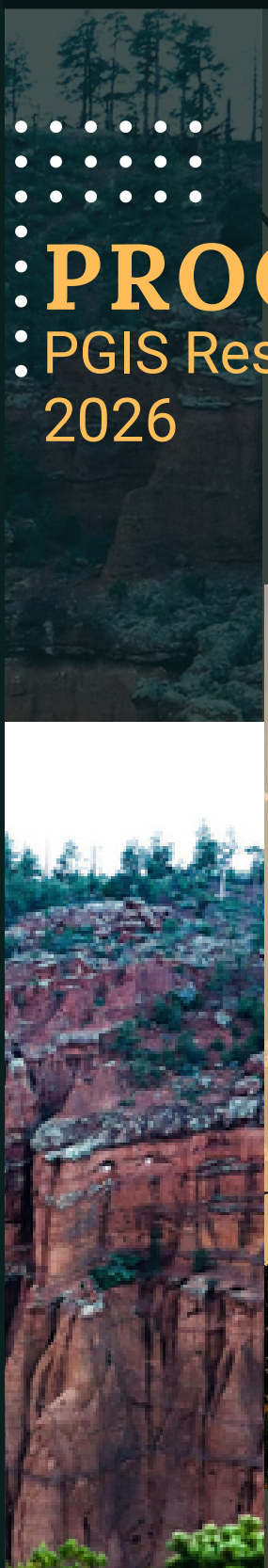
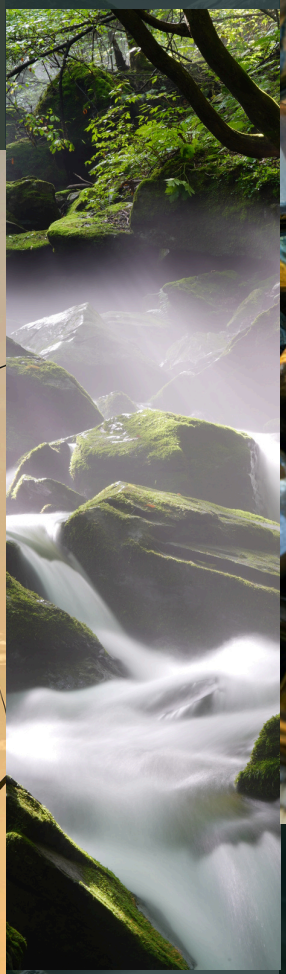
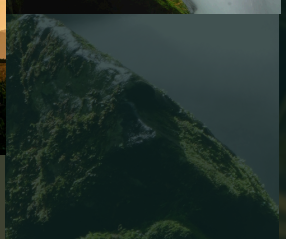
POSTGRADUATE INSTITUTE OF SCIENCE
UNIVERSITY OF PERADENIYA

PGIS RESCON 2026
RESEARCH CONGRESS

PROCEEDINGS

PGIS Research Congress 2026





Volume 13



Cover Image: *Earth Science, as a foundational discipline studying the Earth system, is highly interdisciplinary—spanning geology, paleontology, mineralogy, geophysics, geochemistry, hydrology, engineering geology, oceanography, and environmental geosciences. Featured on the cover, the visual design showcases fossilized trilobites, symbolizing ancient marine ecosystems, biological evolution, and long-term planetary dynamics. This imagery encapsulates the congress theme, "Nature, Science, and Sustainability: Research for a Resilient Planet," while representing the core disciplines represented by the degree programmes of the Board of Study in Earth Sciences.*

Cover Design: Ms. A.D.D.S. De Silva and Ms. P.G.A.R. Chandrasena

POSTGRADUATE INSTITUTE OF SCIENCE (PGIS)

UNIVERSITY OF PERADENIYA

PGIS RESCON 2026

RESEARCH CONGRESS

Nature, Science, and Sustainability: Research for a Resilient Planet

Proceedings of the Postgraduate Institute of Science Research Congress

24th & 25th September 2026

Peradeniya, Sri Lanka

© Postgraduate Institute of Science, University of Peradeniya

Proceedings of the Postgraduate Institute of Science
Research Congress (RESCON) 2026

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ISSN 3051-4622

Published by
Postgraduate Institute of Science (PGIS)
University of Peradeniya
Peradeniya 20400
SRI LANKA

Cover Designed by: A.D.D.S. De Silva
P.G.A.R. Chandrasena

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MESSAGE FROM THE VICE-CHANCELLOR
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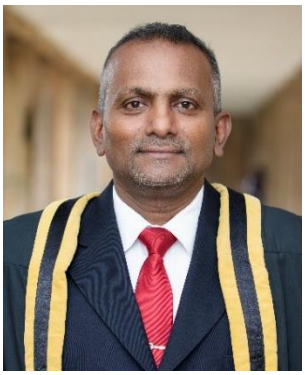
It is with great pride and anticipation that I extend my warmest greetings to all participants of RESCON 2026, the 13th Annual Research Congress of the Postgraduate Institute of Science (PGIS), University of Peradeniya, to be held on 24 and 25 September 2026. The Postgraduate Institute of Science stands as Sri Lanka's premier national institute for postgraduate education and research in the sciences. For three decades, PGIS has fostered a vibrant and intellectually stimulating academic environment in which rigorous scientific inquiry, innovation, and national relevance are pursued in accordance with international standards. Through its multidisciplinary approach and close integration with the University of Peradeniya's strong research ecosystem, PGIS continues to make a significant contribution to advancing scientific knowledge and addressing complex challenges of national and global importance.

The theme of this year's Congress, "Nature, Science, and Sustainability: Research for a Resilient Planet," aptly reflects the vision and aspirations of PGIS. At a time when the world faces increasingly complex and interconnected challenges, scientific advancement requires collaboration across disciplines, institutions, and sectors. Interdisciplinary research and the exchange of knowledge are therefore essential to fostering innovation, strengthening resilience, and translating scientific discoveries into meaningful societal impact.

I am particularly pleased to note that RESCON 2026 will showcase more than 230 research presentations covering a broad spectrum of scientific disciplines. The breadth and diversity of these contributions demonstrate the richness of postgraduate research at PGIS and the commitment of its researchers to addressing emerging scientific and societal challenges. RESCON 2026 is more than an academic gathering. It provides a dynamic platform for students, researchers, established scientists, academics, and industry partners to exchange knowledge, engage in constructive dialogue, establish new collaborations, and explore innovative solutions for national development and global advancement. It is also an important opportunity for our young researchers to present their work to a wider scientific community, receive valuable feedback, and build professional networks that will contribute to their future careers. I commend the Director of PGIS, the academic and organizing committees, session coordinators, reviewers, and all those who have contributed to the successful organization of RESCON 2026. Above all, I congratulate the researchers whose dedication, creativity, and commitment to scientific inquiry form the foundation of this Congress. I am confident that RESCON 2026 will stimulate meaningful scientific dialogue, strengthen research collaborations, and inspire new directions in research. I further believe that the collective achievements presented at this Congress will enhance the reputation of the Postgraduate Institute of Science and the University of Peradeniya as a "Center of Excellence" in education and research. I wish all participants a stimulating, rewarding, and intellectually enriching experience at RESCON 2026, and every success in their continued pursuit of knowledge, innovation, and scientific excellence.

Prof. Terrence Madhujith,
Vice-Chancellor
University of Peradeniya

MESSAGE FROM THE DIRECTOR, PGIS
RESCON 2026



It is with great pleasure that I extend a warm welcome to RESCON 2026, the 13th Research Congress of the Postgraduate Institute of Science (PGIS), University of Peradeniya, to be held on 24–25 September 2026. Guided by the theme, "Nature, Science, and Sustainability: Research for a Resilient Planet," the congress highlights the vital role of scientific research, innovation, and interdisciplinary collaboration in addressing national and global challenges. With more than 400 postgraduate researchers, academics, and leading scientists participating, RESCON 2026 provides a dynamic platform for presenting research, exchanging knowledge, fostering interdisciplinary dialogue, and building partnerships among academia, industry, and other stakeholders. These interactions are essential for advancing evidence-based solutions and contributing to a more resilient and scientifically empowered Sri Lanka.

Established in 1996, PGIS has evolved into a national center of excellence for postgraduate education and advanced research across a broad range of scientific disciplines. As an institute affiliated with the University of Peradeniya, PGIS remains committed to academic excellence, research innovation, capacity building, and the generation of knowledge with meaningful societal impact. The Research Congress (RESCON) was established in 2014 as a platform for postgraduate researchers and scientists to share findings, exchange ideas, and form collaborations. Over the years, it has grown into a significant scientific forum in Sri Lanka, and RESCON 2026 proudly continues this tradition of research excellence and collaboration.

The congress program includes oral presentations from various scientific disciplines, as well as keynote and plenary addresses by eminent international scholars. Pre-conference workshops on emerging areas such as neuroplasticity and brain health, bioanalytical applications, clean energy, technology-driven crop breeding, and academic and professional development have further enriched the program. The response to RESCON 2026 has been particularly encouraging, with 325 abstracts received and 257 accepted following the review process, including international research contributions and presentations by three distinguished international keynote and plenary speakers.

I wish to express my sincere appreciation to the organizing committee headed by Prof. Sanjeewa Malaviarachchi supported by Dr. Sachinthani Karunarathne and many others. I extend my best wishes to all researchers, presenters, keynote and plenary speakers, participants, and partners of RESCON 2026. May this congress inspire new ideas, strengthen scientific partnerships, and empower the next generation of researchers to contribute to sustainable national development and global scientific progress.

Prof. Nanda Balasooriya
Director, Postgraduate Institute of Science (PGIS)
University of Peradeniya

MESSAGE FROM THE CONGRESS CHAIRPERSON
RESCON 2026



It is my distinct honor and privilege to welcome you to RESCON 2026, the 13th Annual Research Congress of Postgraduate Institute of Science (PGIS) at the University of Peradeniya. Scheduled for September 24th and 25th, 2026, this year's RESCON is organized by the Board of Study in Earth Sciences and centers on a profoundly vital theme: "Nature, Science, and Sustainability: Research for a Resilient Planet." In an era defined by rapid technological changes and environmental challenges, our collective mission is to push the boundaries of scientific inquiry to foster global resilience.

I am thrilled to share that RESCON 2026 will feature distinguished keynote and plenary addresses delivered by world-renowned scientists. Their insights will serve as the cornerstone of our academic network and scholarly exchange, driving thought-provoking dialogues that complement our core technical sessions across subject areas covering Earth & Environmental Sciences, Computer Science & Artificial Intelligence, Mathematics & Statistics, Life Sciences, Physical Sciences, and Science Education. Whether you join us in person at our beautiful campus or online, this congress is an unparalleled space to share breakthrough research and forge cross-disciplinary collaborations.

This congress will not be realistic unless the tremendous efforts and time extended by each and every member and their assistants in the main organizing committee and its sub-committees are taken into account. Especially, I extend my sincere appreciation to Prof. Nanda Balasooriya, Director-PGIS, for his unwavering support, Dr. Sachinthani Karunarathne for her professional secretarial work, Prof. Rohana Chandrajith for editorial leadership, and to all conveners, committee and sub-committee members, associate editors, reviewers, session chairs, PGIS staff, and the Young Researchers' Forum for their wonderful contributions. Special thanks also go to Dr. Dilan Ratnayake for the excellent technical support in managing the editorial process and CMT system, Dr. Susanthi Jayasinghe for managing the Research Highlights, Dr. Chandana Jayalath for handling Technical Programs and venues, Dr. Ruwan Nawarathna for setting up an attractive website, Dr. Ruwanthini Siyambalapitiya for smoothly maintaining the registration process. Last but not least, I thank all other convenors of the main organizing committee namely, Prof. Sumudu Rubasinghe, Dr. Rajitha Ranasinghe, Dr. Nadeesha Koralegedara, Dr. Manoj Chathuranga, Dr. Jayampathi Herath, Dr. Bhathiya Athurupana, Mr. UW Rajmal (DB), Ms. AAS Priyadarshani (DR), Ms. Shiromi Rajapura (AR), Ms. Anuradha Iddamalgoda, and Ms. Ajantha Kumari, for their unwavering support in organizing the congress. On behalf of the Organizing Committee, I wish all participants a stimulating and inspiring congress. May RESCON2026 continue to be a beacon of collaboration, discovery, and scientific excellence!

Prof. Sanjeewa P.K. Malaviarachchi
Chairperson- RESCON 2026

MESSAGE FROM THE EDITOR-IN-CHIEF
RESCON 2026



This year marks a significant milestone for the Postgraduate Institute of Science (PGIS), as it celebrates its 30th anniversary. It is also a special year for the Institute as it hosts the 16th Research Congress of the Postgraduate Institute of Science (RESCON 2026), organized by the Board of Study of Earth Sciences. RESCON has become one of the most important events in PGIS's annual academic calendar, providing a valuable platform for postgraduate researchers, academics, and scientists to present their research, exchange ideas, and foster scientific collaborations.

RESCON 2026 received a total of 325 abstracts from researchers in Sri Lanka and abroad. Only abstracts that met the required academic and scientific standards were considered for inclusion in the Congress program. Following this rigorous evaluation process, 257 abstracts were considered for presentation; 223 were ultimately selected and included in the Congress Program.

The two-day Congress features an exciting and diverse scientific program, including a keynote address by eminent scientists from the United States and China, three plenary lectures, and several invited talks. The program provides participants with opportunities to explore recent advances in science, engage in meaningful academic discussions, and develop new research networks and collaborations.

As the Chief Editor of RESCON 2026, I wish to express my sincere appreciation to all reviewers who devoted their time and expertise to rigorously evaluating the submitted abstracts. Their valuable contributions have been fundamental to maintaining the scientific quality of this Congress and to assisting the Editorial Team in selecting high-quality research for presentation. I also wish to convey my deepest appreciation to the Associate Editors, Theme Coordinators, Editorial Assistants, and members of the Young Research Forum for their commitment, professionalism, and tireless efforts in reviewing, coordinating, editing, and preparing these proceedings. The successful organization of RESCON 2026 is a collective achievement, and I am grateful to everyone who has contributed to this endeavour.

Finally, I warmly welcome all participants to RESCON 2026 and hope that they will find the Congress intellectually stimulating, academically rewarding, and an opportunity to establish scientific connections. I wish all participants a successful and enjoyable two days at Peradeniya and look forward to the exchange of ideas and knowledge that will help build a more resilient and sustainable planet.

Prof. Rohana Chandrajith
Chief Editor, RESCON 2026

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KEYNOTE SPEAKER
RESCON 2026



Prof. Suniti Karunatillake
Professor in Planetary Science, Remote Sensing, and Exobiology
Department of Geology and Geophysics
Louisiana State University, USA

Dr. Suniti Karunatillake is a planetary scientist and Associate Professor in the Department of Geology & Geophysics at Louisiana State University. His research focuses on planetary critical zones, Mars geochemistry, regolith hydration, habitability, and the interpretation of satellite and in situ planetary data. He specializes in integrating remote sensing, geochemical mapping, and sedimentological analyses to better understand the geological and hydrological evolution of Mars and other planetary bodies.

Dr. Karunatillake earned a BA in Physics from Wabash College and a PhD in Physics, Astronomy, and Planetary Science from Cornell University, followed by postdoctoral research at Stony Brook University. Over the course of his career, he has contributed extensively to planetary science through interdisciplinary research, NASA-funded projects, mission concept development, and international collaborations. His work has advanced understanding of Martian surface processes, crustal evolution, hydrothermal activity, and the potential for past habitability and biosignature preservation on Mars.

KEYNOTE SPEAKER
RESCON 2026



Prof. Zhao Yuyan
Professor in Planetary Sciences
International Research Center for Planetary Sciences
Chengdu University of Technology (CDUT), China

Dr. Yuyan (Sara) Zhao is a Professor at the Research Centre for Planetary Science within the College of Earth and Planetary Sciences at Chengdu University of Technology, where she also currently serves as Associate Dean of the International Education College. She earned her Ph.D. in Geoscience from Stony Brook University in 2014, following an M.S. and B.S. in Geochemistry and Geology from Sun Yat-sen University.

Dr. Zhao's research focuses on the geochemical and surface processes of terrestrial planets—particularly Mars. Her work investigates halogen cycling, iron oxidation, perchlorate and chlorate formation, and mineral stability under Martian atmospheric and aqueous conditions. She has led experimental studies on jarosite, olivine, and sulfate brines to better understand Mars' past habitability and present-day surface chemistry.

A key member of the science team for China's first Mars exploration mission (Tianwen-1), Dr. Zhao has contributed directly to the analysis of data from the Zhurong rover. She is actively involved in the planetary science community, serving on the Youth Working Committee of the Chinese Society for Mineralogy, Petrology and Geochemistry, as a council member for several academic societies, and as Executive Editor of the journal Planet and an editorial board member of Acta Geochemica. She has authored or co-authored numerous high-impact papers in journals such as Nature Astronomy, Nature Geoscience, Nature Communications, Journal of Geophysical Research, Planets, and Geochimica et Cosmochimica Acta. Her work bridges laboratory experiments, remote sensing, and in-situ rover data to advance understanding of Martian geology, climate evolution, and the potential preservation of biosignatures. Recognized as a leading scientist in planetary geochemistry, Dr. Zhao's interdisciplinary contributions have positioned her as a leading voice in unraveling Mars' complex environmental history on the global stage.

PLENARY SPEAKERS
RESCON 2026



Prof. Ross Mitchell
State Key Laboratory of Lithospheric and Environmental Coevolution, Institute of Geology & Geophysics,
Chinese Academy of Sciences
Beitucheng West Road, Beijing, China.

Professor Ross Mitchell is a Professor at the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGG-CAS), where he has served since 2020. He previously held the position of Associate Professor at IGG-CAS (2019–2020), Research Fellow at the School of Earth and Planetary Sciences, Curtin University (2016–2019), and Postdoctoral Fellow in the Division of Geological and Planetary Sciences at the California Institute of Technology (Caltech) (2013–2016). He received his BA in Geology from Carleton College in 2007 and his Ph.D. in Geology and Geophysics from Yale University in 2013, under the supervision of Professor David A. D. Evans. His research focuses on how the Earth works, from the core to the crust, with particular expertise in paleomagnetism, cyclostratigraphy, and Earth history. His work seeks to understand the dynamics of past supercontinents and develop systems-based approaches to understanding and predicting future supercontinents. He served as Secretary of UNESCO IGCP 648 and has been a member of the FORES Leadership Group since 2021. His distinctions include the National Science Foundation Antarctica Service Medal, Yale University's Philip M. Orville Prize and Estwing Hammer Prize, the Young Scientist Award at the 6th International Dyke Conference, and recognition through the CAS PIFI Special Expert and Young Talents Plan.

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Dr. S. Viswanath
Scientist G, Retd., ICFRE, MoEF&CC, Govt. of India
Former Director, KSCSTE-Kerala Forest Research Institute

Dr. Syam Viswanath is a leading forestry scientist with more than 32 years of research and professional experience in forestry, agroforestry, and sustainable land-use practices. A native of Aluva, Kerala, he is currently based in Bengaluru, Karnataka. He obtained his Master's degree in Forestry from Kerala Agricultural University and a Ph.D. from Kumaun University, Nainital, India. He also completed 10 months of specialized training in Agroforestry at the University of Florida, USA, under an FAO fellowship. Dr. Viswanath served as the Director of the Kerala Forest Research Institute (KFRI) from 2018 to 2023, contributing significantly to forestry research, capacity building, and the promotion of sustainable agroforestry systems. He has published more than 140 research papers and has guided 25 Ph.D. students, demonstrating his substantial contribution to forestry research and education. His recognitions include the Dr. K. G. Tejwani Memorial Award (2021). In recognition of his contributions to forestry, a new fungal species discovered in Kerala was named *Trichoglossum syamviswanathii* in his honor.

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Keynote Address (1)

MULTINATIONAL COLLABORATIONS IN EARTH-MARS EXPLORATION – PLANETARY GEOSCIENCE AND SUSTAINABLE FUTURES

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The Lanka Space-Time Initiative (LSTI) establishes a transdisciplinary framework that positions Sri Lanka as an anchor for exploring planetary geology, habitability, and the connections between Earth and other planetary environments. At its core is the recognition that, in a world of finite physical resources, information and human intelligence represent perpetual resources that can be shared across institutions and national boundaries to address emerging human and environmental challenges. LSTI brings together scholars and stakeholders from Sri Lanka, China, India, France, and the USA, integrating geology, planetary science, environmental research, education, and community engagement. Earth-based observations and diverse geological environments in Sri Lanka provide reference systems for interpreting planetary processes, while observations from planetary missions offer new perspectives for understanding Earth. This reciprocal approach connects communities hosting Sri Lanka's planetary-analog sites with educators, researchers, policymakers, industry, and young scientists. The Planetary Science Lab's broader scientific program spans multiple planetary environments. On Mars, comparative investigations address soil weathering at Gale Crater, potential hydrothermal processes associated with the proposed paleo-lakes of Eridania, and the magmatic evolution of the Elysium volcanic province. Beyond Mars, geomorphological observations of Pluto's pit-crater chains from New Horizons data are examined as possible analogs for fluid-seep processes, while public datasets from the Dawn mission provide insights into regional variations in hydrogen across Ceres. On Earth, Sri Lanka's serpentinites provide magnesium-rich natural laboratories for investigating hydrothermal processes, chemical weathering, and paleo-habitability, with implications for interpreting proposed hydrothermalism of Mars, including Nili Fossae. These interconnected studies support two long-term goals: the development of the GANGOTRI Mars mission concept led by Louisiana State University and the establishment of a flagship Mars-context geological field program in Sri Lanka. A central principle is generational transfer of research leadership, through mentoring PhD students, postdoctoral researchers, and early-career scientists. LSTI, therefore, represents not only an exploration of planetary environments but also a collaborative model for advancing scientific capacity, knowledge sharing, and sustainable futures through planetary geoscience.

Keynote Address (2)

SEDIMENTARY PROCESSES AND IRON REDOX EVOLUTION ON EARLY MARS: IMPLICATIONS FOR HABITABILITY AND BIOSIGNATURE POTENTIAL

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Understanding the habitability of early Mars requires reconstructing how sedimentary environments evolved and how water-rock interactions influenced the preservation of potential biosignatures. Ancient Martian terrains contain diverse fluvial, deltaic, lacustrine, and groundwater-related deposits, together with clay minerals, iron oxides, carbonates, sulfates, and silica that record interactions among the atmosphere, hydrosphere, and basaltic crust. Observations from Gale and Jezero craters indicate that these sedimentary archives were subsequently modified by water-rock interaction, diagenesis, and redox processes. Distinguishing primary depositional signatures from later mineralogical and geochemical alterations is therefore essential for assessing ancient habitability.

This presentation examines the evolution of iron redox states in early Martian sedimentary systems, from alteration of Fe^{2+}-rich basaltic crust to the formation of Fe-bearing clays and ferric oxides. Particular emphasis is placed on the formation of ferric minerals under conditions in which free molecular oxygen was likely limited. Laboratory simulations of Fe-rich silicate alteration under Mars-relevant aqueous, cryogenic, and anoxic conditions demonstrate that significant iron oxidation can occur without molecular oxygen through coupled mineral-fluid reactions. Ferric minerals may therefore reflect internally generated redox evolution within water-rock systems rather than necessarily indicating an oxygen-rich atmosphere. Iron oxidation-reduction processes can generate heterogeneous redox gradients, influence clay and iron-oxide formation, regulate the availability of chemical energy, and affect the preservation or alteration of organic matter. Recent observations of fine-grained sediments, organic-bearing materials, and Fe-S-P mineral associations at Jezero highlight mineral-organic and redox interfaces as important targets in the search for ancient life. By integrating sedimentological, mineralogical, experimental, and rover-based observations, this study develops a framework to reconstruct Martian sedimentary redox systems and assess their implications for ancient habitability and the preservation of biosignatures. The findings also help identify promising materials and environments for future in situ exploration and Mars sample-return investigations.

Plenary Talk (1)

SCIENCE WRITING: TRICKS OF THE TRADE FOR HIGH IMPACT PUBLISHING

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Science is not finished until it is communicated. Yet, as scientists, we often treat writing as a secondary chore-a mere vessel for transporting data-rather than an integral part of the research process. In this talk, I will argue that effective science writing is a deliberate act of translation: transforming complex, multivariate geophysical and geological datasets into a coherent, linear narrative that guides the reader's mind.

We will dissect the anatomy of a compelling paper, moving beyond the rigid structure to focus on the "arc" of the story. How do we frame a research question so that it feels urgent? How do we present uncertainty without undermining our authority? And crucially, how do we write for the busy, distracted reviewer who must be convinced in the first paragraph?

In this Plenary Talk, I will offer practical strategies for crafting clear, concise, and compelling prose from structuring the perfect abstract to designing figures that tell a story without a caption. Good writing is not a soft skill; it is a core scientific competency. It is how we turn noise into signal, and data into discovery.

Plenary Talk (2)

SECURING NUTRITIONAL SECURITY, ECOLOGICAL RESILIENCE, AND CLIMATE RESILIENCE ON SMALL FARMS: COULD FOOD FORESTS OFFER A SCALABLE PATHWAY?

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Globally, agroforestry is recognized for its potential to mitigate climate change, conserve natural resources, and sequester carbon, thereby enhancing its acceptability among farmers. Among agroforestry systems, Food Forests (FF) closely resemble homestead agroforestry. FF are deliberately planted ecosystems that mimic natural forests to produce food and are also called 'forest gardens' or 'edible forests'. However, they differ structurally and functionally from Miyawaki forests and conventional homestead systems such as Kandyan home gardens in Sri Lanka and multi-tier agroforestry in Kerala.

A typical FF combines diverse large, medium, and small canopy fruit trees with fast-growing, short-duration perennials such as banana (*Musa* spp.) and papaya (*Carica papaya*). These provide early canopy cover for slower-growing fruit crops without substantially compromising light and nutrient availability. A continuous live mulch suppresses weeds, reduces soil-moisture loss, and enhances nutrient availability through leguminous nitrogen fixation and decomposition of litter and fine roots. Interspaces are cultivated with mixtures of legumes, oilseeds, green manures, cereals, millets, vegetables, and spices, maintaining continuous green cover. Periodic canopy management and shade regulation minimize competition and promote fruit-crop growth. FFs are increasingly recognized as ecologically sustainable models for improving food, nutritional, and economic security among smallholders.

The food forest concept began in Austria in 1970 and has expanded globally, particularly in the Global South. Kerala alone has more than 200 recognized FFs, ranging from about 5 cents to one acre. In developed countries, FFs emphasize healthy food, livelihoods, recreation, education, and community benefits, whereas in developing economies they focus more strongly on livelihood, health security, and additional income. Minimum size and canopy criteria used in developed countries may be less relevant in the Global South due to smaller landholdings.

Management is critical to FF success. A representative canopy structure may comprise large (12.5%), medium (12.5%), small (25%), and temporary/nurse plants (50%), with approximately 25 plants within a 40 × 40 ft unit. Enriched compost may be applied during establishment, while 30–35 crop species can be integrated between fruit trees,

including cereals, pulses, vegetables, oilseeds, green manures, millets, and spices. Soil health is maintained through locally prepared bio-manures such as Jeevamrutham, while drip irrigation is important during dry periods, particularly in subhumid regions. Fencing, protective nets, and live fences such as *Gliricidia maculata* provide additional protection. Maintaining continuous green cover or live mulch remains a defining feature.

A major feature of FFs is high biomass turnover during establishment, potentially approaching 40 t/acre of green biomass. Decomposition can increase soil organic matter and improve soil structure and microbial diversity. Periodic harvesting of fruits, nuts, vegetables, and pulses can strengthen household nutritional security while generating marketable surplus. Minimal use of inorganic fertilizers, pesticides, and herbicides can reduce production costs. Value addition, processing, preservation, and marketing of crops such as jackfruit, banana, and mango can further supplement farm income. FF establishment and maintenance also face challenges. Soil erosion control must be adapted to terrain, slope, and drainage and may require additional investment. Birds, wild boar, porcupines, pests, diseases, and other biotic pressures require appropriate management. Maintaining livestock and poultry for manure, marketing highly perishable crops, installing and maintaining drip irrigation, and regularly monitoring soil health can be demanding. Changes in soil pH may also facilitate the establishment of invasive species such as the African giant snail (*Achatina fulica*). Despite these constraints, FFs are increasingly considered climate-resilient and ecologically sustainable options for improving food and nutritional security among smallholders in the Global South.

The potential of FFs extends beyond individual farms. Organically produced food may support differentiated value chains through farmer cooperatives and producer networks. On-farm training in processing and value addition can build skills, strengthen social capital, and reduce post-harvest losses. FFs can also function as field laboratories for monitoring soil health, microbial activity and diversity, soil organic matter, biomass accumulation, and carbon sequestration. Further research is needed to quantify biomass and dry-matter production, belowground root decomposition, microbial diversity, long-term carbon fixation, and the carbon-sequestration potential of woody perennials.
This presentation draws on observations from a food forest in Thenkurissi, Palakkad, Kerala, and interactions with other farmer practitioners. It concludes by examining whether smallholder farms can meet household food needs while responding to climate variability, soil degradation, and rising input costs. Although FFs are not a universal solution, they represent a promising basis for research-backed, farmer-led climate-resilience strategies in smallholder landscapes.

Keywords: nutritional security, live mulch, canopy management, biomass production, crop diversity, food forest

Invited Talk -1 ***Life Science***

KEEPING AHEAD OF OUTBREAKS: ONE HEALTH SURVEILLANCE OF EMERGING AND MOSQUITO-BORNE VIRAL DISEASES IN SRI LANKA

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Emerging and re-emerging infectious diseases pose a major threat to global health, food security, and economies. Many zoonotic diseases are caused by bacteria, viruses, or parasites originating in animals and have triggered significant outbreaks in recent decades. These agents often emerge at the human-animal-environment interface, underscoring the need for a One Health approach, especially in Sri Lanka, where a tropical climate, urbanization, biodiversity, and global connectivity heighten risks. As a result, Sri Lanka continually faces challenges posed by both endemic and emerging viral diseases. Mosquito-borne viral infections are a leading public health concern in Sri Lanka. Dengue causes annual outbreaks, and chikungunya and Japanese encephalitis remain periodic threats. Climate variability, ecological changes, flooding, and global travel further increase the risk of introducing new mosquito-borne diseases, including Zika, West Nile, and other emerging bunyaviruses. These problems point to the need for robust surveillance and diagnostics to enable rapid public health actions. This presentation will review the drivers of emerging infectious diseases and the rising significance of mosquito-borne viruses in Sri Lanka from a One Health perspective. It will emphasize the integration of surveillance and diagnostics across human, animal, vector, and environmental health. Advances in molecular diagnostics, genomic surveillance, and field-deployable technologies will be highlighted as essential for outbreak detection and response. Furthermore, the benefit of collaboration among veterinarians, entomologists, clinicians, public health officials, environmental scientists, and researchers will also be discussed. Integrating disease surveillance, diagnostics, and One Health partnerships will boost Sri Lanka's capacity to anticipate, detect, and control mosquito-borne viral diseases before they cause major disease outbreaks. This forward-thinking approach is vital for defending public health and supporting the nation's development in a connected world.

Acknowledgment: Generous support of the Dr. Robert and Julia Simmons Professorship in Pathobiological Sciences, School of Veterinary Medicine, Louisiana State University, Baton Rouge, LA 70803, USA

Keywords: Arboviruses, diagnostics, emerging infectious diseases, One Health, surveillance

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Invited Talk -2 ***Life Science***

ENGINEERING THE CROPS OF TOMORROW FROM THE GENOMES OF EXTREMOPHYTES

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Developing stress-resilient and sustainable crops is critical for global food security as environmental stresses intensify. Modern agriculture depends heavily on fertile soils and freshwater resources, creating an urgent need for crops that can maintain productivity under more challenging conditions. Extremophytes are plants that thrive in some of the harshest environments on earth, having evolved diverse mechanisms to survive and grow under multiple, often simultaneous, stresses. Their genomes therefore represent an underexplored source of genetic diversity for developing resource-efficient, resilient crops. By integrating systems biology approaches across extremophyte systems, my lab investigates how stress tolerance is encoded, regulated, and coordinated across plants. Our work shows that stress resilience is mediated by developmentally regulated and spatially resolved gene expression programs. Extremophyte lineages have repeatedly recruited gene families involved in abiotic stress responses and developmental regulation, together with elevated basal expression of select genes that may provide a state of stress preparedness. They also exhibit a greater capacity for transcriptional reprogramming, enabling plants to dynamically redirect resources toward growth while maintaining stress resilience. At the tissue level, this plasticity involves coordinated regulation of cell-wall remodeling, hormone signaling, redox homeostasis, and controlled cell death to preserve tissue integrity and sustain growth under stress. By uncovering how extremophytes maintain growth under extreme conditions, we aim to translate these evolutionary solutions into crops suited to marginal and abandoned agricultural lands. These discoveries also enable applications in biofuel production, phytoremediation, rare-metal recovery, habitat conservation, and future extraterrestrial agriculture.

Keywords: genomics, evolutionary biology, extremophytes, single-cell transcriptomics, engineering crops, stress tolerance

Invited Talk -3 ***Earth & Environmental Sciences***

DEEP MAGMATIC ORIGIN OF SÉÍTAH OLIVINE IN JEZERO CRATER: A QUANTITATIVE TEST FROM CRYSTALLIZATION MODELING ON MARS

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The Séítah formation on the floor of Jezero crater, Mars, is an olivine-bearing cumulate whose grains are chemically out of Fe–Mg equilibrium with the host bulk rock, raising the fundamental question of whether the olivine crystallized in situ within a near-surface body or was inherited from a deeper magmatic environment. Resolving this question is critical to interpreting forthcoming Mars Sample Return cores, as the two scenarios would yield samples that record very different depths of magmatic plumbing. This study quantitatively tests the two competing hypotheses by adapting the Mangan–Marsch sheet-like-body crystallization framework to Martian gravity (g = 3.73 m s−2) and to the compositional range of the Séítah-forming magma. The constant-viscosity formulation is evaluated on a uniform 250 × 250 grid spanning magma-body thicknesses of 15–100 m and melt viscosities of 10^2–10^4 Pa · s, and is compared with the SuperCam-resolved olivine grain population. In-situ crystallization is excluded across the entire parameter space by three independent criteria: in 66.5% of the (Zt, μ) plane the host body solidifies before any olivine crystal can cross the upper nucleation front, and in the remaining 33.5% the first surviving crystal arrives only after the body is ≥ 70% solidified, yielding at most a thin micro-cumulate incompatible with the observed ≥ 15 m thickness and ~41 wt. % olivine of Séítah. By contrast, Stokes settling of pre-existing grains escapes the upper capture front at less than 17% bulk solidification and reproduces the observed top-to-bottom grain-size gradient across the Issole–Bastide–Brac traverse without further adjustment. The Séítah olivine is therefore inherited from a deeper magmatic environment, and returned Séítah cores will provide direct geochemical access to the Martian interior rather than to shallow-subsurface cooling.

Acknowledgment: This study was supported by the National Natural Science Foundation of China (42441801, 42273041).

Keywords: Crystallization modeling, Jezero crater, Mars sample return, Olivine cumulate, Séítah formation

Invited Talk -4 ***Earth & Environmental Sciences***

SERPENTINE WEATHERING UNDER ARID CONDITIONS: IMPLICATIONS FOR ALTERATION PRODUCTS AND SPECTRAL DETECTABILITY ON MARS

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Serpentine-bearing ultramafic rocks record water-rock interaction and are important targets for reconstructing past aqueous environments on Mars. However, serpentine exposed at planetary surfaces may be modified by subsequent weathering, oxidation, carbonate formation, and salt accumulation, potentially obscuring its primary mineralogical and spectral signatures and complicating geological interpretation. This study investigates serpentine-derived soils developed on ultramafic rocks from the Dalabute and Karamay ophiolitic mélanges in the Junggar Basin, China, an extremely arid terrestrial analogue for Martian surface environments. Mineralogical, spectroscopic, geochemical, and microtextural analyses were conducted using XRD, Raman, FTIR, visible–near-infrared, Mössbauer spectroscopy, in addition to BSE–EDS and bulk elemental and carbon analyses. The weathering profiles showed limited leaching, strong evaporation, and near-surface accumulation of carbonates and salts. Fine-grained fractions concentrate detrital silicates, evaporative/authigenic precipitates, ferric components, and carbon-bearing materials, whereas coarse fractions preserve serpentine-rich protolith signatures. Total organic carbon is higher in fine-grained soils (0.49–1.30 wt.%) than in coarse fractions (0.09–0.45 wt.%), indicating enhanced organic-carbon retention. Microtextures showed carbonate occurring as coatings, cements, and pore- or fracture-fillings on serpentine-rich grains, while pyroaurite occurs in close association with serpentine, supporting localized authigenic precipitation. Ferric signatures are strongest in fine surface materials but likely reflect mixed contributions from serpentine-associated, redistributed, and detrital sources rather than simple progressive oxidation. These combined processes can overprint primary mineralogical signals and weaken diagnostic serpentine spectral features. Arid serpentine weathering, therefore, provides a process-based analog for interpreting the preservation, alteration, and detectability of serpentine-bearing materials on Mars.

This work is funded by the National Natural Science Foundation of China (Grant Nos. 42441803 and 42525801).

Keywords: Arid weathering, Carbonate, Fe oxidation, Mars analogue, Serpentine

Invited Talk -5 ***Earth & Environmental Sciences***

ZIRCON DIFFUSION CHRONOMETRY REVEALS BRIEF ULTRAHIGH-TEMPERATURE METAMORPHISM IN A PROLONGED PALEOPROTEROZOIC OROGEN

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Ultrahigh-temperature (UHT) metamorphism (≥900 °C) represents the most extreme thermal record in the evolution of the continental crust. Whether such extreme conditions occurred as short-lived thermal pulses (~1 Myr) in Precambrian orogens remains a fundamental question. In this study, we integrate phase equilibria modeling, conventional thermobarometry, and high-resolution NanoSIMS trace-element mapping (Ti, Dy, Yb) with diffusion modeling in zircon to resolve the timescales of UHT metamorphism in the Paleoproterozoic Jiao-Liao-Ji orogen, North China Craton. Petrological analysis of pelitic granulites reveals a three-stage P–T path: peak pressure at ~1.30 GPa and 850 °C, followed by decompression heating to ≥940 °C, and subsequent cooling to ~600 °C. Zircon grains preserve Archean detrital cores (2500–2750 Ma) with primary oscillatory zoning in Ti and REE (Dy, Yb), overgrown by metamorphic rims dated at ca. 1.85 Ga. These sharp compositional gradients enable diffusion chronometry. Using a plane-sheet diffusion model with step-function initial conditions and fixed boundary compositions, we model the relaxation of Dy, Yb, and Ti profiles across oscillatory-zoned lamellae. Uranium profiles, which resist diffusion, are used to define initial geometry and account for analytical convolution. Our results yield brief timescales: best-fit durations of 0.02–0.62 my for the heating event, with UHT residence times of only 0.05–1.3 my These provide the first robust evidence for ultrafast (~0.1 my) UHT pulses in the Paleoproterozoic. Additionally, Ti zoning provides empirical constraints on Ti diffusivity in natural zircon, yielding diffusion coefficients that are three to five orders of magnitude faster than those inferred from experimental calibrations. The UHT event is spatially and temporally linked to ca. 1.85 Ga mafic intrusions, suggesting transient mantle upwelling (e.g., slab break-off or ridge subduction) as the heat source. Our findings demonstrate that vigorous crust-mantle interactions during early plate tectonics could generate short-lived, high-grade thermal perturbations comparable to those in Phanerozoic settings. This study highlights the power of NanoSIMS-guided zircon diffusion chronometry in resolving the tempo of Precambrian thermal-tectonic processes.

Keywords: Ultrahigh-temperature metamorphism, Zircon, Diffusion chronometry, Paleoproterozoic, North China Craton

Invited Talk -6 ***Earth & Environmental Sciences***

SAFEGUARDING THE NATIONAL ENERGY BUDGET: A COST ACCOUNTING STANDARDS FRAMEWORK FOR ENERGY RAW MATERIAL PROCUREMENT

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Energy security is a cornerstone of economic stability. In 2024, Sri Lanka spent over US$2 billion on importing coal, crude oil, and refined petroleum products. The procurement of substandard coal crisis at the Lakvijaya (Norochcholai) Power Plant – where coal with a Gross Calorific Value (GCV) as low as 5,520 kcal/kg was supplied (contract specification: 5,900 kcal/kg) – resulted in documented losses of Rs. 2.24 billion (Auditor General) and broader economic losses estimated at Rs. 8.5 billion (PUCSL). Substandard imports have continued; reportedly, more than 30 shipments have now been received. This study aims to design, mathematically formalize, and validate a preventative cost accounting framework based on the Standards for Cost Accounting (SCAS). – an educational cost accounting framework – that can pre-emptively quantify economic losses from substandard energy inputs. A design science and embedded single-case study methodology was used. Data were triangulated from Auditor General reports, CEB submissions, PUCSL investigations, technical plant data, and verified media reports. The analysis covers the period December 2025 – February 2026. Relevant SCAS standards (SCAS 2, SCAS 6, SCAS 8, SCAS 12, and SCAS 24) were formalized into mathematical models and applied to the documented coal data. A 5-8% drop in GCV translates into a proportional reduction in net effective capacity (SCAS 2), an abnormal material loss (SCAS 6), an increase in per-unit fuel cost (SCAS 8), and accelerated maintenance costs (SCAS 12). For a single shipment, the preventable loss is estimated at Rs. 500–600 million. If the same deviation occurred across 30 shipments, the cumulative preventable loss would be Rs. 15–18 billion. A non-arbitrary Procurement Decision Matrix (derived from contract tolerance, plant design limits, and economic breakeven) is proposed to enable pre-acceptance evaluation of any coal shipment based on its certified GCV. The proposed SCAS framework provides a transparent, mathematically rigorous basis for evaluating coal shipments, quantifying potential economic losses, penalizing suppliers, and protecting consumers from tariff hikes. Its prospective application can prevent future losses regardless of how many shipments have already been accepted. Implementing it could save the nation hundreds of millions of rupees annually.

Keywords: Standards for cost accounting (SCAS), Energy security, Coal quality, Procurement, Abnormal material loss, Capacity determination



Earth & Environmental Sciences

EES 01 ***Earth & Environmental Sciences***

TRANSFORMING UNIVERSITY CLIMATE ACTIONS INTO VERIFIABLE CARBON ACCOUNTS USING AI AND NATIONAL MEASUREMENT, REPORTING, AND VERIFICATION (MRV) INTEGRATION

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The Paris Agreement requires countries to translate their Nationally Determined Contributions into measurable, reportable, and verifiable actions supporting net-zero transitions. Higher Education Institutions (HEIs) play a significant role in this responsibility, given their geographic distribution across provinces and states, positioning them as locally determined yet nationally networked contributors to climate action. This study develops an AI-enabled framework to automatically detect digitally published university climate actions, quantify their carbon implications, and support Measurement, Reporting, and Verification (MRV) readiness and community climate engagement. When sufficient activity details are available on institutional websites or related digital sources, an AI-based crawler identifies climate-relevant content, extracts structured information, classifies actions, and supports carbon quantification using activity data and emission factors. The model analyses institutional actions against an MRV-oriented climate-action taxonomy and generates missing action categories across mitigation, adaptation, and cross-cutting sectors. The methodology integrates automated web crawling, a climate-action keyword lexicon, a climate action data model, hybrid vector-graph retrieval, Retrieval-Augmented Generation (RAG) Large Language Model (LLM) reasoning, and MRV-ready data structuring. A pilot across 19 Sri Lankan universities demonstrated feasibility, with RAG-based interpretation achieving a factual-grounding score of 0.91, verified by two LLMs. Results indicate that AI-enabled pipelines can convert adequately documented university activities into structured carbon accounts while exposing action gaps across mitigation, adaptation, and cross-cutting domains. The framework provides a flexible data exchange mechanism customizable for integration with a national MRV system, enabling universities to become data-ready contributors to national climate accountability. The study concludes that automated detection, evidence-grounded AI interpretation, gap-category generation, and standardized MRV data exchange can strengthen HEI carbon accounting, MRV readiness, and coordinated climate action by transforming published university activities into verifiable contributions to national climate goals and net-zero pathways.

Keywords: Carbon accounting, Carbon quantification, Net-zero transitions, Retrieval-augmented generation, University climate actions

EES 02 ***Earth & Environmental Sciences***

EVALUATING THE EFFECTS OF NEAREST-NEIGHBOR ROOT DENSITY ON FAUNAL SPECIES AROUND MANGROVE PROP ROOTS

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Spatial and temporal dimensions are key components of ecological systems. Nearest-Neighbor Distance (NND) is referred to as the shortest center-to-center linear distance from a specific location of a subject to its closest neighboring subject within the same demarcated area. Mangrove underwater root systems and their associated fauna offer excellent opportunities for NND studies, yet such studies remain scarce. In the current study, NND analysis was used to examine whether the spatial arrangement of proproots influenced associated epibiotic faunal diversity by modifying fine-scale habitat structure. Similar principles were applied for the first time to the prop root habitat of the *Rhizophora mucronata*-dominated mangrove systems in Chilaw Lagoon, where structural components such as prop roots generate fine-scale spatial heterogeneity within intertidal environments. This study was conducted at 15 study sites, with 2 m × 2 m plots were established at each site. Epibiotic organisms observed on or attached to the prop roots were sampled using standardized sampling units. Shannon diversity index (H') was calculated for these standardized prop root-associated epibiotic species. Across the Spearman's Rank Correlation Analysis, it was shown that H' increased with higher prop-root density (r_s=0.838, $p< 0.01$), abundance (r_s=0.838, $p< 0.01$), and the lower Clark-Evans nearest-neighbor index (r_s=-0.843, $p< 0.01$), demonstrating that aggregated prop root arrangements support significantly higher biodiversity than uniform or random configurations. The PCA plot revealed that root density and the number of roots were the dominant drivers of site-level variation, while salinity had comparatively little influence, emphasizing the primacy of biological structure over abiotic gradients. According to the CCA (Canonical Correspondence Analysis), the assemblage of underwater root-associated organisms was divided into two primary ecological groups: a salinity-tolerant community and a habitat-dependent community influenced by root architecture. The convergence of distance-dependent indices, diversity metrics, and non-parametric tests highlights that prop-root spatial patterning is not merely a structural attribute but an active ecological filter shaping community composition.

Keywords: Mangroves, Nearest-neighbor distance, Prop roots, Spatial analysis

EES 03 ***Earth & Environmental Sciences***

HOW PRO-ECOLOGICAL PACKAGING SHAPES BRAND IMAGE AND PURCHASE INTENTION IN THE FOOD INDUSTRY: AN EXPERIMENTAL STUDY IN SRI LANKA

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Growing environmental concerns have heightened the importance of sustainable packaging in shaping consumer decision-making. This study explores the impact of pro-ecological packaging claims on purchase intention and brand image, while comparing consumer choices under quick (30 seconds) versus deliberate (90 Seconds) shopping conditions. Demographic associations, particularly age and gender, were tested using chi-square analysis. A comparison of altruistic versus egoistic brand ratings was also conducted. A controlled experimental design was employed with seven packaging prototypes, categorized as pro-ecological (altruistic and egoistic), greenwashing, and conventional, across two product categories: chocolate and apple juice. A sample of 60 participants was selected with balanced representation across gender and age groups. Results indicate that pro-ecological packaging significantly enhances purchase intention and brand image, with stronger effects under deliberate shopping conditions. Age was a significant influencing factor, with participants aged 25–34 years demonstrating stronger preferences, whereas gender showed no significant association, in contrast to findings reported in previous studies. Most ratings between altruistic and egoistic appeals were similar, with only slight differences observed. It was also found that a notable proportion overlooked ecological factors in their purchase decisions. In conclusion, the study offers practical insights on packaging while emphasizing the importance of consumer awareness.

Keywords: Consumer behavior, Ecological appeals, Green marketing, Purchase decision-making, Sustainable consumption

EES 04 ***Earth & Environmental Sciences***

SPATIAL HETEROGENEITY OF LANDSLIDE RISK IN NUWARA ELIYA: WHY EASTERN SLOPES FACE DISPROPORTIONATE IMPACT DURING CYCLONE DITWAH

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Landslides triggered by tropical cyclones are a major geohazard in the Sri Lankan highlands. In November 2025, during Cyclone Ditwah, the Nuwara Eliya district received heavy orographic rainfall, yet a post-event assessment revealed significant spatial variation in landslide activity, with the eastern divisions experiencing greater impacts than the western division at similar altitudes. This study examines the diversity of this "East Side Bias" through GIS-based spatial analysis to create more targeted disaster risk management protocols. The multi-layer spatial assessment was performed using ESRI ArcMap 10.8, integrating SRTM-derived terrain derivatives, National Building Research Institute (NBRI) susceptibility maps, historical landslide inventories (2000–2024), field-verified Ditwah event points cross-validated with Sentinel-2 imagery, and an IMERG rainfall intensity raster. Kernel Density Estimation (KDE) and spatial overlay analysis were used to detect clustering patterns and to correlate hazard occurrence with slope aspect and rainfall gradients. The results show statistically significant eastward clustering of high-hazard landslide points, centered on the Hanguranketa–Mathurata–Walapane corridor. There are two main mechanisms that account for this pattern. First, orographic amplification of rainfall occurred on windward escarpments, with rainfall totals 1.2–1.7 times higher on eastern slopes than on western slopes at similar elevation, and eastern soils reaching the 150mm/day saturation threshold a full day earlier and maintaining critical soil moisture levels longer throughout the event. Secondly, dip-slope geological conditions in eastern sub-districts resulted in structurally predisposed failure planes, reducing the effective rainfall threshold for slope mobilization. Validation against existing NBRI susceptibility maps confirmed core hazard zones, with the exception of 18% of the new landslide occurrences identified as having moderate susceptibility, almost exclusively on eastern aspects, indicating systematic under-classification of cyclone-specific wind-yard hazard. These findings support the need for aspect-conditioned susceptibility modeling, differentiated early-warning strategies, and flexible hazard-mapping systems that account for cyclone approach vectors to enhance disaster resilience in Sri Lanka.

Keywords: Cyclonic geohazards; GIS Spatial analysis; Landslide susceptibility; Kernel Density Estimation (KEM); Orographic rainfall

EES 05 ***Earth & Environmental Sciences***

A NOVEL U-NET-BASED GEOAI APPROACH FOR COCONUT DISEASE SEGMENTATION FROM UAV RGB IMAGES AND DIGITAL SURFACE MODEL

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Coconut plantations in Sri Lanka are frequently affected by pests and diseases, reducing productivity and plantation health. Manual field inspections are time-consuming and inefficient for large-scale plantation monitoring. Recent developments in unmanned aerial vehicle technology and Geospatial Artificial Intelligence (GeoAI) have enabled automated agricultural monitoring. This study proposed a novel customized U-Net-based GeoAI model, named GeoNet, to segment coconut pest attacks using unmanned aerial vehicle (UAV) RGB imagery and Digital Surface Model (DSM) data in the Weligama area of Southern Province, Sri Lanka. The main objective was to develop and evaluate customized U-Net models for segmenting healthy and pest-affected coconut trees, and to compare their performance with the U-Net model. Imagery data with a 20 cm spatial resolution were collected from the same coconut plantation during the same survey, comprising 288 manually digitized polygon features representing healthy and pest-affected coconut trees, derived from 33 original samples. The experimental results demonstrated that GeoNet achieved higher segmentation performance than the U-Net model across both study areas. In Study Area 1, GeoNet showed a modest improvement over U-Net, with the F1-score increasing from 82% to 88% for healthy coconut trees and from 79% to 81% for pest-affected trees, representing improvements of 6% and 2%, respectively. In Study Area 2, no healthy coconut trees were present, resulting in a 0% F1-score for both models, while GeoNet showed a 4% improvement over U-Net for pest-affected trees, increasing the F1-score from 46% to 50%. The improved performance was mainly attributed to the customized geospatial canopy feature extraction and background suppression achieved through Multi-scale Dynamic Attention Blocks (MSDAB), Spatial and Spectral Enhancement (SSE) gates, large-kernel depth-wise convolutions, and Convolutional Block Attention Module (CBAM). In Study Area 2, GeoNet slightly outperformed U-Net for pest-affected trees, although further validation was needed to confirm its generalizability. Future work will include ground verification data to improve model validation and reliability.

Keywords: Coconut, GeoAI, GeoNet, U-Net, UAV

EES 06 ***Earth & Environmental Sciences***

CLIMATE CHANGE INDUCED DISTRIBUTION PATTERNS AND CONSERVATION PRIORITIES OF ENDEMIC SERENDIB SCOPS-OWL (*Otus thilohoffmanni*) IN SRI LANKA: A SPECIES DISTRIBUTION MODELLING APPROACH

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Climate change is a major driver of biodiversity loss, particularly for range-restricted tropical forest species. This study presents the first climate-based species distribution assessment for the endangered Serendib Scops-owl (*Otus thilohoffmanni*), a wet-zone endemic nocturnal bird of Sri Lanka. Current and future potential distributions were assessed using Species Distribution Modelling (SDM), together with an evaluation of the protected-area network under future climate scenarios. Occurrence records from passive acoustic surveys were supplemented with GBIF and eBird data. Records were screened against IUCN Red List 2021 range maps, and spatial sampling bias was reduced using SDMtoolbox 2.0 in ArcGIS, retaining 87 occurrence points. Current bioclimatic variables were obtained from WorldClim v2.1, while future projections for 2021–2040, 2041–2060, 2061–2080, and 2081–2100 were derived from the MIROC6 General Circulation Model under SSP126, SSP370, and SSP585 scenarios. Models were developed in R using *maxnet*, with parameter optimization through *ENMeval*. Model performance was high (mean TSS = 0.89 ± 0.08). The current suitable habitat was largely restricted to southwestern wet-zone forests, covering approximately 6,167.37 km². Temperature seasonality (BIO4) was the most influential variable (43.62%), followed by mean temperature of the coldest quarter (BIO11: 27.84%) and precipitation of the wettest month (BIO13: 13.54%). Projections indicate a progressive decline in suitable habitat, with only approximately 20.6% of the current extent remaining by 2100. Gap analysis showed that 70.3% of currently suitable habitat lies outside the existing protected-area network. These findings highlight the species' vulnerability to climate change and the need for landscape-scale conservation, habitat connectivity, and measures beyond existing protected areas.

The Mohamed bin Zayed Species Conservation Fund (*232532965*) *is acknowledged.*
Keywords: Climate change, Distribution modeling, Gap analysis, Serendib Scops-owl

EES 07 ***Earth & Environmental Sciences***

DETERMINATION OF PLANT GROWTH PROMOTING ACTIVITIES OF BACTERIA ISOLATED FROM *Spondias dulcis* (AMBARELLA) RHIZOSPHERE IN AVISSAWELLA, SRI LANKA

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Excessive use of chemical fertilizers in agriculture may lead to soil degradation and a decrease in beneficial microbial populations. Plant growth-promoting bacteria (PGPB) that inhabit the rhizosphere offer a promising alternative to chemical fertilizers and play an important role in sustainable agriculture. This study aimed to isolate and characterize PGPB from the rhizosphere soil of *Spondias dulcis* ('ambarella') from Avissawella, Sri Lanka, and to assess their plant growth-promoting activities. Bacterial colonies were isolated from rhizosphere soil samples using enrichment, serial dilution, spread plate, and streak plate techniques. Bacterial isolates with distinct morphological features were screened for their ability to solubilize phosphate, produce ammonia, fix nitrogen, and produce indole-3-acetic acid (IAA). Isolates with comparatively higher plant growth-promoting properties were selected for further investigation using Gram staining, catalase test, oxidase test, motility test, and antagonistic activity. Two isolates with promising results were identified using 16S rRNA gene sequencing. Fourteen bacterial isolates were isolated from the soil sample. All isolates showed varying intensities of ammonia production and IAA production in peptone water and tryptophan-supplemented nutrient broth, respectively. Four isolates exhibited phosphate-solubilization activity on Pikovskaya's agar. Eleven out of fourteen isolates showed nitrogen fixation ability when grown on nitrogen-free Jensen's medium. The five isolates (SBA2, SBA4, SBA5, SBA7, and SBA8) with higher plant growth-promoting properties showed no antagonistic activity among them. All five isolates were Gram-negative and oxidase-positive, and three of them were catalase-positive and motile. The two selected bacterial isolates (SBA4 and SBA5) based on clear bands produced on Agarose gel electrophoresis, were identified as *Bacillus pumilus* and *Pseudomonas plecoglossida*. The low sequencing similarity to *Bacillus pumilus* (80.78%) indicates low-confidence identification and may explain the Gram-negative reaction. Both species were previously reported as PGPBs. The results suggest that the *Spondias dulcis* rhizosphere is enriched with diverse native bacteria having multiple plant growth-promoting properties, with potential as biofertilizers in sustainable agriculture and environmentally friendly soil management practices in Sri Lanka.

Keywords: Biofertilizer, Plant growth-promoting bacteria, Rhizosphere, *Spondias dulcis*, Sustainable agriculture

EES 08 ***Earth & Environmental Sciences***

HARNESSING LIGNOLYTIC FUNGI FOR THE DECOLORIZATION OF SYNTHETIC DYES: A MYCOREMEDIATION APPROACH

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Textile industrial wastewater causes a significant environmental concern due to its complex molecular structure and resistance to conventional treatment methods. This study aimed to isolate and identify lygnolytic fungi with potential for the bio-decolorization of synthetic dyes. Fungal isolates from decaying wood were obtained, and pure cultures were maintained on Potato Dextrose Agar (PDA). Isolates were subjected to a liquid dye decolorization assay using 25 mg L^{-1} of Methylene Blue (MB) as the model dye. Promising isolates were further optimized under different pH (5, 7, 9), shaking speeds (0, 25, 50 rpm), initial dye concentrations (25, 50, 75 mg L^{-1}), and most commonly used commercial synthetic textile dyes (Jakazol Brilliant Blue (JBB), Solarus Red (SR), Jakazol Yellow (JY)). Dye decolorization was determined by measuring absorbance using a UV-Vis spectrophotometer at 12-hour intervals. The Laccase enzyme activity was assessed using 2,2-azinobis (3-ethylbenzthiazoline-6-sulfonic acid) (ABTS) plate assays. All the experiments were conducted in triplicate with controls. Two isolates, out of 30, exhibited over 60% MB decolorization and were identified as *Rhizomucor* sp. and Mucor irregularis. *Rhizomucor* sp. recorded 72.4 % ± 0.1 of decolorization within 84 h at pH 5, 25 rpm, and 25 mg L^{-1} dye concentration, while M. irregularis recorded 72.61% ± 0.02 of decolorization within 48 h at pH 7 in static conditions. Both species achieved complete removal (>99.5%) of JBB, SR, and JY within 72 h, and were positive for laccase production. The findings highlight their potential as eco-friendly and cost-effective treatments for dye-contaminated wastewater and provide a foundation for enzyme- based wastewater treatments.

Keywords: ABTS**,** Dye decolorization, Laccase, Methylene Blue dye, Textile wastewater

EES 09 ***Earth & Environmental Sciences***

ASSESSMENT OF HOSPITAL WASTEWATER CHARACTERISTICS AND PRE-TREATMENT COMPLIANCE WITH SRI LANKAN STANDARDS: A CASE STUDY AT KANDY HOSPITAL

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Hospital wastewater contains organic pollutants, suspended solids, and pathogenic contaminants that can disturb treatment processes and harm the environment if discharged without pre-treatment. Sri Lankan hospitals commonly rely on preliminary treatment (screening and grease trap) before wastewater reaches wastewater treatment plants. This study focuses particularly on variable hospital loading conditions. The objectives of this study are to characterize hospital wastewater quality over four years and to evaluate compliance with pre-treated wastewater discharge standards at Kandy National Hospital. Monthly samples were collected from the hospital manhole between 2022 and 2026, after preliminary treatment and transmission to the treatment plant. Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and pH were analyzed using APHA Standard Methods and compared against tolerance limits under Gazette Extraordinary No. 2264/17 of the National Environmental Act, No. 42 of 1980 (List 6A). Mean concentrations (± SD) were 295.7 ± 130.1 mg L^{-1} for BOD (range: 160-640), 618.6 ± 366.2 mg L^{-1} for COD (range: 305-2010), and 157.5 ± 110.1 mg L^{-1} for TSS (range: 90-450); mean pH was 7.2 ± 0.6 (range: 5.56-9.2). TSS remained fully compliant with its 500 mg L^{-1} limit throughout. BOD exceeded its 400 mg L^{-1} limit in 4 of 48 months (8.33%), and COD exceeded its 800 mg L^{-1} limit in 6 of 48 months (12.5%), with a peak COD of 2010 mg L^{-1} in June 2024. One pH reading (9.2) is marginally outside the 5.5-9.0 range. This study shows that screening and grease-trap pre-treatment maintain compliance under normal conditions but are insufficient during periods of high organic loading, likely linked to changing hospital activity. This study highlights the need for regular monitoring and pre-treatment improvements, such as flow equalization or biological pre-treatment, to confirm reliable compliance and improved wastewater management in Sri Lankan healthcare services.

Keywords: Environmental compliance, Hospital wastewater, Pre-treatment efficiency, Wastewater quality

EES 10 ***Earth & Environmental Sciences***

ETHNOBOTANICAL SURVEY OF MEDICINAL PLANTS IN PUNGUDUTIVU ISLAND, JAFFNA DISTRICT: A *SIDDHA* PERSPECTIVE

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Siddha Medicine is a traditional medical system that treats diseases using herbo-mineral preparations. This field study was conducted on March 1, 2024, during the 'Munpani' (early dew) season using the transect belt method in Pungudutivu, an island in the Jaffna Peninsula, which is a unique dry-zone ecosystem. The study aimed to explore and document the plant species used in *Siddha* medicine. The region possesses a variety of naturally occurring plant species. Field observations and ethnobotanical data collection were carried out using the belt transect method, supplemented by field documentation and botanical identification of the recorded plant specimens. This study identified over 102 plant species across 40 botanical families. The findings indicate that *Fabaceae* (19.6%), *Euphorbiaceae* (9.8%), and *Solanaceae* (4.9%) were the most prevalent. Plants were identified based on their morphology and *Siddha* medicinal properties, such as taste and potency. The flora consisted primarily of perennial herbs, shrubs, and trees. Phytochemical screening of the identified species indicates high levels of bioactive secondary metabolites, including alkaloids, tannins, flavonoids, glycosides, and volatile oils. Based on their traditional uses, the recorded plants were categorized 15% as edible fruits and 5% as leafy vegetables (greens), while 10% were identified as 'Kayakalpa' (rejuvenative) herbs. This dry-zone region serves as a rich repository for medicinal plants essential to *Siddha* therapeutics. The field study successfully documented the traditional uses of rare and endemic species. The findings underscore the importance of local biodiversity in providing natural resources for treating ailments such as respiratory, skin, and metabolic disorders. The study therefore provides a foundation for future research and for the systematic documentation and preservation of traditional *Siddha* knowledge and medicinal plant resources in the northern province of Sri Lanka.

Keywords: Conservation, Ethnobotany, Medicinal plants, Pungudutivu, *Siddha* medicine

EES 11 ***Earth & Environmental Sciences***

SYNERGISTIC USE OF EPPAWALA ROCK PHOSPHATE AND *Aspergillus niger* FOR ENHANCED SOIL PHOSPHORUS SOLUBILIZATION

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Phosphorus (P) is an essential plant nutrient, but much of the soil P occurs in fixed forms that are unavailable for plant uptake. Although chemical fertilizers such as Triple Super Phosphates (TSP) can increase P availability, their high cost, environmental impacts, and reliance on finite global P reserves highlight the need for more sustainable alternatives. Eppawala Rock Phosphate (ERP) is a valuable P resource in Sri Lanka; however, its low solubility limits its direct use as a fertilizer. Phosphate-solubilizing microorganisms can enhance P availability by converting fixed P into plant-available forms. In this study, P availability was evaluated in Red Yellow Podzolic soils collected from Peradeniya using seven treatments, each with seven replicates. Phosphate-solubilizing microorganisms were isolated using ERP-mediated Pikovskaya (PKV) media and screened for their solubilization efficiency. Among the tested organisms, *Aspergillus niger* showed the highest efficiency compared to *Penicillium sp.*, *Aspergillus flavus*, *Aspergillus terreus*, *Bacillus sp.*, and *Pseudomonas sp.*. A liquid biofertilizer (BF) was then prepared using *Aspergillus niger* cultured in potato dextrose broth. The treatments included T1: soil only, T2: soil + ERP, T3: soil + TSP, T4: soil + ERP + TSP, T5: soil + BF, T6: soil + BF + ERP, and T7: soil + BF + TSP. Pots were maintained at field capacity and watered daily. After 45 days, soil samples were analyzed for available P using the Olsen method with a spectrophotometer. The highest P availability was observed in T6 (19.86 mg kg^{-1}), while the lowest was recorded in T1 (0.440 mg kg^{-1}), indicating the effectiveness of combining ERP with BF.

Keywords: Biofertilizer, Phosphorus availability, Phosphorus solubilizing microorganisms, Plant nutrient

EES 12 ***Earth & Environmental Sciences***

CHEMICAL CHARACTERIZATION OF LANKA POND SEDIMENT USING SURFACE TITRATION

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The Lanka Pond in the botanical gardens at Peradeniya shows inhibition of aquatic plant growth despite many replanting attempts, possibly due to sediment characteristics. In this research, the physicochemical properties of sediments were evaluated using potentiometric surface titrations of solid suspensions over a range of pH and ionic strength to determine the surface charge density. The sediment samples were dispersed in $NaNO_3$ electrolyte and were titrated against 0.075 mol dm^{-3} HNO_3 under an inert N_2 atmosphere maintained in a closed system using an auto-titrator. The initial pH of all titrations was recorded, and the pH of selected samples was adjusted to ~9 using 1 mol dm^{-3} NaOH. Experiments varied pH to evaluate surface charge behavior, accounting for protonation–deprotonation of organic matter and solids, given uncertainty in the concentration of surface functional groups in the sediment. Titration at a dosage of 10 g L^{-1} was performed at pH 9, which showed a more negative surface charge than at pH 6, as higher pH promotes deprotonation. This indicated the possible presence of organic and mineral functional groups, resulting in enhanced formation of negatively charged surface sites. Isolating the dosage effect at initial pH ~9, 1.2 g L^{-1} showed less negative surface charge than 10 g L^{-1}, indicating fewer deprotonated surface sites at lower dosage. Results indicated that increasing dosage promotes coagulation of sediment particles, altering surface properties and resulting in weaker proton interactions. Further confirmation of functional groups with protonating oxygen atoms was done by X-ray diffraction (XRD) analysis of the sediment sample. This aligns with the observation of prominent quartz (SiO_2) diffraction peaks, which contribute to the negative surface charge of the sediment. The above observation also strongly indicates the possible presence of organic groups, which could be further confirmed by advanced surface analytical techniques.

Keywords : Dosage, pH, Sediment, Surface titration

EES 13 ***Earth & Environmental Sciences***

ADSORPTION OF MCPA HERBICIDE ONTO NATURAL PYRITE: EQUILIBRIUM, KINETICS, AND pH DEPENDENT STUDIES

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MCPA (2-methyl-4-chlorophenoxyacetic acid) is a widely used phenoxy herbicide that poses significant environmental concerns due to its high mobility and frequent detection in surface and groundwater systems. This study investigated the adsorption behavior of analytical-grade standard MCPA onto natural pyrite (FeS_2) as a potential low-cost adsorbent, evaluating equilibrium, kinetic, and pH-dependent behavior using UV-Visible spectrophotometry. Pyrite particles around 68 μm were suspended (0.2 g) in 200 mL of distilled water containing 0.01 M KCl as background electrolyte, under continuous nitrogen purging. Three experimental series were conducted: pH-dependent studies (pH 3-8), concentration-dependent studies (1-10 μM, 25 min equilibration), and kinetic studies (0-25 min contact time). Then, 15 mL aliquots were withdrawn, centrifuged, filtered, and analyzed by UV-Vis spectrophotometry at 226 nm. Adsorption density increased with contact time and reached an apparent equilibrium at approximately 25 min. Beyond 25 min, a change in adsorption density was observed, suggesting that surface-associated MCPA may undergo degradation on the pyrite surface after the initial adsorption equilibrium. Therefore, 25 min was selected as the equilibrium contact time for subsequent adsorption experiments. Concentration-dependent experiments showed increasing adsorption density with increasing initial MCPA concentration. Langmuir isotherm modeling indicated favorable monolayer adsorption, with a maximum adsorption density (Γ_{max}) of 1.014 μmol m^{-2} and an equilibrium constant (K_L) of 39.80 L μmol^{-1}. The calculated separation factor (R_L = 0.00125) further confirmed the favorable nature of adsorption. Kinetic analysis indicated that MCPA adsorption reached equilibrium within approximately 25 min and followed the pseudo-first-order kinetic model with a rate constant (k_1) of 0.1425 min^{-1}. pH-dependent experiments identified around pH 5 as the optimum condition, attributed to enhanced electrostatic attraction between anionic MCPA species and the positively charged pyrite surface. The findings demonstrate that natural pyrite is a promising, low-cost adsorbent for removing MCPA from aqueous systems.

Keywords: Adsorption, Kinetics, MCPA, Pyrite, UV-Vis spectroscopy

EES 14 ***Earth & Environmental Sciences***

RIVER-SPECIFIC AMBIENT WATER QUALITY THRESHOLDS FOR THE KELANI RIVER, SRI LANKA: A MULTIVARIATE STATISTICAL APPROACH

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Ambient water quality refers to the inherent hydrochemical state of a river under minimally disturbed conditions and serves as a baseline for assessing anthropogenic impacts. In contrast, the generalized water quality standards adopted in Sri Lanka are not river-specific, making it difficult to implement river-specific management strategies. The current study aims to establish ambient water quality thresholds for the Kelani River in Sri Lanka using multivariate statistical approaches. Surface water samples from 40 locations were collected along the river continuum from Adam's Peak to the Kelani Estuary. Physicochemical parameters such as pH, electrical conductivity (EC), and turbidity were measured using a multiparameter probe and turbidity meter. Major cations and anions were measured using Inductively Coupled Plasma Optical Emission Spectroscopy and ion chromatography. Principal Component Analysis (PCA), Factor Analysis (FA), and Hierarchical Cluster Analysis (HCA) identified dominant hydrochemical processes and spatial hydrochemical zones. Principal Component Analysis identified three major components: PC1 (56.77%), PC2 (12.26%), and PC3 (11.01%), representing mineral dissolution, particulate influence, and buffering, respectively. PCA and FA suggested ionic enrichment (PC1) as the dominant hydrochemical process controlling river water chemistry. Based on river morphology and PC1 patterns, three hydrochemical zones were identified: an upper, less-impacted, forested region characterized by lower EC values and dominant natural mineral dissolution processes, a moderately impacted middle catchment influenced by urbanization and agriculture, and a highly enriched downstream region near the estuary influenced by anthropogenic ionic enrichment (industrialization). HCA further confirmed the classification of these three hydrochemical groups. The upper, less-impacted region was considered the baseline for establishing ambient water thresholds. The framework supports river-specific ambient water quality assessment, SDG 6.3.2 monitoring, and future Gaussian Process Regression (GPR)-based evaluation of anthropogenic enrichment.

Keywords: Ambient water quality, Hydrochemical zonation, Multivariate statistics

EES 15 ***Earth & Environmental Sciences***

SURFACE CONTAMINATION OF EDIBLE VEGETABLES BY MICROPLASTICS IN THE KALPITIYA PENINSULA: IMPLICATIONS FOR HUMAN EXPOSURE AND FOOD SAFETY

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Microplastics are significant environmental pollutants with potential adverse effects on human health. Ingestion through vegetables has emerged as a novel pathway for their accumulation in the human body. This study investigated human exposure to microplastics through commonly consumed leafy vegetables in Sri Lanka. Cabbage and onion leaves cultivated in Kalpitiya were selected as representative samples. Vegetables were washed once to simulate routine household washing before microplastic extraction. Surface microplastics were recovered by sequential washing, and the wash water was treated with Fenton reagent to remove organic matter, then density-separated using saturated $ZnCl_2$. Suspected particles were identified under a stereomicroscope based on unnatural colors and morphological features. Onion leaves showed the highest mean surface microplastic abundance (1.2 ± 0.7 particles g^{-1}), while cabbage recorded 1.1 ± 0.5 particles g^{-1}. Estimated daily intake (EDI) and annual intake were calculated using microplastic concentrations, vegetable ingestion rates, and average body weights. Cabbage contributed the highest potential dietary exposure, with daily intake estimated at 7.2×10^{-4} particles g^{-1} day^{-1} in children and 1.9×10^{-4} particles g^{-1} day^{-1} in adults. For onion leaves, corresponding values were 3.5×10^{-4} and 9.3×10^{-5} particles g^{-1} day^{-1}, respectively. These findings indicate that vegetable surfaces can serve as a pathway for microplastic ingestion. Although detected levels were relatively low, long-term accumulation may pose potential health risks. Strengthening policies and management strategies is essential.

University of Sri Jayewardenepura (*RC/URG/FOT/2024/86*) *is acknowledged.*

Keywords: Daily intake, Microplastics, Vegetables

EES 16 ***Earth & Environmental Sciences***

THE SEASONAL VARIATION OF MICROPLASTIC ABUNDANCE AND ITS CORRELATION WITH WATER QUALITY PARAMETERS: A STUDY ON KANDY LAKE

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The objectives of the project are to determine how the presence and composition of microplastics vary with the seasons and to investigate the relationship between microplastic abundance and water quality parameters. This research is essential for developing management and mitigation plans to protect water bodies. Water samples were collected from seven previously determined sampling points at Kandy Lake's inflows and outflows once every two months. From each location, 5 liters of water were passed through a 100 µm stainless-steel wire mesh, and the retained solids were collected in glass bottles. From each sampling site, a water sample was collected to analyze the water quality parameters in the area of interest. pH, alkalinity, DO, and BOD_5 for the collected water samples were analyzed using standard APHA methods. For highly polluted water samples, digestion was carried out using either 30% H_2O_2 or Fenton's reagent. After digestion, density separation was carried out using a sodium chloride solution. The top layer of the sodium chloride solution was extracted and filtered onto a microfiber filter paper, and the residue on the filter paper was observed under a microscope to identify and count microplastics. A significant increase in microplastic abundance was observed between November 2025 and January 2026, where the microplastic count increased from 5.8 ± 2.2 particles L^{-1} to 16.2 ± 4.9 particles L^{-1}. In March, the count observed is 12.2 ± 2.3 particles L^{-1}. The correlation coefficient (r^2) between $Mn^{2+}_{(aq)}$ and microplastic abundance is 0.80, whereas with $Fe^{3+}_{(aq)}$ it is 0.84. In conclusion, the above observations state that the Ditwah cyclone has increased the microplastic abundance in Kandy Lake. A study to determine whether microplastics act as a transport medium for metal ions is currently being conducted based on the results of this study.

Financial Assistance from Grant No. NRC 24-014 is acknowledged.

Keywords: Cyclone Ditwah, Kandy Lake, Microplastics, Seasonal fluctuations, Water quality parameters.

EES 17 ***Earth & Environmental Sciences***

COMPARATIVE STUDY OF STRUCTURAL CONTROL OF GRAPHITE MINERALIZATION IN THE HIGHLAND AND WANNI COMPLEXES OF SRI LANKA

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Sri Lanka hosts world-renowned vein graphite deposits with exceptionally high carbon purity and crystallinity, mainly within the Highland and Wanni Complexes. Despite their economic importance, structural factors controlling mineralization across these terrains remain poorly understood. This study presents a comparative structural investigation of deposits at Bogala, Kahatagaha, Ragedara, Pussahena, Naboda, Baduraliya, Lihiniwhera, Paragoda, and Neluwa. Field investigations, structural mapping, borehole observations, and geophysical surveys (VLF-EM, Self-Potential, Electrical Resistivity Imaging) were used to evaluate links between mineralization and geological structures. Graphite veins generally occur perpendicular to the regional foliation trend (N30°–45°W) and are strongly associated with antiformal folds. Deposits near antiform axial regions, especially in the Highland Complex, showed greater vein thickness, strike continuity, and richer mineralization. In contrast, occurrences tied to shear zones, particularly in the Wanni Complex and southwestern regions, display limited continuity, shorter strike lengths, and thinner veins. Drilling at Neluwa and Lihiniwhera confirmed limited depth persistence and discontinuous mineralization in structurally less favorable zones. The study suggests fracture openness, deformation intensity, and fluid pathways strongly influenced deposition, with intense shearing less favorable for thick, continuous veins. These findings provide new insights into comparative structural controls on Sri Lankan graphite mineralization and support improved exploration models for economically viable deposits. Future work will integrate geochemical and isotopic analyses to further constrain the origin and evolution of graphite-forming fluids.

China-Sri Lanka International Collaborative Research Grant No: ICRP/NSF-NSFC/2024/BS/01, funded by the National Science Foundation, is acknowledged.

Keywords: Antiformal structure, Graphite veins, Shear zone, Structural controls

EES 18 ***Earth & Environmental Sciences***

ETHNOBOTANICAL SURVEY OF MEDICINAL FLORA IN ARALY POINT REGION, JAFFNA DISTRICT: A *SIDDHA* PERSPECTIVE

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Siddha medicine is deeply rooted in the ancient Tamil tradition. This field study was conducted on 25th August 2025 in the Araly Point coastal region of Jaffna District, Sri Lanka. Aimed to document the medicinal plant diversity, compile an inventory of medicinal plant species, and record their traditional uses in *Siddha* medicine. Vegetation sampling was conducted using the belt transect method with each transect measuring 50 m × 5 m. All plant species occurring within each transect were recorded and identified based on their morphological characteristics. The recorded species were also classified according to their life cycles and growth forms. The survey recorded 90 plant species from 36 families. Leguminosae was the dominant family, accounting for 16% of the recorded species, followed by *Euphorbiaceae* with (8%). The flora was predominantly composed of Perennial plants, which constituted 71% of the total plant species identified in the study area, followed by Annual plants (28%) and Biennial plants (1%). Trees represented the dominant growth form (31.2%). While shrubs and herbs each accounted for 29.4%, climbers and twiners were comparatively uncommon. Representative medicinal species included *Borassus flabellifer*, *Azadirachta indica*, *Phyllanthus niruri,* and *Solanum trilobatum*. Based on *Siddha* texts (Materia Medica – Vegetable Section), the medicinal properties of the recorded plant species were evaluated in terms of taste, potency, and post-digestive effect. This is the first ethnobotanical survey of the Araly Point coastal region documenting its rich medicinal flora and emphasizing its conservation. The findings highlight the potential of these plant resources for future *Siddha*-based research and sustainable therapeutic practices.

Keywords: Araly point, Ethnobotany, Medicinal flora, Plant diversity, *Siddha* medicine

EES 19 ***Earth & Environmental Sciences***

SUSTAINABLE REMOVAL OF CHEMICAL OXYGEN DEMAND AND NUTRIENTS FROM WASTEWATER USING MICROALGAE

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The increasing demand for sustainable wastewater treatment necessitates the development of environmentally friendly approaches for reducing organic pollutants and excess nutrients in contaminated water. Microalgae-based treatment has emerged as a promising green solution due to its ability to degrade organic matter, assimilate nutrients, and improve water quality through natural biological processes. This study evaluated the efficacy of microalgae in removing Chemical Oxygen Demand (COD) and nutrients from domestic wastewater using a small-scale open-tank system. Microalgae were collected from Beira Lake, and the dominant species was identified as *Microcystis* sp. Four experimental tanks (2.5 L each) were prepared containing: distilled water (DW), distilled water with algae (DW + A), wastewater with algae (WW + A), and wastewater alone (WW). To promote algal growth and biomass production, 5 mL of BG-11 medium was added daily to each tank. All cultures were maintained at 25 °C under continuous artificial light. Results demonstrated a reduction in COD levels in algae-containing systems, decreasing from 12.8 mg L^{-1} to 6.4 mg L^{-1} in DW + A, and from 19.2 mg L^{-1} to 12.8 mg L^{-1} in WW + A, whereas COD in WW decreased from 22.4 mg L^{-1} to 16 mg L^{-1}. A gradual decline in pH was observed across all treatments: DW (9.88 to 7.61), DW + A (9.29 to 7.24), WW + A (7.20 to 6.79), and WW (7.21 to 7.04), indicating increased metabolic activity. Nitrogen uptake by *Microcystis* sp. was evidenced by decreased N-NH_3 concentrations in algal treatments: DW + A (3.92 to 2.87 mg L^{-1}) and WW + A (3.05 to 2.31 mg L^{-1}). Total phosphate levels increased in DW + A (0 to 5.66 mg L^{-1}) and WW + A (0 to 5.64 mg L^{-1}). Chlorophyll-a concentration increased in WW + A (0.85 to 1.11 mg L^{-1}) but slightly decreased in DW + A (0.55 to 0.39 mg L^{-1}), suggesting enhanced algal growth in nutrient-rich environments. These findings indicate that *Microcystis* sp. effectively facilitates the reduction of organic matter and the assimilation of nutrients in wastewater under laboratory conditions. This study highlights the potential of microalgae-based treatment as a sustainable and eco-friendly alternative for wastewater management and future environmental applications.

Keywords: Ammonia, Chemical Oxygen Demand, Microalgae, Phosphate, Wastewater

EES 20 ***Earth & Environmental Sciences***

HYDROGEOCHEMICAL INFLUENCES ON URINARY STONE FORMATION IN CLIMATICALLY CONTRASTING REGIONS OF SRI LANKA

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Urinary stone disease is a common health issue that burdens Sri Lanka's health sector. It was hypothesized that drinking-water geochemistry could influence stone formation. This study investigates the association between water geochemistry and the biomineralization of urinary calculi in high-incidence regions of Wilgamuwa (dry zone) and Mandaram-Nuwara (wet zone). Twenty-eight groundwater and 15 kidney stone samples were analyzed for major ions and trace elements. Drinking water used by stone cases is dominated by Ca^{2+} and HCO_3^-, whereas most groundwater is Ca-Mg-HCO_3 type. Trace elements Sr, Zn, Mn, and Ba showed considerable concentrations across both regions. Gibbs plots indicated that rock-water interactions strongly influence water chemistry. Kidney stone analysis by infrared spectroscopy and XRD revealed calcium oxalate monohydrate, mixed, and uric acid compositions, supported by SEM observations of tetragonal bipyramidal oxalate crystals. Chemical analyses showed appreciable Zn, Sr, Cu, Ni, Mn, and Ba. Spearman's rank correlation demonstrated significant positive associations between Sr, Ba, and Zn in kidney stones and local groundwater, suggesting a geochemical contribution to stone formation. Elevated dietary or environmental exposure may increase urinary ion concentrations, promoting supersaturation and stone nucleation. Microstructural thin-section observations revealed alternating concentric lamellae, indicating multistage growth linked to temporal variations in urinary composition. The mean $\delta^{13}C$ value of $-20.71 \pm 0.33‰$ ($n = 6$) suggests a predominantly C_3 plant-derived dietary carbon source, pointing to dietary influence. Collectively, the findings indicate a possible association between urinary stone biomineralization and the geochemical characteristics of dietary and drinking-water sources, as reflected by trace-element enrichment in both kidney stones and local water.

Keywords: Carbon isotopes, Dry zone, Groundwater, Kidney stones, Spearman's rank correlation

EES 21 ***Earth & Environmental Sciences***

SYNTHESIS OF GRAPHITE OXIDE-HEMATITE COATED SAND COMPOSITE FOR REMOVAL OF MCPA FROM CONTAMINATED WATER

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Pesticide contamination of surface water is a growing environmental concern in agricultural countries such as Sri Lanka, where herbicide runoff from paddy cultivation threatens surface water quality and drinking water sources. Current adsorbent composites often have limitations, including high cost and limited adsorption efficiency, highlighting the need for low-cost, effective materials for pesticide removal. This study focuses on the development and evaluation of a graphite oxide-hematite coated sand composite (S-Fe_2O_3-GO5) for the removal of 2-methyl-4-chlorophenoxyacetic acid (MCPA), a widely used chlorophenoxy herbicide. The composite was synthesized by coating silica sand with Fe_2O_3 through co-precipitation and thermal treatment. Graphite oxide, synthesized using the improved Hummers' method, was subsequently deposited onto the iron oxide-coated sand through five successive immersion-drying cycles, producing the final S-Fe_2O_3-GO5 composite. Successful synthesis and surface functionalization were confirmed using FTIR and Raman spectroscopy. FTIR analysis revealed characteristic Fe-O stretching vibrations at 524 and 570 cm^{-1} and graphite oxide-associated functional groups corresponding to carbonyl (C=O, 1720 cm^{-1}), aromatic C=C (1625 cm^{-1}), and epoxy C-O-C stretching bands (1203 cm^{-1}), confirming successful GO deposition on the composite surface. Raman spectra further confirm that GO exhibits bands at 1350 cm^{-1} (D band) and 1590 cm^{-1} (G band), with the elevated ID/IG ratio relative to graphite indicating oxidation-induced structural defects characteristic of graphene oxide. Preliminary adsorption studies were conducted using UV-visible spectrophotometry, with the maximum absorption wavelength of MCPA identified at 226 nm. Absorption experiments were performed using a 5 ppm MCPA solution, an adsorbent dosage of 5 g L^{-1}, and a contact time of 2 h. The removal efficiency of S-Fe_2O_3-GO5 (56.6%) is significantly higher than that of the raw sand (5.3%), indicating that the synthesized composite is more effective at MCPA removal.

Keywords: Adsorption, Graphite oxide, Hematite-coated sand, MCPA, Water treatment

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GIS-BASED HABITAT SUITABILITY ANALYSIS FOR SALTWATER CROCODILES (*Crocodylus porosus*) IN DIYAWANNA LAKE, USING ANALYTICAL HIERARCHY PROCESS

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Diyawanna Lake in Sri Jayewardenepura Kotte, Sri Lanka, is a modified urban water body that supports a resident crocodile population despite intense human pressure. Understanding spatial determinants of habitat suitability in such environments is critical for wildlife management and safety, yet spatially explicit assessments remain limited. A GIS-based multi-criteria decision analysis (MCDA) integrated with the Analytical Hierarchy Process (AHP) was applied to evaluate saltwater crocodile habitat suitability across the lake. Based on prior studies, seven environmental and anthropogenic criteria were incorporated: slope and elevation of the bund, solar radiation, population density, distance to roads, distance to water, and land cover. Criteria layers were derived from NASA SRTM DEM, Landsat 8 classification, and humanitarian datasets, standardized to a five-class scale and projected to WGS 1984. Pairwise comparisons used a nine-point scale, with a Consistency Ratio (CR) < 0.1 confirming reliability. A weighted overlay in ArcGIS 10.8 produced a composite suitability map with three categories: least suitable, suitable, and highly suitable. Crocodile sighting locations (n = 28) were spatially joined for validation. AHP identified slope (31%) and elevation (28%) as most influential, followed by land cover (16.9%). Anthropogenic variables, including population density (9.6%) and distance to roads (8.4%), were negatively associated with suitability, reflecting crocodiles' sensitivity to disturbance. The weighted overlay showed that 76.43% of the lake was suitable, 8.32% highly suitable, and 15.25% least suitable. Highly suitable zones concentrated along margins, canals, and vegetated wetlands, while the least suitable areas were urbanized and structurally modified. Recorded sightings aligned with suitable and highly suitable zones, supporting model validity.

Keywords: Analytical hierarchy process, Habitat suitability modeling, Saltwater crocodile, urban wetland

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EFFECT OF FERTILIZER APPLICATION IN PADDY (*Oryza sativa* L.) CULTIVATION ON WELL WATER QUALITY IN THE NORTH CENTRAL PROVINCE, SRI LANKA

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Groundwater is a widely used freshwater source in rural communities in Sri Lanka, yet increasing chemical fertilizer use in paddy (*Oryza sativa* L.) cultivation threatens its quality. This study investigated the impact of chemical fertilizer application in paddy cultivation on the physicochemical and microbiological quality of well water in the North Central Province of Sri Lanka. Well water samples were collected at varying distances (near paddy field: 0-50 m; far from the paddy field: 1000-2500 m) from three locations, from April to August, 2025. A total of six wells were selected, with four water samples per well, resulting in 24 water samples; the same wells were sampled repeatedly. pH, electrical conductivity, total hardness, nitrate, and phosphate concentrations were analyzed. Total culturable bacteria and fungi were isolated by spread plating. Total coliforms and fecal coliforms were enumerated using membrane-filtration on mENDO and mFC agar, respectively. Physicochemical parameters and total and fecal coliform counts were analyzed by proximity using one-factor ANOVA. Statistically higher pH (near: 8.79±0.05, distant: 7.83±0.19), electrical conductivity (near: 1197±77.6 µS cm^{-1}, distant: 738±50.9 µS cm^{-1}), total hardness (near: 262±43.5 mg L^{-1} as $CaCO_3$, distant:146±7.71 mg L^{-1} as $CaCO_3$), and nitrate concentration (near: 29.548±1.559 mgL^{-1}, distant: 24.754±2.627 mg L^{-1}) were observed in wells near fertilizer-applied paddy fields compared to distant wells ($p<0.05$). There was no statistically significant difference in phosphate concentrations (near: 0.232±0.009 mg L^{-1}, distant: 0.215±0.013 mg L^{-1}) ($p>0.05$). pH, EC, and phosphates exceeded the World Health Organization (WHO) drinking water standards, indicating likely fertilizer leaching. Yet factors such as geology, well depth, groundwater flow, sanitation, land use, and irrigation may influence water chemistry. Significantly elevated total coliform counts in wells near paddy fields (471±186 cfu/100 mL) and shifts in culturable bacterial and fungal communities were observed. Fecal coliform counts were significantly higher in wells away from paddy fields (5±4 cfu/100 mL), indicating potential contamination from nearby septic tanks and warranting guidelines on septic tank distance. The findings underscore the need for integrated groundwater management strategies towards ensuring public health and sustainability.

Keywords: Fertilizer application, Groundwater management, Groundwater quality

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COMPARATIVE ASSESSMENT OF UAV-DERIVED DIGITAL TERRAIN MODEL ELEVATION ACCURACY USING DIFFERENT PROCESSING SOFTWARE AND FLIGHT HEIGHTS

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Computer vision and camera-equipped Unmanned Aerial Vehicles (UAV) have substantially enhanced the capabilities for mapping and three-dimensional (3D) modeling. UAV-based photogrammetry enables the acquisition of consistent, high-spatial- and temporal-resolution products through advanced image processing and machine learning techniques. However, the accuracy of these products depends heavily on flight altitude, image overlap, Ground Control Point (GCP) distribution, sensor characteristics, and data processing workflows. This study aims to investigate the influence of flight altitude and processing software on the elevation accuracy of UAV-derived Digital Terrain Models (DTMs) to meet engineering accuracy requirements. A comparative analysis was conducted using six datasets generated from two UAV flights at altitudes of 80 m and 100 m over the same study area. Ten GCPs were used for georeferencing, while 1600 independent Check Points (CPs) were employed for validation. Elevation accuracy was evaluated using Root Mean Square Error (RMSEz), Accuracy at 95% confidence level, bias, and residual distribution analysis. This was to provide a comprehensive assessment of error magnitude, distribution, and reliability. Furthermore, the study identifies optimal parameter configurations to improve vertical accuracy in UAV-based mapping. The 80 m flights produced 16–25% lower RMSEz values than 100 m flights across all software platforms. At 100 m, only Pix4D maintained ASPRS Class 2 (≤ 0.30 m) accuracy, while Metashape and iTwin Capture Modeler decreased to Class 3 (≤ 0.50 m). 95% vertical accuracy. Results confirmed that 80 m DTMs achieved higher and more consistent vertical accuracy than 100 m outputs. Bias values were small and within ASPRS class tolerance limits for all datasets. Thus, the combination of a 20 MP camera, 80 m flight height, 80% overlap, well-distributed GCPs, and Pix4D mapper (RMSEz = 0.17 m, ASPRS Class 2), provided the best DTM accuracy for engineering applications.

Keywords: Digital terrain model, Photogrammetry, Unmanned aerial vehicles

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INTEGRATED MINERALOGICAL AND RADIATION CHARACTERIZATION OF GEM-BEARING LAYERS- A CASE STUDY FROM A GEM MINE IN VERALUPITIYA, SRI LANKA

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Sri Lanka is renowned for secondary alluvial gem deposits formed through prolonged weathering and fluvial concentration of diverse minerals. Characterizing their mineralogy and radioactivity supports safe resource evaluation. While the Kelani River Basin is known for gem mining, detailed data on mineral composition and radiological signatures remain limited. This study characterizes the mineralogy and radioactivity of a gem-bearing profile from an active deep mine in Veralupitiya, Sri Lanka. Three samples collected at depths of 0.76, 2.60, and 3.81 m, representing the topsoil, intermediate soil, and gem-bearing (illam) layer, were analyzed by particle-size distribution, microscopy, micro-Raman spectroscopy, and Geiger-Müller surveys. The topsoil contained quartz, feldspar, biotite, zircon, and minor garnet; the intermediate layer contained quartz, feldspar, ilmenite, zircon, spinel, and garnet; and the illam layer contained sapphire, spinel, garnet, rutile, tourmaline, and zircon, with monazite as an accessory. Heavy fractions had specific gravities of 4.0–4.2, indicating corundum, spinel, garnet, metamict zircon, and ilmenite. Sedimentological features, including subrounded to angular particles and well-preserved zircon, suggest limited transport and abrasion. High quartz in the upper layers indicates greater compositional maturity than the illam layer. Ambient gamma dose rates averaged ~0.40 μSv/h. Elevated radioactivity is attributed to zircon throughout the profile and trace monazite in the illam layer, though Geiger-Müller surveys lack radionuclide-specific resolution. The study concludes that the area hosts secondary alluvial deposits with significant gem potential and emphasizes radiological monitoring to ensure occupational safety in deep mining.

Keywords: Alluvial deposits, Gold recovery, Heavy minerals, Radiation assessment

UTILIZATION OF MAGNETICALLY PURIFIED GRANITE SAW DUST AS A SUSTAINABLE RAW MATERIAL FOR CERAMIC TILE PRODUCTION

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Granite processing generates fine sawdust that is commonly discarded, creating waste-management problems associated with its accumulation and disposal, while the ceramic industry continues to depend on mineral raw materials. This study investigated the feasibility of using purified granite sawdust (GSD) as a partial raw material in ceramic tile manufacturing, with iron-bearing impurities reduced through magnetic separation. Approximately 5 kg of GSD collected from Colombo Stones Industries (Pvt.) Ltd., Mirigama, Sri Lanka, was washed, dried, and sieved to <63 μm. Magnetic separation was evaluated at 0.2–1.5 T with 3–5 passes; purification refers to magnetic removal of iron-bearing particles, with the optimum condition achieving up to 85% Fe_2O_3 removal at 1.2 T with three passes. X-ray diffraction and X-ray fluorescence were used to characterize raw and purified GSD. Purified GSD was incorporated as a partial replacement of conventional ceramic raw materials at four levels (0, 15, 30, and 45 wt. %) and fired to 1100 °C. The purified GSD showed an increase in SiO_2 from 59.30 to 61.06 wt. % and a decrease in Fe_2O_3 from 4.96 to 2.02 wt. %. Mean compressive strength increased from 41.54 MPa for the control to 47.77, 51.24, and 53.47 MPa at 15, 30, and 45 wt. % GSD, respectively, while water absorption decreased from 0.75% to 0.73%, 0.38%, and 0.35%. Firing shrinkage ranged from 5.7% to 6.1% under the selected firing conditions, and Loss on Ignition (LOI) ranged from 3.7% to 6.0%. Results are presented descriptively because inferential statistical significance testing was not performed. Although 45 wt. % GSD gave the highest measured strength and lowest water absorption, 30 wt. % GSD provided the most balanced combination of strength, low water absorption, shrinkage, and LOI. The findings demonstrate laboratory-scale potential for using purified GSD at replacement levels up to 45 wt. % in ceramic tile manufacture, while further scale-up and long-term performance assessment are required.

Keywords: Ceramic tile manufacture, Granite saw dust, Magnetic separation, Sustainable materials, Waste utilization

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SPATIAL DISTRIBUTION OF SELECTED SOIL NUTRIENTS AND POTENTIALLY TOXIC ELEMENTS IN PADDY LANDS ASSOCIATED WITH THE KATUPOTHA TANK CASCADE SYSTEM

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Soil plays a vital role in ecosystem functioning by supplying essential nutrients for plant growth and sustaining biogeochemical processes. However, soil quality can be affected by the accumulation of potentially toxic elements (PTEs), which persist in the environment and pose risks to ecosystems and human health. In tank cascade systems, soil properties often vary spatially due to erosion, sediment deposition, and agrochemical inputs transported through interconnected tanks. Therefore, this study aimed to assess the status and spatial distribution of selected nutrients and PTEs in paddy soils associated with six interconnected ancient tanks within the Katupotha tank cascade system, Mihintale, Sri Lanka. A total of 162 surface soil samples (0–15 cm) were collected from paddy fields directly irrigated by each tank, using a stratified random sampling method. Nutrients and PTEs were analyzed using standard laboratory protocols, and their spatial distribution was mapped using ArcGIS 10.8. No statistically significant differences were observed among the six tank-associated paddy fields for major nutrients and PTEs (Kruskal–Wallis's test, $p > 0.05$). However, some elements showed apparent tendencies toward relatively higher concentrations in lower-cascade fields. The observed spatial tendencies may be associated with agricultural inputs, including fertilizer and agrochemical applications, and movement of water through the cascade network, which may influence the transport and redistribution of dissolved elements. Such transport may redistribute elements within the cascade, potentially contributing to nutrient loss from agricultural soils and downstream accumulation, with implications for soil fertility management. These spatial tendencies and their potential links to agricultural inputs and hydrological processes require further investigation. The observed patterns in this study provide a useful baseline for monitoring nutrient and PTE distribution and supporting sustainable soil fertility management and environmental conservation in tropical tank cascade systems.

Financial assistance from PGIS Grant (Grant No: PGIS/2024/02) is acknowledged.

Keywords: Paddy soil, Soil fertility, Soil health, Spatial variability, Sustainable land management

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FABRICATION AND DEVELOPMENT OF A MICROFLUIDIC DEVICE USING PDMS-GLASS FOR THE ANALYSIS OF ELECTROCHEMICALLY ACTIVE PESTICIDES

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Pesticide contamination in surface and groundwater is a growing environmental concern, particularly in developing countries, threatening drinking water quality, aquatic ecosystems, and human health. While standard laboratory methods such as gas chromatography–mass spectrometry (GC–MS) and liquid chromatography–tandem mass spectrometry (LC–MS/MS) provide exceptional sensitivity and selectivity, they are constrained by high capital costs, laborious sample clean-up procedures, long turnaround times, and the requirement for highly skilled operators. While PDMS-based microfluidic devices integrated with electrochemical detection have been reported for pesticide analysis, no prior study has demonstrated the electrochemical detection of these pesticides using microchip electrophoresis. This study addresses that gap by fabricating a PDMS-based microchip electrophoresis device using a silicon wafer mold and a custom-built high-voltage power supply integrated with a gold band electrode for the amperometric detection of these electrochemically active pesticides. Initial electrochemical investigations using cyclic voltammetry in 10 mM borate buffer (pH 10.0) at a glassy carbon working electrode revealed distinct oxidation potentials for each pesticide, with profenofos at approximately +0.6 V and carbosulfan at approximately +0.4 V. The assembled PDMS microchip successfully detected profenofos and carbosulfan by amperometry, with oxidation peaks observed at 27 and 49 s after injection, respectively. These results demonstrate the potential of the developed device as a low-cost microfluidic sensor for monitoring electrochemically active pesticides.

Keywords: Electrochemical detection, Microfluidic device, PDMS microchip electrophoresis, Pesticide contamination

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INVESTIGATION OF AIR QUALITY IN THE KANDY CITY AREA SPECIFIC TO GALAHA JUNCTION AND KANDY CLOCK TOWER

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Urban air pollution has emerged as a critical environmental and public health concern in rapidly urbanizing cities, particularly in regions where complex topography and traffic congestion restrict pollutant dispersion. This study assessed ambient concentrations of carbon dioxide (CO_2) and nitrogen dioxide (NO_2) at two major traffic-dominated hotspots in Kandy, Sri Lanka: Galaha Junction and the Kandy Clock Tower. To address the lack of consistent localized air quality monitoring, real-time measurements were acquired using calibrated low-cost gas sensors, specifically an MH-Z19 sensor for CO_2 and a MiCS-6814 sensor for NO_2. The sensors were integrated with an Arduino microcontroller platform configured for direct, continuous data logging to an onboard SD card and a computer interface. Monitoring was conducted across both sampling locations during peak and off-peak traffic hours over multiple months, accompanied by simultaneous manual vehicle counts. The mean CO_2 level was 1.02 times the current global background concentration, whereas the mean NO_2 level reached 2.0 times the global baseline at both sites. Monthly variability was more pronounced for NO_2, reflecting the combined influence of traffic fluctuations and localized atmospheric dispersion. Notably, morning rush hours (office opening times) exhibited higher pollutant levels than evening closing periods, with concentrations consistently higher at the Kandy Clock Tower than at Galaha Junction. Statistical analysis revealed strong positive correlations between vehicle volume and NO_2 concentrations at Galaha Junction ($r=0.79$) and at the Kandy Clock Tower ($r=0.72$), indicating that vehicular traffic is the dominant driver of short-term pollutant variations. Overall, this study demonstrates the efficacy of calibrated, low-cost sensor nodes for high-resolution urban air quality assessment and provides foundational baseline data to support targeted mitigation strategies and environmental management in Kandy.

Keywords: Air pollution, MHZ19, MICS-6814, Nitrogen dioxide

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LARGE-HERBIVORE PRESSURE POTENTIALLY LIMITS FOREST RECOVERY IN TROPICAL MONTANE CLOUD FORESTS OF HORTON PLAINS NATIONAL PARK, SRI LANKA

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Successful seedling recruitment and survival are critical for forest resilience and recovery. In Horton Plains National Park (HPNP), Sri Lanka, tropical montane cloud forests (TMCFs) are affected by long-term canopy dieback and poor regeneration. We hypothesized that pressure from large herbivores, primarily sambar deer (Rusa unicolor), constrains natural regeneration through herbivory. To test this hypothesis, we evaluated seedling survival in a herbivore-exclusion experiment comprising 20 fenced–unfenced 1 m^2 plot pairs located no more than 15 m apart across 20 locations and monitored over 18 censuses (2016–2025). The dataset comprised 1,935 woody seedlings (1,093 fenced and 842 unfenced) representing 29 species. Species were classified into guilds as early-successional, late-successional, or climax using published ecological literature and experts' field knowledge. Cox mixed-effects models included location and species as random effects and evaluated treatment, successional guild, and their interaction. Across guilds, fencing reduced mortality risk by 58% (hazard ratio [HR] = 0.42, $p < 0.001$). In unfenced plots, climax seedlings had 3.47 times the mortality risk of early-successional seedlings ($p < 0.001$), whereas late-successional seedlings did not differ significantly (HR = 1.28, $p = 0.405$). Within fenced plots, neither late-successional nor climax seedlings differed significantly from early-successional seedlings. The treatment × guild interaction showed a stronger fencing effect for climax seedlings (interaction HR = 0.39, $p < 0.001$), whose mortality was reduced by 82% under exclusion (HR = 0.18, $p < 0.001$). Fencing also reduced mortality by 53% among early-successional seedlings (HR = 0.47, $p < 0.001$) and 50% among late-successional seedlings (HR = 0.50, $p < 0.001$). These findings demonstrate that large-herbivore exclusion substantially improves woody seedling survival, with the strongest benefit among climax species. We suggest that large-herbivore pressure disproportionately affects the succession of climax species, creating a regeneration bottleneck that may hinder natural regeneration and delay TMCF recovery in HPNP.

Keywords: Cox mixed-effects model, Forest regeneration, Herbivory exclusion, Seedling survival, Successional guild

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EXTRACTION, CHARACTERIZATION, AND TEXTILE APPLICATION OF NATURAL DYES FROM SELECTED SRI LANKAN PLANTS

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The growing environmental and health concerns associated with synthetic textile dyes have increased interest in sustainable alternatives derived from natural plant resources. The objective of this study was to use natural dyes to dye textiles and assess their efficiency compared with synthetic dyes. The study focuses on the extraction, characterization, and textile dyeing potential of natural colorants derived from selected Sri Lankan plant species, including *Caesalpinia sappan*, *Artocarpus heterophyllus*, *Terminalia chebula*, and *Indigofera tinctoria*. The plant materials were extracted using an aqueous extraction method. *Caesalpinia sappan* and *Artocarpus heterophyllus* were extracted in water at 80 °C for 60 min, while *Terminalia chebula* was soaked in water for 24 h without heating, and *Indigofera tinctoria* was processed using a conventional aqueous vat-dyeing method to obtain dye extracts suitable for textile applications. The extracted dyes were applied to natural textile substrates, including cotton, wool, and embroidery threads, using controlled dyeing procedures. Selected textile samples were kept in the dyeing solution for a period of 24 h. The influence of different inorganic mordants, namely alum, ferric, stannous, copper, and magnesium salts, on color development and fastness properties was systematically evaluated, while *Indigofera tinctoria* was applied without mordanting due to its inherent dyeing characteristics. The mordant concentrations used were 10% alum, 2% Cu^{2+}, 5% Fe^{3+}, 1% Mg, and 1% Sn^{2+}. Characterization of the extracted dyes and dyed fabrics was performed using UV–Visible spectroscopy and Fourier Transform Infrared (FTIR) spectroscopy. FTIR analysis confirmed the presence of polyphenolic, aromatic, and carbonyl functional groups responsible for effective dye–fiber interactions. Color strength analysis using the Kubelka–Munk (K/S) function showed satisfactory dye uptake across different textile substrates, with K/S values of 14.20 for *Caesalpinia sappan*, 18.73 for *Artocarpus heterophyllus*, 24.01 for *Terminalia chebula* with an Fe mordant, and 14.64 for *Indigofera tinctoria*. Furthermore, wash and light fastness tests revealed good to excellent fastness properties with minimal color fading after repeated washing and sunlight exposure. The findings demonstrate the potential of selected Sri Lankan plant-based dyes as sustainable alternatives to synthetic dyes in textile processing, thereby contributing to environmentally friendly, value-added textile applications.

Keywords: FTIR, Natural dyes, Plant-based colorants, Sustainable textile dyeing

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DEVELOPMENT OF AN ELECTROANALYTICAL TECHNIQUE FOR THE DETECTION OF AS(V) USING GOLD-GRAPHENE QUANTUM DOTS MODIFIED CARBON FIBER MICROELECTRODE

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The presence of arsenic in water poses a significant environmental and health threat, highlighting the need for precise and affordable detection techniques. In this research, an electroanalytical method was developed to detect As(V) using a gold-graphene quantum dot (Au-GQD)-modified carbon fiber microelectrode (CFME). CFME was fabricated with a sealing apparatus and electrochemically characterized by cyclic voltammetry in 1.0 mM $K_4[Fe(CN)_6]$ in 0.1M NaCl. The steady-state sigmoidal voltammogram, showing a limiting current of around 4.5 nA, confirmed the effective sealing of the carbon fiber within the glass capillary. Au-GQDs were produced using a microwave-assisted technique and analyzed through ultraviolet-visible (UV-Vis) spectroscopy, Fourier transform infrared (FTIR) spectroscopy, and photoluminescence investigations. The presence of graphene quantum dots and gold nanoparticles was confirmed by the UV-Visible spectrum, which showed distinct absorption peaks at approximately 280 and 524 nm. While visible photoluminescence under UV light verified the luminous nature of the Au-GQDs, FTIR analysis identified carboxyl (-COOH) functional groups on the GQD surface. The CFME was electrochemically cleaned and then modified with Au-GQDs using cyclic voltammetry. Anodic stripping voltammetry optimized critical parameters, determining the best conditions as a deposition potential of -0.6 V, a deposition duration of 300 s, and 30 deposition cycles. Under these optimized conditions, the modified electrode exhibited a favorable linear response for As(V) in 0.5 M H_2SO_4, with a correlation coefficient (R^2) of 0.93 and a limit of detection of 10 µM. The findings indicate that the Au-GQDs-modified CFME offers an easy, sensitive, and cost-effective approach for arsenic detection, with potential applications in monitoring environmental water quality.

Keywords: Anodic stripping voltammetry, Arsenic detection, Carbon fiber microelectrode, Electroanalytical method, Gold-Graphene quantum dots

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PUBLIC PERCEPTIONS OF THE BLUE-GREEN SPACE AROUND KANDY LAKE, SRI LANKA

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Urban blue-green spaces, such as Kandy Lake, can enhance ecological sustainability, recreation, and human well-being. This study assessed public perceptions of the blue-green space around Kandy Lake through a cross-sectional social survey conducted in 2025. Data were collected from 105 respondents, including local residents and visitors to the Kandy Lake area, using an interviewer-administered Google Form and distribution of the printed questionnaire. The study examined awareness, recreational use, environmental perceptions, and conservation attitudes regarding blue–green spaces. Most respondents were aged 20–30 years (74.3%) and had attained at least Advanced Level education (98.1%). The lake was primarily used for exercise (33.9%), relaxation (28.2%), and recreation (23.3%). 49.5% noticed birds, while 36.9% sometimes noticed plants. Over 50% rated shade and greenery favorably, whereas cleanliness received predominantly low ratings (scores 1–2). Education level was not significantly associated with awareness of the term "blue–green space" (Pearson's Chi-square test, $\chi^2 = 9.43$, df = 10, p = 0.432). Although 53.4% were unfamiliar with the term, over 80% recognized its ecosystem and biodiversity benefits, and nearly 90% supported conservation awareness programs. These findings suggest that unfamiliarity with the terminology does not necessarily indicate limited ecological awareness; rather, respondents recognized the ecological and social benefits of the space despite limited familiarity with the formal concept of "blue-green space." This highlights a distinction between formal environmental terminology and everyday environmental values and practices. Kandy Lake, therefore, functions as a shared socio-ecological and recreational space shaped by public perceptions and everyday engagement. Participatory conservation and interpretive education could strengthen collective environmental awareness and engagement. However, the predominance of young and highly educated respondents limits the generalizability of the findings.

Keywords: Conservation, public engagement, socio-ecological system, urban blue–green space

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TROPHIC POSITION ESTIMATION OF A FISH COMMUNITY IN A TROPICAL RESERVOIR USING THE STABLE ISOTOPE ANALYSIS TECHNIQUE

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Trophic level estimation is fundamental for understanding food-web structure, energy flow, and ecosystem functioning. Stable isotope ratios of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) are widely used to determine trophic positions in freshwater ecosystems. Selecting a suitable baseline organism is critical, as it provides the reference point for higher trophic positions. This study, conducted in the Deduru Oya Reservoir, Sri Lanka, during September 2020 and September 2022 (both inter-monsoonal periods), evaluated temporal changes in fish trophic dynamics using stable isotope analysis. The trophic positions of 38 fish species were estimated using *Amblypharyngodon melettinus* as the baseline, chosen for its phytoplanktivorous habit and abundance as a primary consumer. Calculations were based on $\delta^{15}N$ signatures of dorsal muscle tissue. Temporal variation was assessed using ten species recorded in both years. Results indicated an apparent increase of about one trophic level in most species in 2022 compared with 2020, including *Dawkinsia filamentosa*, *Pterygoplichthys* sp., *Glossogobius giuris*, *Etroplus suratensis*, and *Esomus danricus*. However, these shifts were likely influenced by baseline $\delta^{15}N$ variation. A decline of ~4‰ was observed in the baseline organism (13.21 to 9.24‰), comparable to the typical enrichment per trophic transfer and sufficient to bias estimates. Findings demonstrate that baseline $\delta^{15}N$ variation can substantially affect trophic-position calculations, suggesting observed increases reflect isotopic shifts rather than dietary change. This highlights the importance of proper baseline selection. Incorporating multiple baselines representing different energy pathways and conducting seasonal sampling would improve the accuracy and comparability of trophic-position estimates, providing more reliable insights into tropical reservoir food webs.

Keywords: Baseline organism, Food-web dynamics, Freshwater reservoir, Stable isotope analysis, Trophic position

Panicum maximum AND ITS BIOCHAR AS EFFECTIVE ADSORBENTS FOR REMOVAL OF Cr(III) FROM AQUEOUS SOLUTIONS

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Contamination of water resources by Cr(III) mainly results from industrial discharges; therefore, its effective removal is essential, as excessive contamination can degrade water quality and human health, and Cr(III) can be oxidized to the more toxic Cr(VI) form. *Panicum maximum* (PM), a widely grown invasive plant, is known for its ability to phytoremediate heavy metal ions, although the removal of heavy metal ions from contaminated water using PM-derived adsorbents has been studied only to a limited extent. The objective of this study was therefore to investigate the use of unprocessed dry leaves of PM and its biochar for effective adsorption of Cr(III) from aqueous solutions. Parameter optimization, carried out at ambient temperature using 10 mg L^{-1} solutions of Cr(III) for both raw and biochar of PM leaves, was evaluated by determining Cr(III) concentrations before and after adsorption using atomic absorption spectrophotometry, leading to the values of 0.400 g dosage, 30 min shaking time, 20 min settling time, and pH of 5.0, resulting in 82.77% and 80.70% adsorption for raw and biochar PM, respectively. X-ray fluorescence spectroscopic analysis reveals the adsorption of Cr(III) onto both biosorbents, with the appearance of a peak responsible for Cr(III) after treatment of biosorbents with Cr(III) solutions. Moreover, unprocessed PM fibers obey the Freundlich isotherm (R^2 = 0.9278), while the biochar obeys the Langmuir isotherm (R^2 = 0.9534). This suggests that adsorption occurs on a heterogeneous surface and multilayer adsorption occurs in unprocessed biosorbent, whereas the biochar surface is more homogeneous, favoring monolayer adsorption. Continuation of this study to investigate Cr(III) removal under dynamic conditions and in large-scale treatment would be necessary to reach a practical solution.

Keywords: Biochar, Chromium(III) ions, Isotherm, Optimization, *Panicum maximum*

EVIDENCE FOR SERPENTINIZATION-DRIVEN HYDROGEN-FORMING PROCESSES IN SRI LANKAN ULTRAMAFIC TERRANES

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The potential for natural (white) hydrogen generation within serpentinite bodies in Sri Lanka remains poorly constrained, largely due to limited mineralogical and petrological investigations, despite the growing significance of these resources for sustainable energy. This study focuses on the alteration history of serpentinite outcrops and possible hydrogen generation from Ussangoda, Indikolapelessa, and Ginigalpelessa by integrating field reconnaissance observations with laboratory-based X-ray diffraction (XRD) analysis. Field mapping was used to identify diagnostic surface features and to collect representative samples, which were subsequently analyzed to determine mineral phase assemblages. XRD results from nine samples indicate a dominant presence of serpentine-group minerals across all sites, with lizardite identified as the principal secondary phase, characterized by strong basal reflections at approximately $2\theta = 12.1°$ and 24.3°. Other secondary mineral phases include magnetite (notably at ~35.8° 2θ) and antigorite (around 60.2° 2θ), indicating variable degrees of serpentinization and oxidation conditions. Relict primary olivine (forsterite) signatures were detected exclusively in samples from Indikolapelessa (I1–I3), with peaks at approximately 32.5° and 53.7° 2θ, suggesting an incomplete alteration sequence and preservation of protolith characteristics in this locality, particularly in sample I2. In contrast, samples from Ussangoda and Ginigalpelessa exhibit more advanced serpentinization with no detectable primary olivine remnants. The coexistence of serpentine minerals, relict olivine, and magnetite supports a progressive hydration–oxidation system consistent with serpentinization processes that generate reducing conditions favourable for natural hydrogen formation. These results highlight the geological potential of Sri Lankan ultramafic bodies as prospective targets for white hydrogen exploration, while also emphasizing the need for further geochemical and isotopic investigations to quantify actual hydrogen generation and flux.

Keywords: Ginigalpelessa, Indikolapelessa, Serpentinization, Ussangoda, White hydrogen

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COMMUNITY-BASED INVESTIGATION ON HUMAN-CROCODILE CONFLICT IN NILWALA RIVER BASIN, MATARA, SRI LANKA

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Human-crocodile conflict poses a significant socioeconomic challenge in communities living along the banks of the Nilwala River in Matara, Sri Lanka. This study investigates the community perceptions among selected residents of the Nilwala River Basin. A field survey was conducted to collect data on crocodile sightings, attacks, impacts on livelihoods, and community-based recommendations to reduce conflicts. A household-based questionnaire survey was conducted over a two-month period and covered selected localities with high levels of human-crocodile conflict, such as Piladuwa, Kadduwa, Kotuwegoda, and Karagoda. A total of 100 randomly selected households were interviewed. Among the respondents, 38.9% resided within 40–50 m and 39.2% within 51–100 m of riverine habitats, indicating closer proximity to crocodile habitats. Most respondents (57.8%) observed crocodile activity in riverine waters, 19.6% reported terrestrial activity, and 20.6% reported activity in both habitats. Crocodile attacks were most frequently reported in the evening (63.7%), when human activity near water bodies was highest. Respondents identified the main reasons for crocodile attacks as the release of crocodiles from Ahungalla Zoological Garden (39.2%), inadequate fencing (16.7%), breeding and population growth (12.7%), sand mining activities (11.8%), and flood-related habitat disturbances. Respondents showed mixed perceptions of government efforts to mitigate this conflict, with 37.2% identifying fence construction as a key intervention. Only 11.7% of respondents were aware of existing awareness programs, indicating a need for public education. As reported, 45.1% of respondents had their daily livelihood activities restricted due to limited access to water resources, and 31.4% feared attacks during their daily activities. Furthermore, respondents reported more encounters with crocodiles and attacks on livestock during times of flooding. The findings highlight the need for coordinated conflict mitigation measures, including improved public awareness, appropriate fencing where feasible, and evidence-based management strategies that promote both community safety and crocodile conservation.

Keywords: Crocodile attacks, Human-crocodile conflict, Livelihood activities, Nilwala River Basin, Public awareness

GOHAGODA MUNICIPAL SOLID WASTE DUMPSITE, SRI LANKA: A MICROBIOLOGICAL PERSPECTIVE AND HEAVY METAL STATUS

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Open dumping of solid waste can degrade soil and water quality. The Gohagoda Municipal Solid Waste Dumpsite (GMSWD), an open dump near the Mahaweli River, is the main waste disposal site in the Kandy District, Sri Lanka. An in-depth investigation of the site's microbiological and heavy-metal status is imperative to identify public health threats. This study aimed to investigate the microbiological and heavy-metal status of the dumpsite soil leachates, water from the nearby Mahaweli River, and soil leachates from a nearby, less-contaminated shrubby site. Soil samples (n=48) were collected at two distances from the dumpsite perimeter (0 m and 50 m) and from two depths (0–10 cm and 40–50 cm), each at four points along the perimeter, in triplicate. Water samples (n=5) from the river Mahaweli and soil (n=5) from a nearby shrubby area were collected. The total culturable bacteria and fungi, as well as β-hemolytic bacteria and fungi, were quantified. Antibiotic sensitivity of isolated Escherichia coli was evaluated against six clinically relevant antibiotics. Heavy metals were analyzed using X-Ray fluorescence spectroscopy. The site closest to the river had the highest abundance of bacteria and β-hemolytic bacteria, and bacterial abundance differed significantly among sites (p=0.0175). Most were Gram-positive (77.8%). Fungal abundance was the lowest within the dumpsite compared to the river Mahaweli and the shrubby area. Among *E. coli*, 4% were resistant to Amikacin and Cefotaxime. Almost all *E. coli* were sensitive to the four other antibiotics. A significant variation in inhibition zone diameters was observed in the 0-10 cm depth among sites for Amikacin (p=0.00202), Gentamicin (p=0.000285), Ciprofloxacin (p=0.0023), Levofloxacin (p=0.00376), and Cefotaxime (p=0.0028). Cu, Ti, and Ni were observed in the dumpsite, while Mn was detected in the shrubby area. The presence of β-hemolytic bacteria, antibiotic-resistant *E. coli*, and heavy metals at the dumpsite underscores the need for an alternative to open dumping of solid waste in Kandy District to prevent public health risks.

Keywords: Antibiotics, Antibiotic sensitivity, Bacterial abundance, Heavy metals, Open dumping

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SEASONAL AND SPATIAL VARIATIONS IN WATER QUALITY, IONIC COMPOSITION, AND HEAVY METAL DISTRIBUTION IN KURUNEGALA LAKE, SRI LANKA

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Kurunegala Lake is an important urban freshwater ecosystem in Sri Lanka, but is increasingly threatened by pollution and seasonal changes. This study assessed seasonal and spatial variations in water quality using physicochemical, ionic, and elemental parameters. Triplicate samples were collected in the wet and dry seasons from 12 impacted and 10 less-impacted sites, classified by proximity to pollution sources, including wastewater discharge, runoff, and drainage. Physicochemical parameters (temperature, pH, TDS, salinity, EC) were measured using standard methods. Pooled samples from impacted and less-impacted sites were analyzed for ionic composition using ion chromatography (IC) and for elemental distribution using XRF. One-way ANOVA tested seasonal and spatial variation. Impacted sites generally showed higher EC, TDS, and salinity, but no significant spatial differences within seasons ($p > 0.05$). Significant seasonal variation in pH was observed at both impacted ($p=4.09 \times 10^{-8}$) and less-impacted sites ($p=2.86 \times 10^{-15}$). At impacted sites, temperature ($p=0.0198$), EC ($p=1.15 \times 10^{-9}$), and TDS ($p=7.55 \times 10^{-11}$) varied seasonally. IC revealed phosphate concentrations were highest in the wet season at impacted sites (15.324 mg L^{-1}), indicating nutrient inputs from runoff and decomposition. Chloride remained consistently elevated at impacted sites in both seasons (~12.8 mg L^{-1}), suggesting persistent anthropogenic inputs. XRF showed elevated levels of Si, Ni, Cu, Co, Fe, S, and Cl at impacted sites. Despite variations, all parameters remained within WHO and Sri Lankan drinking water standards, indicating moderate anthropogenic influence and underscoring the need for continued monitoring and sustainable lake management.

Financial support from the Multidisciplinary Research Grant (MRG) – University Research Council, University of Peradeniya (Grant No. 2025-28) is acknowledged.

Keywords: Anthropogenic pollution, Ionic composition, Kurunegala Lake, seasonal variation, Water quality

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SPATIAL AND TEMPORAL ANALYSIS OF LAND USE CHANGE AND ITS SOCIO–ENVIRONMENTAL IMPACTS IN THE WELIMADA DIVISIONAL SECRETARIAT DIVISION, SRI LANKA (2005-2025)

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Land-use change is evident in the urbanization of areas in Sri Lanka, and it has different impacts on local communities. The study focuses on the spatial and temporal land-use changes and impacts within the Welimada Divisional Secretariat Division (DSD) in Sri Lanka from 2005 to 2025. The study used both primary and secondary data sources: an interview survey with 30 respondents selected across three Grama Niladhari (GN) divisions; governmental reports; previous research reports; and Landsat 5 and 8 satellite imagery (2005-2025). Using interview data, the analysis employed thematic analysis to identify the socio–environmental impacts and the major challenges of land-use changes. Normalized Difference Vegetation Index (NDVI) analysis was used to identify spatial and temporal land-use changes, and Spearman's correlation analysis was also used to assess the relationship between land use and socio–environmental impacts. The findings revealed that the forest cover decreased continuously from 50.43% in 2005 to 37.59% in 2025. Further, the share of developed land increased substantially from 2.45% to 15.46%, reflecting rapid urbanization and infrastructure expansion within the study area. There were noticeable positive socio–environmental impacts, such as improvements in livelihoods, infrastructure development, urban growth, and settlement expansion. Negative impacts include loss of traditional livelihoods, population pressure, resource competition, loss of forests and biodiversity, climate variability, and declines in vegetation health. The correlation analysis confirmed a strong positive relationship ($\rho = 0.866$) between land-use changes and their impacts. Sustainable land management strategies, environmental conservation programs, and proper policy implementation are essential to minimize environmental degradation and ensure balanced regional development within the study area.

Keywords: Land use changes, NDVI, Socio-environmental impacts, Welimada

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EFFECT OF HERBICIDE METRIBUZIN ON FRESHWATER PLANKTON COMMUNITIES: A MICROCOSM STUDY

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Direct and indirect effects of the herbicide metribuzin on the structure of the aquatic plankton community were investigated by exposing plankton to metribuzin concentrations of 0, 0.025, 0.1, 0.25, 0.5, and 1.0 mg L^{-1} for 20 days in 18 microcosms (glass tanks containing 8 L of pond water). Each treatment was executed in three replicates. Total phytoplankton and zooplankton abundance and chlorophyll a concentration in microcosms were evaluated at 5, 10, 15, and 20 days after pesticide exposure. Plankton community and taxon responses to pesticide concentrations were analyzed using the similarity percentage procedure (SIMPER) and a two-way ANOVA. The study found that the highest metribuzin exposure levels (0.25-1.0 mg L^{-1}) significantly affected phytoplankton and zooplankton taxa. SIMPER analysis showed that phytoplankton dissimilarity between the control and treatment groups increased after 15-20 days of pesticide exposure, with values exceeding 80% at 0.25-1.0 mg L^{-1}. *Gonium* colonies, *Closterium* sp., *Tetrastrum* sp., and *Scenedesmus* sp. were the main contributors to the phytoplankton community dissimilarity. Generally, they declined in abundance, with *Gonium* colonies, *Closterium* sp., *Tetrastrum* sp., and *Scenedesmus* sp. showing abundance declines of 96-98%, 99-100%, 67-99%, and 91-100%, respectively, compared to the control in 0.25 -1.0 mg L^{-1} treated tanks after 15 days, while *Syndera ulna* and *Navicula* sp. contributed with higher abundances in the same tanks. Zooplankton community changes were minimal among treatment groups; however, *Eucypris* sp. and *Moina* sp. abundances decreased slightly, by 64-91% and 43-57%, respectively, relative to the control after 15 days at 0.25-1.0 mg L^{-1}. Results showed that pesticide residues have a direct, rapid impact on the phytoplankton and zooplankton community structure. Species composition induced by pesticides underscores the importance of considering pesticides' indirect effects on the ecological food chain in aquatic environments.

Financial assistance from the National Science Foundation (NSF), Sri Lanka. (Grant No: RG/2024/EB/01) is acknowledged.

Keywords: Metribuzin, Phytoplankton, Zooplankton

INFLUENCE OF RESERVOIR-INDUCED MICROCLIMATE VARIATIONS ON RICE YIELD IN THE DEDURU OYA IRRIGATION AREA, KURUNEGALA DISTRICT, SRI LANKA (2004 – 2025)

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This study focuses on the influence of reservoir-induced variations in temperature, rainfall, and humidity on rice yield in the Deduru Oya irrigation scheme in the Kurunegala District, Sri Lanka (2004-2025). The study used spatial and temporal analyses, descriptive analysis, and Pearson's correlation analysis to examine the relationship between microclimatic factors and rice yield. The findings of this study revealed that reservoir-induced microclimatic modifications directly influence and buffer the surrounding 0-20 km area. Based on a mean temperature difference of nearly 1.76 °C, the reservoir area is warmer than the farthest area. Most significantly, rainfall and humidity increased over time in both zones from 2004 to 2025. Statistical analysis indicates that the relationship between rice yield and climatic variables varies significantly by cultivation season and proximity to reservoir areas. In the far reservoir area, rainfall during the Maha season showed weak (-0.11) to moderate (-0.25) negative correlations with crop yield. In the near-reservoir area, relative humidity has a strong negative impact on rice yield during the Maha season (-0.5458). Equally, during the Yala season, no statistically significant correlation was observed between humidity and rice yield (0.29 and 0.42). The findings prove that the Deduru Oya reservoir plays a crucial role in water security and supports agriculture, but it also has a hidden impact on the local microclimate and indirectly influences food security in Sri Lanka.

Keywords: Deduru Oya, Irrigation area, Kurunegala district, Microclimate variations, Rice yield

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ENVIRONMENTAL-TO-ECOLOGY IMPACT INDEX (EEII): A COMPOSITE FRAMEWORK FOR DATA-DRIVEN MANGROVE ECOSYSTEM MONITORING

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Coastal and mangrove ecosystems are increasingly affected by anthropogenic emissions and climate variability. Effective monitoring requires integrating environmental and ecological indicators. This study presents a conceptual framework and preliminary analyses for the Environmental-to-Ecology Impact Index (EEII), which links environmental indicators with ecological responses using multi-source geospatial and ecological variables. Indicators derived from remote sensing, vegetation indices, spectral bands, and radar backscatter were combined with ecological parameters including above- and below-ground biomass (AGB and BGB), soil carbon, total carbon stock, and spatial attributes. Total carbon stock was selected as the ecological indicator due to mangroves' high carbon storage capacity. A structured dataset of 300 georeferenced observations was analyzed, with total carbon stock as the target variable and Sentinel-2 spectral bands (B1–B12), Sentinel-1 radar backscatter (VV, VH), and ecological measurements as predictors. Random Forest Regression was applied to predict carbon stock and evaluate variable contributions. The satellite-only model achieved $R^2 = 0.3359$, RMSE = 785.83, MAE = 464.36, whereas the integrated model achieved $R^2 = 0.9942$, RMSE = 73.66, MAE = 38.89, indicating substantially lower errors and higher explained variance. Feature importance identified soil carbon as the most influential predictor (0.70), followed by AGB (0.18) and BGB (0.08). Results highlight the value of integrating multi-source data for ecosystem monitoring. The framework supports scalable index assignment and classification of georeferenced areas by ecological condition and vulnerability, enabling spatial prioritization in coastal and mangrove regions where carbon storage is critical for climate regulation.

Keywords: Carbon stock prediction, Ecological modeling, Environmental-to-Ecology impact index, Machine learning, Remote sensing

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SCREENING AND ISOLATION OF CELLULOSE- PRODUCING BACTERIA FROM DIVERSE SOURCES FOR SUSTAINABLE BACTERIAL CELLULOSE BIOPRODUCTION

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Bacterial cellulose is widely used in biomedical, food, textile, and packaging industries due to its high purity, biocompatibility, and excellent mechanical strength, whereas plant cellulose requires extensive purification to remove impurities such as lignin and hemicellulose, making its processing more complex and less efficient. This preliminary screening study aimed to isolate and screen potential cellulose- producing bacteria, particularly *Komagataeibacter* (formerly *Gluconacetobacter*), from various natural and fermented sources. Samples including fresh toddy, kombucha, nata de coco, coconut wine, pineapple, and commercial vinegar were streaked onto Hestrin- Schramm (HS) agar, and distinct colonies were subcultured to obtain isolates. Each sample and isolate was inoculated into HS broth in five replicate culture bottles and incubated statically at 30 °C and 37 °C for 7- 10 days. Only the fresh toddy sample incubated at 30 °C produced a thin, whitish, translucent pellicle at the air- liquid interface, suggestive of cellulose production; pellicle formation was not observed at 37 °C or in the other tested sources. The pellicle was purified with 5% NaOH and washed with distilled water until the pH reached neutrality, consistent with the removal of cellular material from a cellulose matrix. Biochemical characterization of the toddy isolate revealed negative results for Indole, Voges-Proskauer, Citrate, Urease, and Oxidase tests, and positive results for Methyl Red, Catalase, and KOH tests. Triple Sugar Iron (TSI) results indicated glucose fermentation without gas or H_2S production. Based on these characteristics, the isolate was preliminarily identified as a member of the genus *Gluconobacter* within the acetic acid bacteria group. These findings suggest that traditional fermented toddy is a promising source for isolating cellulose- producing bacteria. Results are presented as preliminary screening data, pending chemical and structural verification (e.g., FTIR and XRD) and precise determination of cellulose yield. Future work will address 16S rRNA gene sequencing for definitive taxonomic identification, structural confirmation of the pellicle, and quantitative yield assessment to support the isolate's biotechnological potential.

Keywords: Bacterial cellulose, Cellulose- producing bacteria, *Gluconobacter*, Toddy

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RECONSTRUCTION OF PREHISTORIC LANDSCAPE PATTERNS IN THE BAMBARAGALA

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Victoria Reservoir was constructed under the Accelerated Mahaweli Development Program in 1984, resulting in the submergence of the Hulu Ganga valley and transformation of the physical and cultural landscape of Bambaragala (Old Teldeniya), Sri Lanka. Although several archaeological studies have been conducted, reconstruction of the cultural landscape has received limited attention. This study aims to reconstruct the pre-reservoir landscape of Bambaragala and examine how environmental features influenced the spatial distribution of prehistoric and later human activities. The study employed a multidisciplinary archaeological landscape approach using Geographic Information System (GIS)-based spatial analysis, remote sensing, field observations, historical cartographic analysis, and archaeological and epigraphical evidence identified by the Central Cultural Fund since 2014. These datasets were integrated into a GIS environment to examine relationships among water resources, topography, climatic conditions, lithic resource areas, rock shelters, archaeological sites, and other evidence of past human occupation. Historical cartographic analysis and archaeological evidence identified protohistoric symbols, caves, a Mesolithic open-air lithic site, lithic raw-material sources, and a probable early historic stupa within the submerged area east of Bambaragala Raja Maha Vihara. Epigraphical evidence (300 BCE–100 CE) identifies the 'Pocani' Dynasty, the 'Parumaka' chieftain class, three forgotten settlements - 'Koligama', 'Kalata', and 'Cittanagara'; and a stupa named 'Koligamahi Tube'. Evidence also includes an industrial landscape associated with metalworkers, fine arts, and architectural remains; more than 80 caves; a rock-cut tunnel; and minor artifacts. The integrated spatial analysis indicates that archaeological evidence was closely associated with water availability, exploitable resources, topography, and naturally sheltered locations. These findings indicate that favorable environmental conditions supported human activities from the prehistoric to the late historic periods, including lithic and metal technologies, agriculture, and regional interactions. The reconstructed landscape provides a framework for understanding human–environment interactions and settlement patterns in Bambaragala before reservoir inundation and highlights the importance of Archaeological Impact Assessment, Environmental Impact Assessment, and historical records in reconstructing archaeological landscapes affected by large-scale development projects.

Keywords: Bambaragala, Mesolithic archaeology, Prehistoric landscape, Spatial analysis, Victoria reservoir

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SEASONAL VARIATION IN THE OCCURRENCE AND COMPOSITIONAL CHARACTERISTICS OF MICROPLASTICS IN LAGOONAL ENVIRONMENTS ALONG THE SOUTHEAST COAST OF SRI LANKA

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Microplastics (MPs) pollution has emerged as a significant environmental concern in coastal ecosystems due to its persistence and potential ecological impacts. This study investigated seasonal variation in the occurrence and compositional characteristics of MPs in the lagoonal environment along the Southeast coast of Sri Lanka, extending from Kalmunai to Panama, to assess MP abundance, morphology, color distribution, and polymer composition in water and sediments. Sediment samples were collected from 14 locations and water samples from 7 locations during the wet season in January 2026, and the findings were compared with previously reported dry-season data from the same locations collected in August 2023 and July 2025. MPs were extracted by density separation with a saturated NaCl solution (1.20 g mL^{-1}), followed by vacuum filtration. Visual characteristics of MPs were observed using petrographic microscopy, while polymer identification was performed using Fourier Transform Infrared (FTIR) spectroscopy. A Scanning Electron Microscope (SEM) was used to examine the surface morphology of representative MP particles. The results revealed a marked increase in MP abundance in the wet season. Across all sampling locations, the overall microplastic concentrations during the wet season were 55.1 MPs kg^{-1} in sediment and 47.8 MPs L^{-1} in water, compared with 41.4 MPs kg^{-1} and 17.7 MPs L^{-1}, respectively, during the dry season. Fibers (55.97%) were the dominant MP morphology in sediments, whereas fragments (33.06%) were more abundant in water samples. Black (28%), White/transparent (25.06%), and blue (24.8%) particles were the most frequently observed colors. The highest MP abundances were recorded at Periya Kalapuwa, Paladi Kalapuwa, and Kalmunai Kalapuwa, potentially reflecting direct disposal of waste into lagoonal environments and the discharge of waste into rivers and canals, which may subsequently transport MPs into the coastal environment. These findings provide valuable insights into seasonal MPs dynamics along the southeastern coast of Sri Lanka.

Keywords: Lagoonal environment, Microplastics, Seasonal variation, Southeastern coast of Sri Lanka

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UNRAVELING BEACH-ROCK GENESIS ALONG THE SOUTHEASTERN COAST OF SRI LANKA: EVIDENCE FROM MINERALOGICAL AND ELEMENTAL ANALYSES

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Coastal sedimentary formations are critical archives of shoreline dynamics, sediment provenance, and Holocene paleoenvironmental change. Although beach rocks have been documented along several Sri Lankan coasts, those on the southeastern coast remain poorly characterized in terms of geochemistry and mineralogy. This study investigated beach rock composition and geochemistry along southeastern beaches to interpret the depositional environment and formation history. Five samples collected between Komari and Pottuvil were analyzed using petrographic microscopy, FT-IR, XRF, and PXRD. Petrography revealed moderately to well-sorted sandstone as the dominant lithology, reflecting high-energy deposition, with abundant bioclasts, heavy minerals, and pervasive carbonate cement. Heavy mineral enrichment indicates hydraulic sorting followed by early diagenetic cementation. FT-IR spectra showed Fe-O absorption bands at 450 and 556 cm^{-1}, consistent with iron-bearing minerals, and carbonate vibrations at 1420 cm^{-1}, C-H stretching at 2927 cm^{-1}, and weak hydroxyl bands near 3747 cm^{-1} linked to clays. XRD confirmed quartz as the dominant silicate, with subordinate ilmenite, rutile, calcite, aragonite, orthoclase, magnetite, monazite, and garnet. XRF revealed CaO (36.5 wt.%), Fe_2O_3 (23.8 wt.%), and TiO_2 (22.3 wt.%) as dominant oxides, confirming extensive carbonate cementation and Fe-Ti-rich heavy minerals. Collectively, findings indicate southeastern beach rocks formed from heavy mineral-rich sediment derived from crystalline source rocks, hydraulically sorted, and cemented under intertidal diagenetic conditions.

Keywords: Aragonite, Beach rock, Coastal geology, Heavy minerals, Southeastern coast



Life Sciences

LS 01 ***Life Sciences***

SUSTAINABLE SYNTHESIS OF *Dendrocalamus giganteus* LEAF-DERIVED SiO_2 NANOPARTICLES

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This study demonstrates a sustainable, high-yield methodology for synthesizing high-purity amorphous silica nanoparticles (SiO_2 NPs) from silica extracted from the leaves of *Dendrocalamus giganteus* (Dragon bamboo). Using biogenic sources mitigates the high cost and toxicity of traditional synthetic precursors such as tetra-ethyl orthosilicate (TEOS) and tetra-methyl orthosilicate (TMOS). The extraction process involved calcination of mature leaves at 1023 K, followed by acid leaching with concentrated hydrochloric acid (HCl) and subsequent treatment with concentrated sodium hydroxide (NaOH) to produce a sodium silicate precursor solution. This method achieved a silica ash yield of 17.7% (w/w), with X-ray fluorescence (XRF) analysis confirming a SiO_2 purity of 90.9%. The synthesis of SiO_2 NPs was performed using a newly modified sol-gel technique that involved simultaneous hydrolysis and condensation reactions. Systematic optimization of synthesis parameters revealed that the choice of acid catalyst and medium pH critically dictates particle morphology and size. Citric acid was identified as the optimal catalyst over acetic acid and HCl at a neutral pH (~7), utilizing a dual-template system of CTAB and Triton X-100. Under these specific conditions, Scanning Electron Microscopy (SEM) imaging and particle size analysis through ImageJ software confirmed the formation of well-ordered, spherical nanoparticles with the smallest average diameter of 62±25 nm. The HCl and acetic acid-catalyzed SiO_2 had the average particle sizes of 90±27 nm and 162±53 nm, respectively. Conversely, deviations to acidic (pH 3) or alkaline (pH 10) environments resulted in larger, irregular aggregates measuring 175 nm and 150 nm, respectively. Characterization by Fourier Transform Infrared (FT-IR) spectroscopy confirmed the successful formation of the amorphous silica framework, showing dominant siloxane (Si-O-Si) stretching bands at 1050 cm^{-1}, complemented by symmetric stretching at 800 cm^{-1}, bending vibrations at 460 cm^{-1}, and reactive surface silanol (Si-OH) groups at 960 cm^{-1}. X-ray diffraction (XRD) patterns further confirmed the amorphous nature of the product, as evidenced by a characteristic broad "amorphous hump" at $2\theta = 22°$. These results indicate that *Dendrocalamus giganteus* leaves serve as an excellent, eco-friendly alternative for producing high-quality, well-ordered silica nanoparticles using combined CTAB and Triton X-100 templates, with citric acid as a catalyst at neutral pH.

Keywords: *Dendrocalamus giganteus,* Silica nanoparticles, Green synthesis

LS 02 ***Life Sciences***

EVALUATION OF TOTAL PHENOLIC CONTENT, ANTIOXIDANT POTENTIAL, AND ANTI-INFLAMMATORY ACTIVITY OF THREE EDIBLE FERNS OF SRI LANKA

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Edible ferns are utilized in Sri Lankan traditional cuisines and indigenous medicine. However, scientific evidence regarding their phytochemical composition and therapeutic potential remains limited. Therefore, this study aims to evaluate the total phenolic content (TPC), antioxidant capacity, and anti-inflammatory activity of three edible fern species, namely, *Acrostichum aureum* (Keran koku)*, Blechnum orientale* (Baru koku)*,* and *Diplazium esculentum* (Miyana dalu). Shade-dried fronds of the above ferns were powdered and sequentially extracted into n-hexane, ethyl acetate (EtOAc), and methanol (MeOH) using ultrasonication for 30 minutes. The resulting dry crude extracts were evaluated for total phenolic content, DPPH free radical scavenging activity, and protein (albumin) denaturation inhibitory activity, and IC50 values were determined for each assay. Key findings revealed that *B. orientale* showed the strongest bioactivity; specifically, MeOH extract contained the highest total phenolic content (TPC, 4.88 ± 0.03 mg GAE g^{-1}) and antioxidant capacity (IC_{50} 10.18 ± 2.64 ppm) relative to the reference standard, L- ascorbic acid (IC_{50} 2.84 ± 0.01 ppm) and its MeOH and EtOAc extracts showed good anti-inflammatory activity (IC_{50} 346.71 ± 2.52 ppm and 351.16 ± 2.84 ppm, respectively) compared to positive control, diclofenac sodium (IC_{50} 242.73 ± 1.54 ppm). *D. esculentum* showed moderate TPC content (1.99 ± 0.02 mg GAE g^{-1}) and moderate anti-inflammatory activity in MeOH extract (IC_{50} 420.74 ± 1.64 ppm), while *A. aureum* had the lowest overall bioactivity across all assays. This study demonstrated that *B. orientale* and *D. esculentum* exhibit notable TPC levels, *in vitro* antioxidant and anti-inflammatory activities. Further investigations are currently underway to explore additional biological properties and to isolate bioactive compounds using activity-guided fractionation.

Financial assistance from the grant URG/2025/41/AHS is acknowledged.

Keywords: Anti-inflammatory, Antioxidant, Edible ferns, Total phenolic content

LS 03 ***Life Sciences***

DETECTION AND MOLECULAR CHARACTERIZATION OF *Citrus tristeza* VIRUS AND HOP STUNT VIROID ASSOCIATED WITH CITRUS CULTIVATION IN BADULLA DISTRICT, SRI LANKA

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Citrus species are among the most widely grown fruits in the world. However, industry-based commercial citrus farming in Sri Lanka remains underdeveloped. Badulla District is one of the major citrus-growing districts in Sri Lanka, yet citrus productivity in the region is threatened by viral and viroid diseases, which reduce yields and impair tree health. Among these pathogens, *Citrus tristeza* virus (CTV) is considered one of the most economically important viruses affecting citrus worldwide. The present study was primarily aimed at detecting and characterizing CTV and Hop stunt viroid (HSVd) associated with citrus cultivation in Badulla District. Leaf samples were collected from citrus trees exhibiting symptoms such as leaf chlorosis, stunted growth, and dieback, and analyzed using serological and molecular techniques. Serological detection of CTV was performed using the Triple Antibody Sandwich Enzyme-Linked Immunosorbent Assay (TAS-ELISA), with 90% of analyzed samples testing positive for CTV. Reverse transcription polymerase chain reaction (RT-PCR) confirmed CTV positivity in the same 90% of the analyzed samples. In addition, HSVd was successfully detected by RT-PCR and characterized using primers designed in this study, with an expected amplicon size of 211 bp. Of the 100 tested samples, 45% produced the expected amplification, indicating the presence of HSVd. The identities of CTV and HSVd were confirmed through Sanger sequencing and phylogenetic analysis. This study represents the first molecular detection and characterization of HSVd in Sri Lanka. Most HSVd-positive samples were co-infected with CTV, indicating widespread mixed-pathogen infections in citrus cultivation in the Badulla district. The findings of this study provide valuable molecular data to support future epidemiological studies and the development of effective management strategies to reduce the impact of CTV and HSVd.

Financial assistance from the National Agricultural Research Plan (NARP) (Grant No. NARP/PVIC/2024/01) *is acknowledged.*

Keywords: *Citrus tristeza* Virus (CTV), hop stunt viroid (HSVd), RT-PCR, TAS-ELISA

LS 04 ***Life Sciences***

ASSESSMENT OF WATER QUALITY CHANGES ON DNA METHYLATION PATTERNS IN GUPPY (*Poecilia reticulata*)

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Water quality can influence gene activity through various regulatory mechanisms, with DNA methylation among the most important epigenetic processes involved. However, limited studies have examined the effects of physicochemical parameters and heavy metals on DNA methylation in fish. This study aimed to evaluate the effects of selected water quality parameters, including pH, water hardness, and heavy metals (lead (Pb), and cadmium (Cd)), on DNA methylation patterns in guppies (*Poecilia reticulata*). A controlled 14-day laboratory acute exposure was conducted using 12 tanks (n=5). Pb (0, 0.025, 0.075 ppm), Cd (0, 0.02, 0.04 ppm), pH (6.5, 7.5, 8.5), and hardness (80, 90, 100 ppm) were selected as graded laboratory stress conditions to assess concentration- and parameter-dependent responses. DNA methylation was assessed using HpaII and MspI digestion followed by PCR amplification of the 18S rRNA gene and gel electrophoresis. Pb and Cd produced dose-dependent changes in methylation, with pronounced responses at higher exposure levels indicating hypomethylation. Cd also induced changes even at the lower concentrations tested (0.02 ppm), indicating high sensitivity. Variations in pH also affected methylation, with acidic (6.5) and alkaline (8.5) conditions showing higher methylation than neutral pH (7.5), possibly via pH-driven proton-gradient effects on methyltransferase activity. Water hardness showed a non-linear response, peaking at 90 ppm, potentially linked to Ca^{2+}/Mg^{2+}-dependent ionoregulatory gene activity. This suggests that deviation from optimal conditions triggers epigenetic stress responses in fish. Behavioral observations supported these findings, with initial hyperactivity followed by reduced feeding and weakness. Short-term lab exposure to altered water quality modified DNA methylation patterns in guppies, indicating potential as molecular stress indicators. Further studies under realistic conditions and multiple generations are needed to validate biomarker potential and assess the persistence of these changes.

Financial assistance from Wayamba University Research Grants 2024 (*Grant No: SRHDC /URG/2024/10*) *is acknowledged.*

Keywords: DNA methylation, Epigenetics, Guppy, Heavy metals, Water quality

LS 05 ***Life Sciences***

IMPROVED GASTROINTESTINAL STABILITY OF *Lactobacillus rhamnosus* GG THROUGH SOY PROTEIN ISOLATE-INULIN COMPOSITE WALL MATERIAL SYSTEM

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Probiotics are live microorganisms that provide health benefits to consumers. However, probiotic bacteria can lose viability under environmental stresses, including gastrointestinal (GI) and food storage conditions. Encapsulation technology is therefore widely investigated to improve probiotic stability and delivery in functional foods and during GI transit. Although soy protein isolate (SPI) is commonly used as a wall material, its protective ability under harsh GI conditions may be limited. This study evaluated the effectiveness of combining SPI with inulin (SPI+IN) as a protein-polysaccharide composite wall matrix to protect probiotics during GI transit. The prebiotic properties of inulin may further support probiotic activity after release. *Lactobacillus rhamnosus* GG (LGG) was encapsulated by spray drying, and the effects of wall material composition on encapsulation efficiency, moisture content, hygroscopicity, wettability, particle size, morphology, and survival under simulated gastric and intestinal conditions were investigated. Statistical differences were determined using one-way ANOVA followed by Tukey's multiple comparison test ($p < 0.05$). The SPI+IN formulation exhibited low moisture content (4.85 ± 0.18%), high encapsulation efficiency (EE) (90.46 ± 0.08%), and a mean particle size of 4.88 μm. The EE of SPI alone was 90.46 ± 0.68%. Morphological analysis revealed compact, irregularly shaped microcapsules smaller than those of the control and SPI alone. Compared with free cells, encapsulated powders showed significantly lower hygroscopicity ($p < 0.05$), indicating improved storage stability. Under simulated gastric (pH 2.5) and intestinal (pH 7.5) conditions, SPI+IN-encapsulated cells exhibited greater stability than SPI and control formulations. After 2 h of gastric exposure, viable cell counts were 7.00 ± 0.01, 6.61 ± 0.03, and 5.49 ± 0.11 log CFU mL^{-1} for SPI+IN, SPI, and control, respectively ($p < 0.05$). Following intestinal exposure, viability was 8.19 ± 0.03, 7.89 ± 0.06, and 6.49 ± 0.04 log CFU mL^{-1}, respectively. Overall, the SPI+IN composite wall system enhanced probiotic viability compared with the single-wall system, demonstrating effective probiotic delivery under GI conditions and improved physicochemical properties.

Uva Wellassa University (*Grant No UWU/RG/MPhil/2024/12) is acknowledged.*

Keywords: Encapsulation, Inulin, Probiotic, Soy protein isolate, Spray drying

LS 06 ***Life Sciences***

EVALUATION OF THE ANTI-GOUT POTENTIAL OF THE AQUEOUS AND METHANOL EXTRACTS OF TWO SELECTED MEDICINAL PLANTS USING XANTHINE OXIDASE INHIBITION ASSAY

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Gout is a widespread disease associated with abnormal purine metabolism that causes the formation of urate crystals in the joints, resulting in acute arthritis. *Cinnamomum zeylanicum* and *Clitroia ternatea* are two commercially important medicinal plants that exhibit significant biological activities. Previous studies have reported anti-gout activity of *Leucas zeylanica*; however, scientific evidence supporting the anti-gout activity of these two medicinal plants in Sri Lanka remains scarce. The present study aimed to evaluate the anti-gout potential of the aqueous and methanolic extracts of the bark of *C. zeylanicum* and the dried flowers of *C. ternatea,* as well as their 2:1 combined extract, using the xanthine oxidase inhibition assay. Methanolic and aqueous extracts were prepared at a 1:10 (w/v) ratio by maceration in methanol for 24 h and boiling in distilled water for 15 min, respectively. Antigout activity was determined in triplicate using Allopurinol as the reference standard at a concentration of 500 mg L^{-1}. Mean inhibition percentages were analyzed using ANOVA in SPSS 27.0. The xanthine oxidase inhibition activities of the methanolic extracts of bark of *C. zeylanicum*, dried flowers of *C. ternatea,* and the 2:1 combined extract were 32.3%±0.036, 18.22%±0.008, and 29.01%±0.014, respectively. The xanthine oxidase inhibition activities of the aqueous extracts of bark of *C. zeylanicum*, dried flowers of *C. ternatea,* and 2:1 combined extract were 24.8%±0.038,12.34%±0.008, and 20.35%±0.014, respectively. Hence, it was evident that the aqueous and methanolic extracts of the dried flowers of *C. ternatea* and the bark of *C. zeylanicum* have moderate anti-gout activity. The extracts of the bark of *C. zeylanicum* displayed the highest anti-gout activity compared to the dried flowers of *C. ternatea*. However, all tested extracts differed significantly from Allopurinol and showed significantly lower xanthine oxidase inhibitory activity. Further studies are needed to optimize extraction methods and characterize bioactive compounds to develop a medicine to treat gout.

Keywords: Allopurinol, ANOVA, Antigout, Xanthine Oxidase

LS 07 ***Life Sciences***

KNOWLEDGE, ATTITUDES AND PRACTICES OF VETERINARIANS ON CANINE ANAPLASMOSIS IN SRI LANKA

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Canine anaplasmosis is an emerging tick-borne disease of increasing veterinary and public health importance. Veterinarians play a key role in its diagnosis, treatment, prevention, and public awareness. This is the first national survey among Sri Lankan veterinarians on canine anaplasmosis. This study evaluated the knowledge, attitudes, and practices (KAP) of veterinarians in Sri Lanka regarding canine anaplasmosis using a structured self-administered questionnaire. Survey responses were collected from 954 randomly selected registered veterinarians between January and October 2025; 121 veterinarians participated, yielding a response rate of 12.7%. All respondents were aware of canine anaplasmosis, and 79.4% demonstrated moderate to high knowledge scores. Most participants (88.4%) correctly identified common clinical signs of the disease; however, only 27.4% recognized less common manifestations, while 11.6% were unaware of the clinical signs. Awareness of the zoonotic potential of anaplasmosis was limited, with only 53.7% recognizing its public health significance. Veterinarians generally displayed positive attitudes toward disease management, with 98.0% emphasizing the importance of ectoparasite control and 91.8% supporting the need for definitive diagnosis. Despite these positive attitudes, clinical practices were comparatively suboptimal. More than half of the respondents (56.2%) relied solely on clinical signs for diagnosis, and 86.0% did not perform routine screening for canine anaplasmosis. Statistical analysis showed that younger veterinarians and those with fewer years of professional experience had significantly higher knowledge scores (Logistic Regression; $p<0.05$), possibly reflecting greater exposure to updated curricula and emerging information on vector-borne diseases during recent veterinary training. In contrast, experienced practitioners may rely more heavily on established clinical approaches. These findings highlight the need for continuous professional development programs to strengthen diagnostic practices, zoonotic awareness, and evidence-based management of canine anaplasmosis among veterinarians in Sri Lanka.

Keywords: Anaplasmosis, Attitude and practices knowledge, Knowledge score, Sri Lanka

LS 08 ***Life Sciences***

FOOD SAFETY AND QUALITY EVALUATION OF INDIAN MACKEREL AND GOLDEN TREVALLY COLLECTED FROM THE NEGOMBO FISH MARKET, SRI LANKA.

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In Sri Lanka, fish is considered one of the primary sources of protein; hence, the safety and quality of marine fish are matters of public health concern. Marine fish can encounter environmental contaminants and pathogenic microorganisms that can lead to serious public health problems. The aim of the present study was to evaluate the microbiological safety, mercury contamination, physicochemical parameters, and qualitative assessment of biochemicals and phytochemicals in two popular fish species, *Rastrelliger kanagurta* (Indian mackerel) and *Gnathanodon speciosus* (Golden trevally), from the Negombo fish market, Sri Lanka. A total of 10 individual *Rastrelliger Kanagurta* and 5 individual *Gnathonadon speciosus* were obtained on a single sampling session (September 2025). Dorsal muscle tissue was used for all analyses. The mercury content was determined using inductively coupled plasma–mass spectrometry (ICP-MS), and both fish species showed mercury levels below 0.1 mg kg^{-1}, which are considered safe according to internationally accepted safety limits specified by the World Health Organization (0.5 mg kg^{-1}). Proteins, lipids, and carbohydrates were identified by biochemical and phytochemical analyses, whereas starch, glycosides, and phenolic compounds were not detected. The pH values of Golden trevally, 5.98 ± 0.58, and Indian mackerel, 5.86 ± 0.58, were within acceptable freshness limits (6.0- 6.8). Selective and differential microbiological media were used to detect the microorganisms present in both fish species. Gram staining results showed Gram-negative bacteria in Golden trevally and both Gram-positive and Gram-negative bacteria in Indian mackerel. The presence of *Enterobacter cloacae* in Golden trevally and *Rossellomorea marisflavi* in Indian mackerel was identified by Sanger sequencing. In conclusion, both fish species showed acceptable freshness and mercury levels for human consumption. However, the presence of opportunistic pathogens (*e.g., Enterobacter cloacae)* indicates the need for adequate handling and hygiene during fish processing and marketing. However, detecting this microorganism alone does not establish that the fish is unsafe for human consumption.

Keywords: *Gnathanodon speciosus*, Mercury contamination, Microbiological safety, Molecular identification, *Rastrelliger kanagurta*

LS 09 ***Life Sciences***

CHEMICAL AND MICROBIOLOGICAL SAFETY ASSESSMENT OF GIANT TREVALLY *(Caranx ignobilis)* AND SMOOTHBELLY SARDINE *(Amblygaster clupeoides)* OBTAINED FROM COASTAL MARKETS OF NEGOMBO, SRI LANKA

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Fish is an important source of protein for Sri Lankans, and continuous monitoring of seafood safety and quality is essential. The present study aimed to determine the level of total mercury contamination, pH as a freshness indicator, biochemical characteristics, and microbiological safety of two marine fish species, the giant trevally (*Caranx ignobilis*) and the smoothbelly sardine (*Amblygaster clupeoides*), brought (n= 3 from each) from the Negombo fish market. Inductively Coupled Plasma–Mass Spectrometry (ICP-MS) following AOAC Official Method 2013.06 was used to measure mercury concentrations, while pH was measured as an indicator of freshness. Qualitative biochemical and phytochemical analyses were conducted to identify the major biomolecules and phytochemicals present. Microbiological identification was performed by culture-based methods, Gram staining, IMViC tests, Polymerase Chain Reaction (PCR), and Sanger sequencing. The findings revealed that the total mercury concentration in both fish species was less than 0.1 mg kg^{-1}, below the World Health Organization's internationally accepted safety limit of 0.5 mg kg^{-1} for fish intended for human consumption. The mean pH value of *Caranx ignobilis* (5.95 ± 0.04) was significantly higher ($p < 0.05$) than *that of Amblygaster clupeoides* (5.24 ± 0.01), and both were within the acceptable range for fresh fish muscle. Biochemical analysis revealed the presence of carbohydrates, proteins, and lipids, while phytochemical analysis revealed the absence of glycosides and phenolic compounds. A suspected Enterobacteriaceae isolate was recovered during culture-based microbiological analysis and was identified as *Klebsiella pneumoniae*, a Gram-negative, rod-shaped bacterium, by PCR and Sanger sequencing. Although mercury concentrations were below the recommended safety limit, the detection of potentially pathogenic bacteria suggests possible post-harvest hygiene issues. The study highlights the importance of continuous monitoring of seafood quality and safety by integrating chemical and microbiological analyses to protect public health in Sri Lanka.

Keywords: *Amblygaster clupeoides, Caranx ignobilis*, *Klebsiella pneumoniae*, Mercury contamination, seafood safety

LS 10 ***Life Sciences***

SEASONAL VARIATION MODULATES THE RESPONSE OF DWARF RICE VARIETIES TO EXOGENOUS APPLICATION OF GA_3

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Rice (*Oryza sativa*) growth and development rely on the intricate interplay between endogenous hormonal signaling and diverse environmental conditions. Gibberellic acid (GA_3) is a key phytohormone that regulates plant height and many other developmental processes. But its response stability over different seasons needs to be validated to ensure experimental reproducibility. One of the aims of this study is to investigate the growth patterns of black and white dwarf rice varieties under exogenous GA_3 treatment across two distinct growing seasons, with a normal-height reference variety (Tikiri Kekulu) used for comparison. To evaluate this, three-week-old dwarf rice varieties were subjected to daily application of 50 µM GA_3 for seven consecutive days, while untreated dwarf plants were used as a control. Each group consisted of three independent pots with nine plants per pot (27 plants total) randomly arranged under greenhouse conditions. Plant heights were measured weekly, and the experiment was repeated over two seasons (March-April and October-November). A Linear Mixed Model with Restricted Maximum Likelihood was used for data analysis. The results showed that the growth patterns remained unchanged, but the absolute height varied with the season. The height of the untreated reference variety was significantly reduced (-10.76 cm, $p<0.001$) in the October-November trial. Whereas significant increases at baseline (Black: +18.37 cm; White: +21.90 cm; $p< 0.001$) were observed in GA_3-treated dwarf rice. The untreated white dwarf variety was stable during both seasons ($p = 0.904$), while the untreated black variety was slightly but significantly sensitive to seasonal variation (−1.86 cm, $p = 0.025$). This finding shows the height of the reference variety changes across seasons, while the GA_3-induced growth response of the dwarf varieties is similar in both seasons. Untreated Black Dwarf showed seasonal variation, but White Dwarf did not, suggesting that the two dwarf varieties may not share a common causal mutation.

Financial assistance from the Postgraduate Institute of Science, University of Peradeniya (Grant No. PGIS/2024/06) is acknowledged.

Keywords: Dwarf rice, Gibberellic acid, Seasonal variation.

LS 11 ***Life Sciences***

INVESTIGATION OF HEPATITIS C VIRAL LOADS IN A SAMPLE POPULATION OF PATIENTS USING REAL-TIME QUANTITATIVE PCR TECHNOLOGY (q-PCR)

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Monitoring Hepatitis C Virus (HCV) viral loads is essential for confirming diagnosis, initiating treatment, and assessing the Sustained Virological Response (SVR) in patients infected with HCV. The standard, most critical time points for patient management are before treatment (baseline), at the end of treatment (EOT), and 12 weeks after treatment completion (SVR-12). However, viral load testing during treatment is sometimes also performed to assess adherence and identify breakthrough viremia in special circumstances. Pre-treatment viral load is useful for predicting treatment response and determining the treatment course for patients. An end-of-treatment assessment is conducted to detect viral clearance at the conclusion of therapy. In this study, we investigated 10 anonymized patient samples for hepatitis C viral load using real-time quantitative PCR with TaqMan probe chemistry. The study was conducted at the Molecular Medicine Unit, University of Kelaniya, in a retrospective manner, using 10 anonymous patients' samples (remaining after testing), received from January to August 2025. The patient population consisted of 5 samples before treatment, 4 after 3-6 months of treatment, and 1 after 6 months of treatment cessation. Following RNA extraction and quantitative RT-PCR, amplification curves were generated together with the standard curve derived from 4 reference HCV RNA standards. Results revealed a range of viral loads that matched their clinical and viraemic profiles. Among 10 samples, one patient showed a negative RNA profile after 6 months of treatment cessation. Five patients who were evaluated for baseline viral load had $>10^6$ copies/mL, indicating active viral infection requiring treatment. Four patients evaluated 3-6 months after treatment had relatively low viral loads of 10^1-10^3 copies/mL. The viral loads obtained matched the disease profile of the patient population. The study showed that monitoring viral load with a reliable qPCR method would produce important insights for patient management.

Key words: Hepatitis C, Real-time PCR, RNA, Sustained virological response, Viral load

LS 12 ***Life Sciences***

OPTIMIZED KOH–H_2O_2 DIGESTION PROTOCOL FOR THE EXTRACTION OF MICROPLASTICS IN HUMAN POSTMORTEM BRAIN TISSUES

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The brain, which regulates vital and cognitive functions, is increasingly threatened by the accumulation of microplastics within human tissue. Despite rising concern, current studies on microplastic detection lack evaluation of key factors, including processing time, cost, and digestion methods (e.g., acid, alkaline, oxidative, and enzymatic treatments). This study investigates an optimized digestion protocol using potassium hydroxide (KOH), with and without a secondary oxidative step using hydrogen peroxide (H_2O_2, 30% v/v). The effects of reagent concentrations, temperature, and digestion time were systematically evaluated to develop an efficient and reproducible method to determine digestion efficiency using a gravimetric approach. Seven human brain tissue samples (0.5000–1.000 g) obtained from postmortem examinations at Teaching Hospital, Peradeniya, were subjected to four experimental conditions. Initial treatments with 10% and 30% (w/w) KOH at 40 °C for 72 h yielded digestion efficiencies of 37.79 ± 2.85% and 61.04 ± 1.66%, respectively. Introducing H_2O_2 improved efficiencies to 38.75 ± 1.69% and 66.90 ± 1.88%. Increasing the temperature to 50 °C significantly enhanced digestion, achieving 81.62 ± 1.02% (10% KOH) and 90.85 ± 2.34% (30% KOH). The optimized conditions are 30% (w/w) KOH at 50 °C for 48 h, followed by 24 h of oxidation with H_2O_2, Which Produced the highest efficiency (92.57 ± 0.098%). Overall, higher KOH concentration and elevated temperature significantly improve digestion efficiency, while the addition of H_2O_2 consistently enhances performance. This optimized protocol provides an efficient, reliable method for extracting microplastics from human brain tissue, enabling accurate extraction and facilitating future toxicological investigations and assessments.

Keywords: Digestion, Efficiency, Human brain, Optimization

LS 13 ***Life Sciences***

INTER-SPECIES AND INTRA-SPECIES MORPHOLOGICAL CHARACTERIZATION OF *Elatostema* (URTICACEAE) SPECIES IN SRI LANKA

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Elatostema is a group of herbaceous angiosperms that typically thrive in wet-zone rainforests in Sri Lanka. According to the National Red List 2020, nine taxa, including five varieties, are documented, while the Revised Handbook to the Flora of Ceylon documents four species, including endemics. Also, *Pellionia heyneana* was recently reclassified under the genus. The lack of studies has led to difficulties in identification, resulting in species misidentification and taxonomic ambiguities. The main objective of this research is to conduct a morphological characterization of *Elatostema* species both between and within Sri Lanka. It aims to update taxonomic knowledge and improve species identification. Based on literature, herbarium data, and expert guidance, field surveys were conducted across four districts. Specimens and reproductive structures were collected from their natural habitats and preserved for taxonomic study and herbarium deposition. Herbarium specimens at the National Herbarium, Peradeniya, were also examined for morphological variation. Freehand sections and dry leaf surfaces were studied to analyze cystoliths. Micrometric measurements of cystoliths were taken using a stereo microscope and an upright microscope. Morphological characterization was conducted using 42 vegetative morphological characters, including cystolith features, from 52 specimens. Species clustering and character variation were statistically validated using R software, conducting Principal Coordinate Analysis, Neighbor-joining tree, and Factor Analysis of Mixed Data. Nine *Elatostema* species were identified: six known, five varieties, and three potentially new. A species-level field identification key was developed based on easily observable vegetative characters. The results of the statistical analysis distinguished species clusters, validating morphological differentiations. This study updated knowledge of the current diversity of *Elatostema* species in Sri Lanka by confirming that species diversity is higher than reported in existing references. The new field identification key will support future research and accurate species identification. The findings show the need for continued taxonomic research and ecological conservation studies.

Keywords: Cystolith, Field identification key, Herbarium specimen, Morphology, *Pellionia heyneana*

LS 14 ***Life Sciences***

CYTOGENOTOXIC EFFECTS OF SACCHARIN AT REGULATORY AND ELEVATED CONCENTRATIONS: FINDINGS FROM *Allium cepa* BIOASSAYS

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Saccharin (SAC), a synthetic non-nutritive sweetener present in beverages, processed foods, pharmaceuticals, and personal care products, contributes to persistent human exposure. Despite regulatory acceptance, concerns over cumulative toxicity remain inadequately addressed. This study aimed to evaluate the cytogenotoxic effects of SAC using the *Allium cepa* bioassay, a validated eukaryotic genotoxicity model. Healthy onion bulbs were exposed to different SAC concentrations (0.05–1.0 g L^{-1}), representing both permissible levels in beverages and elevated exposure scenarios, for 48 h, and multiple cytogenotoxic endpoints were assessed microscopically. Aerated water and $K_2Cr_2O_7$ (10 µM) served as negative and positive controls, respectively. SAC significantly reduced the mitotic index (MI) across all treatment groups, including at the lowest tested concentration of 0.05 g L^{-1} ($p< 0.05$), indicating reduced cellular proliferation. Phase index analysis revealed disrupted mitotic progression, marked by elevated telophase and reduced anaphase frequencies. Total nuclear abnormalities (NAs) were significantly increased in all SAC-treated groups (≥ 0.05 g L^{-1}) relative to the negative control ($p< 0.05$). Among them, condensed and abnormal-shaped nuclei were the dominant forms, suggesting cellular stress. Notably, the recommended dosage (0.08 g L^{-1}) resulted in a total NAs frequency of 629.70 ‰, demonstrating a substantial biological impact. Total chromosomal aberrations (CAs) were significantly increased, with polar slips, vagrant chromosomes, and breaks as dominant forms. The lowest concentration tested (0.05 g L^{-1}) showed a 141.30% increase in total CAs, approximately threefold higher than the negative control, suggesting chromosomal damage. The detection of significant cytogenotoxic effects at or near regulatory concentrations raises concerns regarding chronic cumulative SAC exposure, particularly in contexts where locally available products may exceed recommended safety thresholds. These findings strongly warrant reassessment of current SAC safety standards, enhanced regulatory monitoring of commercial products, and comprehensive long-term toxicological investigations of chronic SAC exposure.

Keywords: *Allium cepa*, Cytogenotoxicity, Mitotic index, Nuclear abnormalities, Saccharin

LS 15 ***Life Sciences***

AGE AND EXPERIENCE-DEPENDENT KNOWLEDGE-PRACTICE DYNAMICS AND THEIR INFLUENCE ON WATERMELON YIELD IN SRI LANKA

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Watermelon is a popular fruit valued for its sweet, water-rich flesh. As a monoecious plant, insect-mediated pollen transfer from male to female flowers is essential for fruit production. Despite the importance of pollination, watermelon farmers in Sri Lanka show varying levels of understanding and adopt diverse pollination-related practices, often without evidence-based knowledge. This study evaluated relationships among farmers' knowledge of pollination modes, pollinators, and visiting patterns, farming practices, and yield (kg/acre). A structured questionnaire survey was conducted among 70 watermelon farmers across all agroecological zones (Dry: 47, Intermediate: 17, Wet: 6) using purposive and snowball sampling from August 2025 to February 2026. Data were analyzed using R-4.4.1. All respondents were male; most had good knowledge (75.71%), followed by moderate (18.57%), poor (4.29%), and very poor (1.43%). However, science-based practices, including pest management and watering, were predominantly very poor (51.43%). The GLM showed a significant positive association between knowledge and science-based practices ($p = 0.004$), varying across age groups. The association was positive among younger farmers (20–29 and 30–39 years), but weaker among those aged 40–49 years ($\beta = -0.045$, $p = 0.020$) and >49 years ($\beta = -0.060$, $p = 0.0051$). Estimated yield ranged from 833.3 to 1,150,000 kg/acre, with a mean ± SD of 15,128 ± 15,617 kg/acre and a median of 12,500 kg/acre, indicating a right-skewed distribution. Yield was not significantly affected by knowledge ($p = 0.603$) or practice ($p = 0.143$), while years of farming experience (YFE) showed a marginal positive relationship with yield. Overall, despite high knowledge, adoption of appropriate practices remains low, highlighting an age-dependent knowledge-practice gap among Sri Lankan watermelon farmers. Yield was not directly influenced by knowledge, practice, or YFE, suggesting the presence of other yield-determining factors. Age-specific agricultural extension strategies and further research are needed to identify these factors and develop appropriate recommendations.

Financial assistance from PGIS Research Grant (*Grant No: PGIS/2024/01*) *is acknowledged.*

Keywords: Experience, Farming practices, Knowledge, Watermelon pollination

LS 16 ***Life Sciences***

BIO-ORGANO-MINERAL FERTILIZER APPLICATION STABILIZES CARBON BY ACTIVATING MICROBIAL CARBON PUMP THROUGH FUNGAL-DOMINATED COMMUNITIES IN RICE (O*ryza sativa* L.) SOILS

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Carbon (C) stabilization and mineralization are vital for soil fertility and climate resilience in rice farming. This study evaluates the effects of biofilm biofertilizer (BFBF)-based bio-organo-mineral fertilizer (BOMF) practices on microbial abundance and C dynamics in paddy soils compared with the application of chemical fertilizer (CF) alone. The field trials were conducted in Ampara, Anuradhapura, Polonnaruwa, and Puttalam during the 2023/2024 wet season. Three treatments, (a) BOMF practice (500 kg NPK BOMF/ha + 2.5 L BFBF/ha), (b) hybrid practice (225 kg PK BOMF/ha + 62.5 kg CF N/ha + 2.5 L BFBF/ha), (c) CF practice (340 kg CF NPK/ha), and (d) control (no fertilizer), were applied in triplicate within 100 m^2 plots in a randomized block design at each site. Root-zone (0–0.15 m) soil and subsoil (0.15–0.30 m) samples were analyzed for fungi (SF) and total bacteria (STB) by enumerating in potato dextrose and nutrient agar, respectively. A leaching column experiment quantified the C mineralization rate (k) and pool size (C_o). SF and STB were significantly higher ($p < 0.05$) in the root zone of the hybrid practice than in the other practices. SF: STB ratios in both the root zone and subsoils were significantly higher in the hybrid practice, ca. 312% and 1610% greater than those observed in the CF practice, respectively. The hybrid practice had a larger mineralizable C pool (C_o = 25.07 mg kg^{-1}) and a faster mineralization rate (k = 0.174 day^{-1}) in the subsoils, nearly four times that of the CF practice (k = 0.043 day^{-1}). In conclusion, the hybrid practice may rapidly channel organic matter into long-term C pools via a fungal-dominated community. Organic matter inputs of the BOMF likely contributed to the observed response, whereas previous studies reported a low priming effect following BFBF application with reduced CF use, but without organic matter inputs.

Keywords: Biofilm biofertilizer, Climate-smart agriculture, Carbon mineralization

LS 17 ***Life Sciences***

TAXONOMIC AND FUNCTIONAL COMPOSITION OF A COASTAL PLAIN BIRD COMMUNITY IN MANNAR, SRI LANKA

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The South Bar coastline in Mannar, Sri Lanka, is a lowland area with heterogeneous habitats for birds, including forest patches, semi-arid bare land, and tidal water bodies. This study aimed to investigate the bird species assemblage and functional composition of the landscape amid recent, intense industrialization in the region. Point counts were conducted at 14 stations across all habitats during 34 field visits conducted during the peak migratory period, from December 2025 to March 2026. All statistical analyses were performed using the programming language R. Sampling adequacy was confirmed via a sample-based species accumulation curve, which reached an asymptote. A community of 96 bird species was discovered, with a mean Shannon-Wiener Diversity (*H'*) of 2.14. Individual-based sample coverage (C_n) was 99.7%. Chao1 abundance-based and Chao2 incidence-based richness estimates were 101.6 and 108.6 species, respectively, resulting in 88.4% inventory saturation, indicating a minor pool of dynamic, transient species. Among the recorded species, 32 waterbird species (of which 14 were waders), six seabird species, seven raptor species, and four nocturnal species were present. Of these, 24 species were total migrants, and 10 had both resident and migratory populations. Notable and nationally threatened species included critically endangered Common Tern (*Sterna Hirundo*, Mean Relative Abundance (MRA) = 1.19%) and Caspian Tern (*Hydroprogne caspia*, MRA = 2.02%); endangered Grey Francolin (*Ortygornis pondicerianus*, MRA = 0.36%), Little Ringed Plover (*Thinornis dubius*, MRA = 0.01%), and Kentish Plover (*Anarhynchus alexandrines*, MRA = 0.76%); vulnerable Oriental Honey-buzzard (*Pernis ptilorhynchus*, MRA = 0.05%); and rare winter migrant Booted Eagle (*Hieraaetus pennatus*, MRA = 0.02%). Functional composition analysis revealed 13 feeding guilds, including piscivores (19.1%), insectivores (19.4%), granivores (4.3%), frugivores (2.7%), and nectarivores (0.6%), signaling rather complex and healthy ecosystems. Chi-square testing indicated a significantly asymmetric baseline functional composition ($\chi^2 = 8655.5$, $p < 0.01$), with a bias towards aquatic invertebrate and fish prey (59.2%), suggesting that the landscape might contain important foraging habitats for aquatic predatory bird species. The study provides a baseline ecological snapshot of the landscape to inform recommended prospective monitoring programs, to ensure biodiversity-friendly development in the future.

Keywords: Diversity, Endangered, Feeding guilds, Mannar, Migratory

LS 18 ***Life Sciences***

INVESTIGATION OF HEPATITIS B VIRAL LOADS IN A SAMPLE POPULATION OF PATIENTS USING REAL-TIME QUANTITATIVE PCR TECHNOLOGY

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Hepatitis B Virus (HBV) DNA levels guide management of chronic HBV infection, including phase distinction, treatment initiation, and efficacy assessment. Guidelines recommend antiviral therapy when baseline HBV DNA is >20,000 IU/mL (HBeAg-positive) or >2,000 IU mL^{-1} (HBeAg-negative). Therapy aims to achieve undetectable levels (<20 IU mL^{-1}) to reduce the risk of cirrhosis and Hepatocellular Carcinoma (HCC). Initial viral load predicts treatment outcomes. This study aimed to measure HBV load using real-time qPCR in 10 patient samples with different disease profiles. This retrospective study (January–August 2025, University of Kelaniya) analyzed 10 anonymous HBV samples (remaining after testing): 4 pre-treatments, 4 after 3–6 months of therapy, and 2 after 12 months. Viral DNA was extracted, and TaqMan probe-based qPCR was performed. A standard curve from four HBV reference standards and cycle threshold values were used to calculate the viral load. Viral loads reflected viremia status and prognosis. One female patient was negative after 12 months (viral clearance). Four pre-treatment patients showed high replication (10^4–10^6 IU mL^{-1}) and required treatment. Patients on therapy (3, 6, 12 months) had significant reductions (10^1–10^3 IU mL^{-1}), confirming efficacy. Standard and amplification curves confirmed assay reliability and specificity.

Keywords: Clinical diagnostics, Hepatitis B virus (HBV), PCR (q-PCR), Real-time quantitative, Viral load quantification

LS 19 ***Life Sciences***

EFFECT OF THE TEMPERATURE ON BODY SIZE AND SURVIVAL OF *Aedes albopictus*

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Dengue remains a major public health concern in Sri Lanka, where *Aedes albopictus* has become the most abundant dengue vector in many parts of the country. Environmental factors, particularly temperature, strongly influence mosquito development, survival, and adult morphology, highlighting the importance of understanding temperature-driven vector dynamics. This study investigated the effects of temperature on larval development, survival, and adult body size (wing length was considered as a proxy for body size) of Sri Lankan *A. albopictus*. Eggs were collected using standard ovitraps and hatched under laboratory conditions. First-instar larvae (10 larvae/replicate, 3 replicates/treatment) were introduced into glass containers at three constant temperatures (23, 27, and 31) using laboratory ovens. Development time and survival rates were recorded. Adult wing length was measured using a stereomicroscope (ZEISS Stemi 508). Data normality was confirmed by the Anderson–Darling test (p=0.216), and differences were analyzed using one-way ANOVA followed by Tukey's HSD post-hoc test. Temperature had a significant effect on wing length (p=0.018), with adults reared at 23 showing the largest mean wing length (3.07± 0.25 mm), followed by 27 (2.83 ± 0.17 mm) and 31 (2.77 ±0.26 mm). The post hoc test revealed a significant difference between the 23 and 31 (p=0.019). Differences between 23 ^{o}C and 27 ^{o}C (p=0.079) and between 27 ^{o}C and 31^{o}C (p=0.798) were not significant. Development time decreased with increasing temperature (11, 9, and 8 days at 23 ^{o}C, 27 ^{o}C, and 31 ^{o}C, respectively). Survival was highest at 27 ^{o}C (29/30, 96.66%), followed by 23 (26/30, 86.66%) and 31 ^{o}C (22/30, 73.33%). The results indicated that lower temperatures favor larger adult body size, moderate temperatures optimize survival, and higher temperatures accelerate development at the cost of reduced body size. These findings are important for dengue control strategies under changing environmental conditions.

Financial assistance from the University research grant (*Grant No. URG/2023/31/S*) *is acknowledged.*

Keywords: *Aedes albopictus,* Dengue vector, Temperature, Vector control

LS 20 ***Life Sciences***

COMPARATIVE EXTRACTION YIELD, PHYSICOCHEMICAL EVALUATION, AND OMEGA-3 ENRICHMENT OF FISH OIL FROM DIFFERENT ANATOMICAL PARTS OF *Rastrelliger kanagurta*

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Due to the increasing global demand for omega-3 polyunsaturated fatty acids (PUFAs), using marine by-products offers a sustainable and cost-effective strategy for reducing waste. To evaluate a widely accessible, local omega-3 source, this study aimed to compare lipid yields from different anatomical parts of Indian mackerel (*Rastrelliger kanagurta*), benchmark the physicochemical quality of the combined crude oil against a commercial standard, perform qualitative chemical screening, and refine the extracted oil to enrich it in PUFAs. Oil was Soxhlet-extracted separately from the head, skin, flesh, and viscera with hexane at 60 °C, and the combined oil was physicochemically evaluated by standard titrimetric methods and qualitative chemical screening. Then, the crude oil was fractionated via liquid-liquid extraction and urea complexation. Oil yields varied significantly among anatomical parts ($p < 0.05$), with skin yielding the highest oil percentage (31.71%), followed by head (23.16%), viscera (10.27%), and flesh (4.19%). The oxidative stability was determined as the peroxide value (11.17 ± 0.32 meq kg^{-1}), which was well within the acceptable range. The saponification values of fish oil and commercial oil were 195.70 ± 0.60 mg KOH g^{-1} and 181.20 ± 0.55 mg KOH g^{-1}, respectively. Furthermore, the extracted oil showed lower free fatty acid content and acid value than the commercial oil (2.37% and 5.03% for free fatty acid content; 2.63 and 5.32% for acid value, respectively), indicating excellent hydrolytic stability. Qualitative chemical analysis confirmed the presence of steroidal compounds. Crucially, polar impurities were removed by liquid-liquid extraction, resulting in 63.50% oil recovery. The oil was subjected to urea complexation by crystallizing saturated and monounsaturated fatty acids, which resulted in 16.80% therapeutic omega-3. In conclusion, fish oil extraction of *R. kanagurta* byproducts yields a lipid extract comparable with commercial oils in oxidative stability and provides better hydrolytic resistance. Selective urea complexation further concentrates omega-3 content, highlighting Indian mackerel waste as a promising sustainable source for therapeutic lipids.

Keywords: By-product utilization, Fish oil extraction, Omega-3, *Rastrelliger kanagurta*, Urea complexation

LS 21 ***Life Sciences***

TAXONOMIC ASSESSMENT OF THE GENUS *Hyllus* C. L. KOCH, 1846 (ARANEAE: SALTICIDAE) IN SRI LANKA

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The family Salticidae currently comprises approximately 6,960 described species in 695 genera worldwide. Among them, the genus *Hyllus* is widely distributed throughout tropical and subtropical regions of Africa and Asia. *Hyllus semicupreus* has previously been recorded from Sri Lanka. However, information on the diversity and distribution of *Hyllus* species within the country remains scattered and poorly documented. The present study represents a faunistic and taxonomic assessment of the genus *Hyllus* in Sri Lanka, focusing on species identification and documentation of their geographical occurrence records. The specimens available in the NIFS collection covered all major climatic zones in Sri Lanka. These Specimens had been collected by beating, hand collection, and by litter sieving. Collected specimens were preserved in 70% ethanol, identified, and photographed using Olympus SZX7 and Leica M205C microscopes, respectively. A total of 30 specimens deposited in the collection were examined and identified as *Hyllus pudicus*, *Hyllus semicupreus*, and *Hyllus* cf. *pudicus*. *Hyllus* sp. was recorded from Sri Lanka in the previous study. In addition, two more specimens were identified and provisionally named *Hyllus* cf. *pudicus* due to the close morphological similarity of their male palps to those of *Hyllus pudicus.* Among the identified specimens, *Hyllus pudicus* showed a wider distribution across several provinces of Sri Lanka, including Central, North Central, North Western, Northern, Southern, Western, and Uva, whereas *Hyllus semicupreus* was recorded from comparatively fewer localities in the Northern, North Central, North Western, and Southern provinces. *Hyllus* cf. *pudicus* showed a restricted distribution and was recorded only from Northern and North Central provinces. These findings provide baseline information for future taxonomic revisions, biodiversity assessments, and conservation-related studies on Sri Lankan jumping spiders.

Keywords: *Hyllus*, Jumping spiders, Salticidae, Sri Lanka, Taxonomy

LS 22 ***Life Sciences***

PSEUDO-HYPHAL DEVELOPMENT IN *Saccharomyces boulardii* FOR ENHANCED BIOFILM FORMATION: A NOVEL PLATFORM FOR FUTURE BIOTECHNOLOGICAL APPLICATIONS

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The use of *in vitro*-developed probiotic microbial biofilms, especially fungal-bacterial biofilms and their exuded biochemicals, as next-generation medicines or nutraceuticals to modulate the gut microbiota and improve health has recently been introduced. As a promising candidate for these fungal-bacterial biofilm developments, *Saccharomyces boulardii (S. boulardii)* stands at the forefront due to its health benefits, stability, and dimorphism in the human gut environment. The present study aimed to evaluate the dimorphic switching of *S. boulardii* from single cells to elongated pseudo-hyphal or filament-like morphology *in vitro* under nutrient-limited and stress conditions, and to assess its adaptive stress response in biofilm formation during this morphological transition. Synthetic medium containing carbon and nitrogen sources, along with yeast extract, was used as the culture medium. NaCl was added to trigger osmotic stress responses and promote adaptive biofilm formation. Broth cultures were incubated for 5 days at 37 °C under oxygen-available static conditions and subsequently observed under an inverted light microscope at 400× magnification after staining with lactophenol cotton blue. The results revealed pseudo-hyphal development, with single yeast cells also observed attached to the pseudo-hyphae, together forming an initial biofilm pellicle that may comprise numerous bioactive compounds within an extracellular polymeric substance (EPS) matrix. These findings suggest that the resulting structure could serve as a platform for fungal-bacterial polymicrobial biofilm formation, whereby introducing selected probiotic strains to attach to the elongated cells could enable diverse applications in developing future biofilm medicines or nutraceuticals.

Keywords: Biofilms, Nutraceuticals, Postbiotics, Probiotics, Pseudo-hyphae

LS 23 ***Life Sciences***

COMPARATIVE ANTIOXIDANT AND α-AMYLASE INHIBITORY ACTIVITIES OF *Bunchosia glandulifera* AND *Asparagus racemosus*: NATURAL ENZYME INHIBITORS FOR DIABETES MANAGEMENT

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Medicinal plants have long been important in traditional healing, and many of them are now being studied for their health benefits. This study was conducted to determine the selected bioactivities of leaf extracts from *Bunchosia glandulifera* and *Asparagus racemosus* that may help combat oxidative stress and support diabetes management. The dried and ground samples were extracted with methanol using sonication. The methanolic extracts obtained from the plants were screened for antioxidant activity against DPPH (*2,2'-diphenyl-1-picrylhdrazyl*) and ferric reducing antioxidant power (FRAP) assays, enzyme inhibitory assays against α-amylase enzyme, cytotoxicity against brine shrimps, and phytotoxicity against lettuce seed germination. *B. glandulifera* displayed moderate antioxidant potential in the DPPH assay (IC_{50} 127.20 ± 4.85 mg L^{-1}), although it remained less potent than the ascorbic acid standard (IC_{50} 5.05 ± 0.09 mg L^{-1}). However, *A. racemosus* showed substantially weaker activity (909.33 ± 7.16 mg L^{-1}). In the FRAP assay, *B. glandulifera* showed considerably reduced ability (4.29 ± 0.06 µmol dm^{-3} $FeSO_4$ g^{-1}), exceeding the Trolox reference (1.26 ± 0.01µmol dm^{-3} $FeSO_4$ g^{-1}), while *A. racemosus* measured 1.33 ± 0.03 µmol dm^{-3} $FeSO_4$ g^{-1}. At 1000 mg L^{-1}, the methanolic extract of *B. glandulifera* inhibited αamylase by 79.49 ± 1.06%, compared with the positive control, acarbose (66.21 ± 3.34%). *A. racemosus* produced 42.15 ± 2.56% inhibition under the same conditions. *B. glandulifera* extract exhibited markedly stronger αamylase inhibitory activity than acarbose, indicating it is the most potent inhibitor between the two. Neither extract caused significant inhibition of lettuce seed germination nor exhibited notable lethality against brine shrimp in these preliminary assays. *B. glandulifera* and *A. racemosus* both demonstrated notable bioactivity, indicating their potential as sources of antioxidant compounds and αamylase inhibitors that warrant further phytochemical characterization and *in vivo* investigation to explore therapeutic applications.

Keywords: α-amylase, antioxidant, bioactivities, cytotoxicity, phytotoxicity

LS 24 ***Life Sciences***

CHEMICAL INVESTIGATION AND ANTIOXIDANT ENZYME INHIBITORY ACTIVITIES OF ENDOPHYTIC FUNGUS *Nigrospora hainanensis* ISOLATED FROM *Chrysophyllum cainito* LEAVES

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Endophytic fungi produce a wide variety of active natural compounds with great pharmaceutical potential. Endophytes and host plants are involved in a symbiotic relationship that is responsible for the production of natural compounds. Among these, *Nigrospora hainanensis* has emerged as a promising yet unexplored species capable of producing structurally unique bioactive metabolites. The antioxidant and enzyme inhibitory activities of crude extract and chemical investigation of *N. hainanensis* isolated from the leaves of *Chrysophyllum cainito* are evaluated in this study. The fungus was identified through morphological and molecular characterization (ITS rDNA sequencing, Genbank accession OQ473493.1), cultured on potato dextrose broth, and extracted with ethyl acetate. The crude extract was evaluated for antioxidant activity using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP), and for α-glucosidase inhibitory properties using standardized *in vitro* bioassays with appropriate positive controls. The crude extract exhibited low antioxidant activity in both assays, with the IC_{50} value of 224.53±7.10 mg L^{-1} for the DPPH assay compared with the ascorbic acid as a positive control, IC_{50} = 3.47±0.45 mg L^{-1}, and for the FRAP assay, demonstrated reducing activity of 3034.52±14.55 µmol $FeSO_4$ g^{-1}, whereas the positive control, Trolox, exhibited a substantially higher reducing capacity of 15329.53±27.32 µmol $FeSO_4$ g^{-1}. The inhibitory percentage of the α-glucosidase enzyme was 86.70±1.92% at 1000 mg L^{-1}, comparable to that of the positive control, acarbose, 88.97±0.22% at the same concentration. The findings suggest that *N. hainanensis* has a strong potential as an α-glucosidase inhibitor. Chemical investigation of the ethyl acetate extract of *N. hainanensis* led to the isolation of three known compounds, identified as 1,8-dihydroxy-3-methylanthracene-9,10-dione, Ergosta-4,6,8(14),22-tetraen-3-one, and 3,4-Dihydro-8-methoxy-3,5-dimethyl-1H-2-benzopyran-6-ol, structurally confirmed by 1H, 13C, and 2D NMR spectroscopy. Further studies are required to determine the individual bioactivities and mechanism of action of the isolated compounds.

Keywords: Antioxidants, Enzyme inhibitory, *Nigrospora hainanensis*, α-glucosidase

LS 25 ***Life Sciences***

ASPECTS OF PLANT UTILISATION AND BROWSING BEHAVIOUR OF ASIAN ELEPHANTS (*Elephas maximus*) IN MINNERIYA AND KAUDULLA NATIONAL PARKS, SRI LANKA

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The seasonal aggregation of Asian elephants (*Elephas maximus*) in Minneriya National Park and Kaudulla National Park is an ecologically significant phenomenon and an important wildlife tourism attraction in Sri Lanka. Food availability is considered a major factor influencing elephant distribution and seasonal movements within these protected areas. However, information on browse utilization and feeding characteristics of Asian elephants in these parks remains limited. Therefore, this study investigated plant utilization and browsing behaviour of Asian elephants in Minneriya and Kaudulla National Parks. The study was carried out from January 2025 to January 2026 by assessing feeding-related damage to trees along designated trails. The same trails were surveyed four times per month, and only newly observed feeding damage was recorded to avoid double-counting. Vegetation within 5 m of each trail on both sides was systematically surveyed during each visit. Tree species showing evidence of elephant browsing were identified and recorded, while diameter at breast height (DBH) was measured. A total of 16 plant species from 10 plant families were identified as browse species used by elephants. *Bauhinia racemosa* showed the highest proportion of recorded browse observations (22.22%). At the family level, Sapindaceae and Combretaceae each accounted for 16.67% of recorded browse observations. Among the feeding/damage modes, broken shoots accounted for the highest proportion (92.59%), followed by bark stripping (5.56%) and uprooting (1.85%). Young shoots were observed more frequently as feeding targets than bark. The DBH of browsed plants ranged from 10 cm to 200 cm, with trees in the 20–40 cm DBH class accounting for the highest proportion of browsing observations (31.48%). The findings provide baseline information on plant utilization and browsing behaviour of Asian elephants and may support evidence-based habitat management and conservation planning in Minneriya and Kaudulla National Parks.

Keywords: Asian elephant, Browsing behaviour, Feeding ecology, Plant utilization

LS 26 ***Life Sciences***

IDENTIFICATION OF *Candida* SPECIES ISOLATED FROM DENTAL CARIES BIOFILM USING PCR RFLP: A PILOT STUDY

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Dental caries is a biofilm-mediated disease of global burden. Both *Candida* and *Streptococcus mutans* are isolated from dental caries biofilm. Conventional PCR reliably identifies *Candida albicans* and other Candida species (Non-albicans Candida). Species identification remains technically demanding and costly. This pilot study aimed to optimize the protocol using the polymerase chain reaction plus single restriction enzyme-based restriction fragment length polymorphism (PCR-RFLP) protocol for rapid, cost-effective NAC species identification of *Candida* isolated from dental caries biofilm. Twelve NAC isolates recovered from dental caries from an ethics committee-approved study. Biofilm specimens underwent PCR amplification using SCI primers to identify *Candida albicans*, which was found to be non-albicans *Candida*. This study used non-albicans *Candida*. PCR-RFLP was performed using the HaeIII restriction endonuclease only due to availability, and resultant banding patterns were visualized by high-definition agarose gel electrophoresis. DNA sequencing of the ITS1-5.8S-ITS2 region (150-bp amplicon) from all PCR products was conducted to confirm species identity against reference databases. DNA extracted from *C. albicans*, *C. tropicalis, C. parapsilosis, and C. krusei* was used as controls. *C. albicans* (*C. stellatoidea variant)* was predominant (75%; 9/12), followed by *C. orthopsilosis*, *C. krusei*, and *Kodamaea ohmeri* (8.3% each 1/12). HaeIII generated distinct, reproducible banding profiles for *C. albicans* (440–515 bp with enzyme; 515–602 bp without enzyme), *C. krusei* (101 and 450 bp; 398 bp without enzyme), and *C. orthopsilosis* (101 and 458 bp; 516 bp without enzyme). *Kodamaea ohmeri* isolate, and one *Candida isolate (C. stellatoidea)* isolate produced no interpretable restriction patterns. PCR-RFLP using HaeIII offers a rapid and accessible method for identifying key NAC species from dental caries biofilm. However, its failure to resolve *Kodamaea ohmeri* highlights the need for complementary restriction enzymes before broader clinical implementation. This is the first report of *K. ohmeri* from dental caries in Sri Lanka.

Acknowledgments: Supported by the University Research Council (URC), University of Peradeniya (URG/2024/09/D)

Keywords: Dental caries, Non-albicans *Candida,* PCR-RFLP, HaeIII, *Kodamaea ohmeri*

LS 27 ***Life Sciences***

IMPACT OF DRYING METHODS ON THE MICROBIAL SAFETY AND FUNCTIONAL QUALITY OF HAND-MADE CEYLON TEA

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Handmade Ceylon tea production is expanding among smallholders in Sri Lanka, yet the effects of artisanal drying methods on both microbial safety and functional quality have not been systematically compared across different tea varieties. This study investigated the impact of sun drying (30–45 °C, 2–4 days), air drying (25–30 °C, 3–7 days), air frying (70–90 °C, 20–40 min), and oven drying (70–90 °C, 20–40 min) on total aerobic mesophilic bacteria (TAMB), yeast and mould counts, total phenolic content (TPC), total flavonoid content (TFC), and DPPH radical scavenging activity (IC_{50}) of five handmade Ceylon tea varieties: Golden Tips (GT), Silver Tips (ST), Purple Tea (PT), Handmade Black Tea (HBT), and Green Tea (GR). Fresh leaves served as controls. Five types of handmade teas (n=3 per type) collected from selected factories, transported to the laboratory in sterile bags, and subjected to the drying treatments. Microbial enumeration followed ISO standards (ISO 4833 for aerobic microbes, ISO 21527 for yeasts/molds); phytochemical analyses used Folin-Ciocalteu, aluminum chloride colorimetric, and DPPH assay. Two-way ANOVA at 99% Confidence level revealed highly significant main and interaction effects for all parameters ($p< 0.001$). Oven drying reduced TAMB by 2–4 logarithmic cycles (to 1.3×10^3–1.4×10^5 CFU g^{-1}) and achieved near-complete elimination of yeasts and molds in GR and HBT. In contrast, sun- and air-dried samples consistently exceeded 3.0×10^7 CFU g^{-1}, indicating substantially higher fungal contamination. According to morphological characterization, sundried samples harbored presumptive toxigenic *Aspergillus niger* and *A. fumigatus*. Oven drying produced the highest TPC across four varieties (up to 3.7-fold increase in GT) and the lowest IC_{50} values (e.g., 1.31 µg mL^{-1} for GT), but reduced TFC in most varieties. Oven drying is the only method among those tested that simultaneously ensures microbial safety (lowest microbial loads) and superior functional quality for handmade Ceylon tea. Sun and air-drying result in high microbial loads and are therefore not recommended. Air frying requires further optimization. These findings provide an evidence-based framework for upgrading artisanal tea production in Sri Lanka.

Keywords: Antioxidant activity, Drying methods, Handmade Ceylon tea, IC_{50}, Microbial safety, Total phenolic content

LS 28 ***Life Sciences***

COMPARATIVE EVALUATION OF *IN VITRO* ACIDOGENICITY, SUGAR UTILIZATION, ACIDURICITY, AND BIOFILM FORMATION OF DIFFERENT *Candida* SPECIES WITH *Streptococcus mutans*

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Streptococcus mutans is a key cariogenic pathogen, while *Candida* species may contribute to caries through synergistic interactions with *S. mutans*. However, comparative studies of virulence between non-albicans *Candida* (NAC) and NAC–*S. mutans* combinations remain limited. Acidogenicity, sugar utilization, aciduricity, and biofilm formation were evaluated in five ATCC *Candida* species (*C. albicans, C. tropicalis, C. krusei, C. parapsilosis,* and *C. glabrata*) and *S. mutans*. Standardized suspensions of *Candida* species and *S. mutans* at 0.5 and 0.375 McFarland, respectively, were tested. Acidogenicity was assessed using 24-hour pH monitoring in Trypticase Soy Broth supplemented with six sugars. Sugar utilization was determined from concentration changes over time. Aciduricity was evaluated in artificial saliva at pH 3.0, 5.5, and 7.0 by optical density measurements at 1, 2, and 4 hours. Biofilm formation was quantified using the crystal violet assay. Repeated-measures ANOVA was applied. *Candida* spp. produced mild acidity (pH 4.7–5.93), with minimal effects from xylitol and sorbitol ($p = 0.496$). *S. mutans* showed significantly greater acidogenicity (pH 4.6–4.8; $p < 0.001$). Mixed biofilms were more acidogenic, with *C. krusei* and *C. albicans* + *S. mutans* reaching pH 3.62–3.72, significantly lower than mono-species biofilms ($p < 0.001$). They also showed greater sugar utilization and acid tolerance at pH 5.5–7.0 ($p = 0.039$). Glucose and lactose produced the highest *Candida* biofilm biomass, while *S. mutans* showed the strongest formation with glucose. All dual-species *Candida–S. mutans* biofilms exhibited significantly higher optical density than single-species biofilms across sugar substrates, particularly *C. albicans–S. mutans* and *C. krusei–S. mutans*. Mixed *Candida–S. mutans* biofilms demonstrated greater acidogenicity, aciduricity, sugar utilization, and biofilm formation, supporting *Candida* as a cariogenic co-pathogen. These findings suggest that inter-kingdom interactions may increase caries risk and highlight the need for prevention strategies targeting multispecies biofilms.

Acknowledgment- Supported by the University Research Council (URC), University of Peradeniya (URG/2024/09/D).

Keywords: *Candida*, *Streptococcus mutans*, biofilm, dental caries, acidogenicity, polymicrobial interactions

LS 29 ***Life Sciences***

DORMANCY AND GERMINATION OF SEVEN SELECTED IMPORTANT MEDICINAL PLANT SPECIES IN SRI LANKA

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Seed dormancy and germination information are crucial for successful conservation and initiating medicinal plant cultivation. This study sought to determine germination protocols for seven medicinal plant species. *Thottea siliquosa*, *Sida acuta and Sida spinosa*, *Scoparia dulcis*, *Breynia vitis-idaea*, *Rauvolfia tetraphylla*, and *Ophiorrhiza mungos* were selected for this study. Standard germination tests were conducted under ambient laboratory conditions (25 °C). Imbibition test and embryo morphology assessment were conducted to determine seed dormancy. Four replicates of 25 seeds were used in germination and imbibition experiments. The effect of dormancy-breaking treatments, GA_3, and manual scarification on seed germination was studied. Data were analyzed with a generalized linear model and a pooled t-test. Among the seven species, untreated *Ophiorrhiza mungos* seeds showed the highest germination percentage (83.5%), whereas none of the *Rauvolfia tetraphylla* seeds germinated within 30 days. Among the species, *Breynia vitis-idaea* and *Scoparia dulcis* were the only species with <50% germination. Except for *S. acuta* and *S. spinosa,* other species showed signs of imbibition. The mass increment of the manually scarified *S. spinosa* seeds was significantly higher than that of the intact seeds ($p < 0.001$). The presence of physical dormancy in seeds of *S. acuta* and *S. spinosa* was suggested, and manual scarification was identified as a dormancy-breaking treatment. The presence of a water-permeable seed coat, a fully developed spatulate embryo, and significantly increased germination following treatment confirmed physiological dormancy in *R. tetraphylla*. The underdeveloped embryo and the requirement for embryo growth prior to germination suggest that *T. siliquosa* seeds possess morphophysiological dormancy. Non-treated seeds of *S. dulcis*, *B. vitis-idaea*, and *O. mungos* showed >50% germination within 30 days, confirming the absence of seed dormancy. This study generated preliminary information to inform the development of optimized germination protocols to support the conservation and cultivation of the selected medicinal plants.

National Research Council of Sri Lanka (*Grant No. NRC-IDG 24-107) is acknowledged.*

Keywords: Imbibition, Manual scarification, Medicinal plants, Physical dormancy, Seed shape

LS 30 ***Life Sciences***

STRUCTURED STORYTELLING AS AN INTERVENTION FOR EXPRESSIVE LANGUAGE DELAY: A SINGLE CASE STUDY

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Expressive language delay is a common communication disorder in early childhood that can affect language development, social interaction, and academic readiness. This single-case study examined the effectiveness of structured storytelling in improving expressive language skills in a child with expressive language delay. Storytelling provides a naturalistic, engaging, and low-cost therapeutic approach that can be incorporated into speech and language therapy. The participant was a 4-year-3-month-old boy with expressive language delay and no reported medical, neurological, hearing, or developmental concerns. Baseline assessment revealed a Mean Length of Utterance (MLU) of 2.80 morphemes, based on 50 utterances containing 140 morphemes (140 ÷ 50 = 2.80), corresponding to Brown's Stage III. Although he demonstrated approximately 1,000 meaningful words, he had difficulties using past and irregular past tense forms, producing complex sentences, and retelling stories, even with visual cues. The intervention used structured storytelling over 16 weeks as part of routine speech and language therapy, delivered once weekly for approximately 30–45 minutes. Three stories were used: *The Hat Seller*, *The Crow and the Water Pot*, and *The Race of the Rabbit and the Tortoise*. Sessions incorporated colored picture sequences, interactive storytelling, active listening, question-answer discussions, vocabulary teaching, grammatical modelling, and story retelling with and without visual support. After eight weeks, MLU increased to 3.07 morphemes (Brown's Stage IV), with improvements in sentence construction, tense usage, and story retelling with visual cues. At 16 weeks, MLU increased to 4.04 morphemes (Brown's Stage V), accompanied by improved grammatical accuracy, sentence complexity, narrative organization, and the ability to retell familiar stories with minimal assistance and without visual cues. This single-case report suggests that structured storytelling may have contributed to improvements in expressive language, grammatical skills, and narrative abilities, highlighting its potential as a practical, child-friendly therapeutic approach. However, the findings cannot be generalized to children with expressive language delay more broadly. Further research using larger samples and controlled designs is needed to determine the effectiveness of structured storytelling as an intervention.

Keywords: Brown's stages, Expressive language delay, Narrative skills, Structured storytelling, Speech-language therapy

LS 31 ***Life Sciences***

EXTRACTION AND COLOURIMETRIC CHARACTERISATION OF NATURAL DYES FROM BREADFRUIT (*Artocarpus altilis*) ROOTS AS A SUSTAINABLE BIO-COLOURANT

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The large-scale use of synthetic dyes in the textile, food, and pharmaceutical industries has raised serious environmental and health issues, including water pollution and carcinogenicity, mutagenicity, and skin allergies, which are forcing the world towards sustainable and eco-friendly alternatives. The study aimed to extract and characterize natural dyes from the roots of breadfruit (*Artocarpus altilis*) as a renewable, untapped bio-colorant for potential applications. Breadfruit root samples of 25 g were prepared in three forms based on oxidation duration: non-oxidized, 15 min oxidized, and 30 min oxidized, and then subjected to four extraction methods: aqueous extraction, acidic extraction with 0.1 M hydrochloric acid, alkaline extraction with 0.1, 0.2, and 0.3M sodium hydroxide (NaOH), and ultrasonication-assisted alkaline extraction with 0.1M NaOH. The extracted dye solutions were characterized using UV-Vis spectrophotometry over 400–1100 nm and CIELAB colorimetric analysis. The 30-minute oxidized roots treated with 0.2M NaOH yielded the highest dye yield, as indicated by UV-Vis absorbance intensity, confirming the presence of phenolic and polyphenolic compounds in the oxidized roots. A subtle shoulder absorption feature around 430–460 nm was observed in the ultrasonication-assisted alkaline extraction, possibly attributable to flavonoid- or carotenoid-type pigments or co-extracted impurities, but further characterization is required. Colorimetric analysis revealed that acidic extraction resulted in the most saturated color profiles, while alkaline and ultrasonication-assisted extraction yielded darker hues with reduced chroma values and near-zero chromaticity coordinates, even though they showed higher absorption values in solution; however, statistical comparison across treatments was not performed. The results demonstrate the significant potential of breadfruit root as a natural source of dye compounds, but the extraction method and oxidation state affect both dye yield and color performance.

Keywords: Bio-colorant, Breadfruit roots, Colorimetric characterization, Natural dyes, Sustainable coloration

LS 32 ***Life Sciences***

FORMULATION OF AN ANTIMICROBIAL NATURAL ROLL-ON DEODORANT USING *Aegle marmelos* (BAEL) LEAF EXTRACT

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Body odor, caused by bacterial degradation of sweat components in the axillary region, is a common hygiene concern that significantly impacts social confidence and quality of life. Conventional deodorants containing aluminum salts and synthetic preservatives have raised consumer health concerns, driving demand for natural alternatives. This study aimed to develop and evaluate a stable natural roll-on deodorant formulation containing *Aegle marmelos* leaf extract, which possesses documented antimicrobial and anti-inflammatory properties. Fresh Bael leaves were extracted using steam distillation, maceration, and Soxhlet extraction methods. FTIR analysis of the ethanolic extract indicated the presence of functional groups associated with phenolic compounds, flavonoids, alkaloids, and tannins. An optimized oil-in-water emulsion formulation incorporating Bael leaf extract, coconut oil, aloe vera gel, and essential oils was developed and evaluated. The final product exhibited excellent physical stability, a pH of 5.08 ± 0.20 within the skin-compatible range, and the formulation exhibited a decrease in apparent viscosity with increasing spindle speed, from 503.9 mPa·s at 6 rpm to 172.6 mPa·s at 60 rpm using spindle No. 2, indicating shear-dependent, apparently shear-thinning flow behavior suitable for roll-on application. Centrifugal stability testing confirmed the absence of phase separation or discoloration. However, antimicrobial testing against *Staphylococcus aureus* revealed limited efficacy, suggesting the need for higher extract concentrations in future formulations. This research successfully demonstrated the feasibility of developing a stable, aluminum-free natural deodorant using Bael leaf extract, providing a viable alternative to conventional products.

Keywords: *Aegle marmelos,* Antibacterial activity, Formulation, FTIR spectroscopy, Phytochemical extraction

LS 33 ***Life Sciences***

EVALUATING THE IMPACT OF AUDITORY STIMULI ON MODULATING HUMAN TASTE PERCEPTION

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Excessive consumption of sugar and salt is a major public health concern in Sri Lanka, leading to the prevalence of non-communicable diseases such as diabetes and hypertension. Conventional product reformulation strategies often compromise consumer acceptance due to perceived losses in taste quality. Recent advances in multisensory science have shown that sonic seasoning can modulate taste perception. This study investigated the effect of background sound on the perception and recognition thresholds for selected taste modalities in beverages commonly consumed in Sri Lanka, including tea, soup, fresh milk, and carbonated soft drinks. Sensory evaluation was conducted with 30-40 semi-trained panelists under controlled laboratory conditions, in silence, using taste-congruent auditory stimuli. Perceived intensity was measured on a seven-point scale, and recognition thresholds were determined using ascending concentration series and the Best Estimated Threshold (BET) methodology under the same auditory conditions. Auditory stimuli significantly enhanced taste sensitivity by lowering recognition thresholds across modalities. Recognition thresholds showed a decreasing pattern, with sweetness reported at 3.58 g L^{-1} in silence and 2.79 g L^{-1} in music, and saltiness at 0.56 g L^{-1} in silence and 0.42 g L^{-1} in music. Bitterness thresholds also decreased from 0.0059 g L^{-1} to 0.00354 g L^{-1} under silence to low-pitch auditory conditions. Statistical analysis confirmed significant differences between silence and sound conditions with large effect sizes. Application to Sri Lankan common foods demonstrated similar auditory modulation effects. Background sound significantly increased perceived sweetness in fresh milk (2.60 to 3.20) and carbonated soft drinks (4.73 to 5.53), while tea showed a non-significant increase. Salt-associated soundscapes significantly enhanced perceived saltiness in commercial Sri Lankan soup formulations. Overall, these findings demonstrate that auditory stimuli can modulate both supra-threshold intensity and sensory sensitivity, highlighting the potential of sonic seasoning as a non-invasive strategy to maintain sensory satisfaction while reducing sugar and salt content, supporting healthier dietary practices.

Keywords: Cross-modal perception, Non-communicable diseases, Sonic seasoning, Taste perception, Multisensory science

LS 34 ***Life Sciences***

RELATIONSHIP OF RENAL CORTICAL VOLUME WITH eGFR AND BMI IN SRI LANKAN POPULATION: FINDINGS FROM A MULTI-CENTRE CECT STUDY

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The identification of reliable imaging biomarkers that reflect renal functional status remains an important area of nephrological and radiological research. Renal Cortical Volume (RCV) has been proposed as a morphometric indicator of functional nephron mass; however, its relationship with estimated glomerular filtration rate (eGFR) and anthropometric indices has not been adequately characterized in the Sri Lankan population. This study aimed to evaluate the relationships between RCV, eGFR, and body mass index (BMI) in a multi-ethnic Sri Lankan population using contrast-enhanced computed tomography (CECT), and to contextualize the findings within the existing international literature. A prospective multi-center descriptive study was conducted involving 95 participants with ages ranging from 21 to 78 years old (53 males and 42 females, mean age 54.10±14.145 years and 53.98±14.331 years, respectively), who underwent abdominal CECT examinations at seven selected hospitals following the exclusion of individuals with renal impairment, diabetes mellitus, or conditions likely to affect renal morphology or function. RCV was calculated from arterial-phase CECT images via manual segmentation in 3D Slicer. BMI was calculated from measured height and weight, while eGFR was derived using recorded serum creatinine levels. Statistical analysis was performed using SPSS at a significance level of $\alpha = 0.05$. As the data demonstrated a non-normal distribution, associations were evaluated using Spearman´s rank correlation analysis. The mean RCV, eGFR, and BMI were 157.84±41.99 cm^3, 100.32±15.72 mL min^{-1} 1.73m^{-2}, and 23.44±5.29 kg m^{-2}, respectively. RCV exhibited weak positive correlations with eGFR (r=0.181, *p*=0.079) and BMI (r=0.094, *p*=0.365); however, neither association was statistically significant. These findings differ from several previously reported studies that demonstrated stronger positive associations between cortical morphometry and renal functional indices. The present study found no statistically significant associations between RCV and eGFR or BMI in this Sri Lankan cohort, highlighting the importance of population-specific evaluation of imaging biomarkers of renal health.

Keywords: BMI, Contrast-enhanced computed tomography, eGFR, Renal cortical volume, Renal morphometry

LS 35 ***Life Sciences***

ANTIOXIDANT, ANTIUROLITHIATIC, AND NEUROPROTECTIVE POTENTIAL OF VALUE-ADDED SRI LANKAN BLACK TEA FORMULATIONS

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Tea-based functional beverages are increasingly investigated for their potential to prevent non-communicable diseases through natural bioactive compounds. This study systematically evaluated the antioxidant, antiurolithiatic, and neuroprotective potential of value-added Sri Lankan black tea formulations incorporating *Cinnamomum verum* (Ceylon cinnamon), *Trigonella foenum-graecum* (fenugreek), and *Murraya koenigii* (curry leaves). Six formulations containing 97%, 94%, 91%, 88%, 85%, and 70% black tea were supplemented with equal proportions of the three botanicals, while 100% black tea served as the control. Hot tea brews were freeze-dried and evaluated for antioxidant activity using Ferric Reducing Antioxidant Power (FRAP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) assays. Neuroprotective activity was assessed using an acetylcholinesterase (AChE) inhibition assay, while antiurolithiatic potential was evaluated through nucleation and aggregation inhibition assays. All assays were performed in triplicate with appropriate positive controls. The 85% black tea formulation showed the strongest DPPH antioxidant activity, with the lowest IC_{50} (11.72 ± 0.22 mg L^{-1}; ascorbic acid: 7.90 ± 0.10 mg L^{-1}) and highest AChE inhibition (77.41 ± 5.06%; donepezil hydrochloride: 99.29 ± 0.04%). The highest FRAP value (0.86 ± 0.01 mmol Fe^{2+} g^{-1}) was observed for the 94% black tea formulation (Trolox: 1.26 ± 0.01 mmol Fe^{2+} g^{-1}), reflecting assay-specific antioxidant mechanisms. Antiurolithiatic activity varied among formulations: the 88% black tea formulation showed the highest aggregation inhibition (43.87 ± 2.16%; Cystone: 21.95 ± 3.71%), whereas the 70% formulation showed the greatest nucleation inhibition (63.03 ± 0.19%; Cystone: 17.58 ± 1.74%), indicating formulation-dependent effects on calcium oxalate crystallization. Overall, value-added Sri Lankan black tea formulations demonstrated promising antioxidant and antiurolithiatic activities, with potential neuroprotective effects based on AChE inhibition, supporting their potential development as functional beverages.

Sri Lanka Council for Agricultural Research Policy (CARP) under the Inter-institutional Multi-Disciplinary Research Grants (IIMD) (Grant No. IIMD/2024/NIFS/01) is acknowledged

Keywords: Acetylcholinesterase inhibition, Antioxidant activity, Functional beverages, Sri Lankan black tea, Value-added tea formulations

LS 36 ***Life Sciences***

RAPID QUALITATIVE DETECTION OF SUGAR ADULTERATION IN SRI LANKAN BEE HONEY USING UV-VIS SPECTROSCOPY AND CHEMOMETRICS

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Honey adulteration with sugar syrup remains a significant food fraud concern, necessitating rapid, economical, and non-destructive screening methods for routine authenticity assessment. This study aimed to evaluate the qualitative potential of Ultraviolet-Visible (UV-Vis) spectroscopy combined with chemometric analysis for distinguishing authentic Sri Lankan bee honey from sugar-adulterated samples and to verify the applicability of the model using commercial market samples. Authentic honey samples (n = 30) were collected from 10 regions of Sri Lanka (3 samples per region), including both managed hives and wild honey sources. Samples were prepared with sucrose adulteration at 0, 5, 10, 15, 20, and 25% (w/w) levels. Three technical replicate spectra were recorded for each sample-adulteration combination and analyzed using UV-Vis spectroscopy under standardized conditions. The spectral data were processed using principal component analysis and orthogonal partial least squares-discriminant analysis to examine clustering and classification performance. The UV-Vis chemometric model showed moderate discriminatory ability, with 82.2% classification accuracy. These values indicate that the method could separate authentic and adulterated honey samples to a useful extent, although the predictive strength remained limited. The spectral differences were mainly attributable to the dilution of chromophoric compounds and the corresponding changes in visible absorbance. Verification was performed using five commercial honey brands (n = 3 bottles per brand), producing outcomes broadly consistent with the UV-Vis-based screening trends. Overall, the findings indicate that UV-Vis spectroscopy combined with chemometrics shows promise as a rapid, low-cost preliminary screening approach for detecting sugar adulteration in Sri Lankan bee honey. However, the moderate classification accuracy underscores the need for confirmatory analysis using more specific reference methods before definitive authenticity claims can be made.

Keywords: Authenticity screening, Chemometrics, Honey adulteration, Sri Lankan bee honey, UV-Vis Spectroscopy

LS 37 ***Life Sciences***

IN-SILICO ASSESSMENT OF POTENTIAL THERAPEUTIC APPLICATIONS OF PHYTOCOMPOUNDS IN *Plectranthus amboinicus* AGAINST LipL32 PROTEIN OF *Leptospira* spp.

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Leptospirosis is a neglected, widespread zoonotic disease caused by the genus *Leptospira*, with occurrence increasing after monsoon rains in tropical areas. Transmission occurs through direct or indirect contact with urine from infected animals, particularly rats and livestock. LipL32 is a major outer-membrane lipoprotein and virulence factor of *Leptospira*. Due to its role in host inflammatory responses, it represents a potential target for novel drug discovery. This study explored the therapeutic potential of phytocompounds from Mexican mint (*Plectranthus amboinicus*) by evaluating their interactions with LipL32 (PDB ID: 3FRL). Fifty compounds were obtained and screened using SwissADME for pharmacokinetic properties according to Lipinski's rule of five. The 20 resulting drug-like compounds were subjected to toxicity prediction using ProTox-3.0. Cavity-guided blind docking with CB-Dock2 identified luteolin as the most promising compound, with a binding affinity of −10.3 kcal mol^{-1}. Luteolin interacted with Asp132, Thr133, and Tyr178 at the Ca^{2+}-binding site of LipL32. Calcium ions stabilize LipL32 conformation and maintain the structure required for association with Toll-like receptor 2 (TLR2), which mediates inflammatory responses in human renal cells. Binding at this Ca^{2+} site may disrupt the structural integrity required for TLR2 association and subsequent inflammation. These *in silico* findings provide a hypothesis-generating screen suggesting luteolin as a potential drug candidate, requiring further validation through molecular dynamics simulations and *in vitro* and *in vivo* studies.

University Research Council (URC) Multidisciplinary Grant No. 516, University of Peradeniya, for providing funds for this research

Keywords: *Leptospira*, LipL32, Luteolin, *Plectranthus amboinicus,* TLR2

LS 38 ***Life Sciences***

OLD TEA GENETIC RESOURCES OF SRI LANKA: AN UNTAPPED RESERVOIR FOR FUTURE TEA BREEDING AND GENETIC IMPROVEMENT

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The genetic diversity of commercially cultivated tea (*Camellia sinensis* (L.) Kuntze) has narrowed due to heavy reliance on a few commercial cultivars. This narrow diversity has become a threat to long-term crop improvement and resilience against biotic and abiotic stresses. Therefore, the exploration and utilization of non-utilized tea genetic resources are essential for broadening the existing gene pool. The Hakgala Botanic Garden in Sri Lanka maintains a unique population of old seedling tea (OST), introduced during the British colonial era, representing valuable but unexplored genetic resources. This study aimed to assess the genetic diversity of this population and to identify morphologically distinct accessions with potential value for future breeding and conservation programmes. Morphological characterization was evaluated using 15 qualitative and quantitative descriptors standardized under UPOV and IPGRI guidelines, with qualitative traits converted into a numerical matrix to construct a Neighbor-Joining (NJ) tree for cluster analysis. Considerable phenotypic variation was observed among OST accessions, with internode length showing the highest variation (Shannon's index, $H' = 1.22$). The NJ tree grouped the accessions into three major clusters, with several genotypes showing similarity to known reference cultivars. In addition, several distinct subgroups were identified within these clusters, indicating further phenotypic differentiation within the population. Accessions identified across these distinct subgroups possess unique, desirable traits and represent valuable genetic resources for breeding programmes. Cluster C comprised reference cultivars exhibiting China-type characteristics, together with several Hakgala OST accessions that showed similar morphological features. The inclusion of these accessions in the China-type group suggests their potential to enrich the China-type genetic resources conserved in the ex situ tea germplasm collection of Sri Lanka's Tea Research Institute (TRI). Overall, the study revealed substantial phenotypic diversity within the Hakgala OST population, highlighting its value for tea breeding and conservation in Sri Lanka.

Keywords: Crop improvement, Genetic diversity, Morphological characterization, Old seedling tea, Tea germplasm conservation

LS 39 ***Life Sciences***

MOLECULAR AND MORPHOLOGICAL INSIGHTS INTO THE DIVERSITY AND EVOLUTION OF *Oedignatha* SPIDERS (ARANEAE: LIOCRANIDAE) IN SRI LANKA

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Oedignatha Thorell is one of the largest genera in the family Liocranidae, with 45 species across South and Southeast Asia. However, phylogenetic relationships within the genus and its species diversity in Sri Lanka are poorly known. This study presents the first integrative taxonomic identification and confirmation of Sri Lankan *Oedignatha*, combining morphological and molecular approaches. Fieldwork across all bioclimatic zones of Sri Lanka yielded 520 specimens. Male palps and female epigynes were dissected, illustrated, and photographed using standard arachnological protocols, and collected specimens were compared with types of known species. Phylogenetic relationships were inferred using Maximum Likelihood (IQ-TREE 2) and Bayesian Inference (MrBayes 3.2), first from all 44 newly generated *COI* sequences, and separately from a multilocus dataset combining *COI*, 12S rRNA, Histone H3, and 18S rRNA sequences for seven representative taxa. Six species delimitation methods were employed, including topology-based MLPTP, bPTP, mPTP, and distance-based TCS, ABGD, and ASAP. All Sri Lankan *Oedignatha* were recovered as a well-supported monophyletic group (UFBoot = 98%, PP = 0.9997), divided into two morphologically distinct clades. Male palpal morphology, including the retrolateral and ventral tibial apophyses, and female genital morphology were congruent with the molecular topology. Delimitation analyses recovered between 11 MOTUs (ABGD, most conservative) and 30 MOTUs (bPTP, most liberal). Most morphospecies showed consistent boundaries across at least four methods, supporting stable species limits. Discordance within Clades was resolved using morphological and phylogenetic evidence. This study describes 15 new species provisionally designated as *Oedignatha* sp. C, E, F, I, J, K, L, M, N, O, P, Q, S, T, and V, and redescribes *O. bicolor*, *O. gulosa*, *O. retusa*, *O. scrobiculata*, and *O. striata*, establishing the first phylogenetic framework for the genus in Sri Lanka and revealing substantially higher species diversity than previously recognised, with the island's forests emerging as a centre of arachnid diversification and endemism.

Financial assistance from the National Institute of Fundamental Studies is gratefully acknowledged

Keywords: Biodiversity, Cloud forest, Speciation, Species delimitation

LS 40 ***Life Sciences***

DIVERSITY OF RICE PESTS AND THEIR PARASITOIDS IN A PESTICIDE-FREE RICE FIELD IN KANDY, SRI LANKA

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Leptospirosis is a neglected zoonotic disease caused by *Leptospira*, with occurrence increasing after monsoon rains in tropical areas. Transmission occurs through direct or indirect contact with urine from infected animals, particularly rats and livestock. LipL32 is a major outer-membrane lipoprotein and virulence factor of *Leptospira* and a potential target for novel drug discovery due to its role in host inflammatory responses. This study explored the therapeutic potential of phytocompounds from Mexican mint (*Plectranthus amboinicus*) by evaluating their interactions with LipL32 (PDB ID: 3FRL). Fifty compounds were screened using SwissADME for pharmacokinetic properties according to Lipinski's rule of five, and 20 drug-like compounds were subjected to toxicity prediction using ProTox-3.0. Cavity-guided blind docking with CB-Dock2 identified luteolin as the most promising compound, with a binding affinity of −10.3 kcal mol^{-1}. Luteolin interacted with Asp132, Thr133, and Tyr178 at the Ca^{2+}-binding site of LipL32. Calcium ions stabilize LipL32 and maintain the structure required for association with Toll-like receptor 2 (TLR2), which mediates inflammatory responses in human renal cells. Binding at this Ca^{2+} site may disrupt the structural integrity required for TLR2 association and subsequent inflammation. These *in silico* findings provide a hypothesis-generating screen suggesting luteolin as a potential drug candidate, requiring further validation through molecular dynamics simulations and *in vitro* and *in vivo* studies.

National Science Foundation (*Grant No. RG/2025/BT/01*) *is acknowledged*

Keywords: Diversity, *Maha* season, Parasitism rate, Parasitoids, Rice insect pests

LS 41 ***Life Sciences***

PREVALENCE OF BREAKFAST SKIPPING AMONG ADOLESCENTS: A STUDY IN DIVERSE SCHOOL SETTINGS OF CENTRAL PROVINCE, SRI LANKA

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Breakfast skipping among adolescents is an important public health concern, as it may influence dietary adequacy, academic performance, and long-term metabolic health. However, breakfast-skipping patterns may vary by socio-demographic and geographic factors. This study assessed the prevalence of breakfast skipping among adolescents in selected urban, rural, and estate school settings in the Central Province of Sri Lanka and identified associated factors. A school-based cross-sectional study was conducted among 683 adolescents in grades 10 and 11 (aged 14–17 years). Twenty-four schools were proportionately allocated using probability proportional to size in two stages: districts (Kandy 12, Matale 5, Nuwara Eliya 7) and school settings (urban 6, rural 9, estate 7). School settings were classified according to the Department of Census and Statistics, Sri Lanka. Breakfast-skipping patterns and demographic information were collected using a pretested questionnaire. Among participants, 244 (36%) had never skipped breakfast, while 64% reported skipping breakfast at least once a week. The multinomial regression model was statistically significant compared with the intercept-only model, $\chi^2(32) = 70.422$, $p < 0.001$, indicating that the predictors collectively explained variation in breakfast-skipping patterns. Pseudo-R^2 values were Cox and Snell = 0.098, Nagelkerke = 0.103, and McFadden = 0.035, indicating modest explanatory power. Gender was not significantly associated with breakfast-skipping patterns ($\chi^2(4) = 7.334$, $p = 0.119$), whereas school setting ($\chi^2(8) = 19.037$, $p = 0.015$) and maternal education level ($\chi^2(12) = 21.660$, $p = 0.042$) were significantly associated. These findings indicate that nutrition education and school-based breakfast promotion programs should consider socio-environmental and family educational factors when developing strategies to reduce breakfast skipping among adolescents.

Financial assistance from the National Institute of Fundamental Studies, Sri Lanka, is acknowledged

Keywords: Adolescents, Breakfast skipping, Maternal education, School settings

LS 42 ***Life Sciences***

ANTIOXIDANT, CYTOTOXIC, ANTIUROLITHIATIC, AND α-AMYLASE INHIBITORY ACTIVITIES OF FRUITS OF *Sonneratia caseolaris* L. AND *Nypa fruticans* WURMB

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Aqueous extracts of fruits from the underexplored Sri Lankan varieties of edible mangrove species, *Nypa fruticans* (endosperm) and *Sonneratia caseolaris* (ripe and unripe fruits), were evaluated for antioxidant, cytotoxic, α-amylase inhibitory, and antiurolithiatic activities using DPPH radical scavenging, ferric reducing antioxidant power (FRAP), brine shrimp lethality, and calcium oxalate nucleation and aggregation assays as preliminary studies of their bioactive potentials. In the DPPH radical scavenging assay, unripe and ripe fruits of *S. caseolaris* exhibited moderate antioxidant activity, with IC_{50} values of 177.6 mgL^{-1} and 443.60 mg L^{-1}, respectively, compared with the positive control, butylated hydroxyanisole (IC_{50} = 10.03 mgL^{-1}), while *N. fruticans* achieved only 36.67 ± 2.13% radical scavenging activity at the highest concentration tested (1000 mg L^{-1}). Unripe *S. caseolaris* fruit exhibited the highest FRAP value (2111.00 ± 18.49 µmol $FeSO_4$ g^{-1}), followed by ripe *S. caseolaris* fruit (612.54 ± 10.88 µmol $FeSO_4$ g^{-1}) and *N. fruticans* endosperm (95.23 ± 14.69 µmol $FeSO_4$ g^{-1}), which were lower than the positive control Trolox (15,329.53 ± 27.32 µmol $FeSO_4$ g^{-1}). Ripe and unripe *S. caseolaris* fruits exhibited notable but lower α-amylase inhibition of 57.69 ± 0.59% and 61.08 ± 0.06%, respectively, compared to the positive control, acarbose (88.82 ± 1.86 %), and *N. fruticans* exhibited the lowest inhibition (20.99 ± 5.25%). In the antiurolithiatic assays, unripe *S. caseolaris* fruit showed a significant CaC_2O_4 nucleation inhibition of 35.27% after 30 min, compared with the positive control cystone (49.67%; P = 0.0856), whereas ripe *S. caseolaris* fruit (6.36%) and *N. fruticans* endosperm (5.93%) were substantially lower. Aggregation inhibition was time-independent over 90 minutes, with the highest values of 61.37% in cystone, 38.46% in ripe *S. caseolaris* fruit, 33.58% in unripe *S. caseolaris* fruit, and 6.94% in *N. fruticans*. Tested extracts were non-toxic up to 1000 mg L^{-1} in the cytotoxicity assay. *S. caseolaris* and *N. fruticans* are promising sources of bioactive compounds, with unripe *S. caseolaris* fruit showing notable bioactivities. As the first known report describing the bioactivities of these species in the Sri Lankan context, the present findings warrant further phytochemical and pharmacological investigations.

Keywords: α-amylase inhibition, Antioxidant property, Antiurolithiatic activity, *Nypa fruticans*, *Sonneratia caseolaris*

LS 43 ***Life Sciences***

RECOVERY OF VIABLE BUT NON-CULTURABLE *Bacillus subtilis* CELLS THROUGH BIOFILM EXUDATE-MEDIATED RESUSCITATION

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Under adverse environmental conditions, bacterial cells may enter a viable but non-culturable (VBNC) state. Although they remain metabolically active, they lose the ability to grow on routine culture media, thereby failing to be detected by conventional culture-based methods. This study investigated the effect of biofilm exudates (BFEx), which contain bioactive compounds, on the recovery of VBNC *Bacillus subtilis* cells. Cultures of *B. subtilis* grown in nutrient broth (NB) were exposed to heat stress at 50 °C to induce VBNC state, whereas cultures maintained at 25 °C served as normal growth controls. The VBNC state was evaluated by measuring growth kinetics at OD600, colony counts as colony-forming units (CFU mL^{-1}), and metabolic activity using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay at OD_{570}. Recovery of VBNC cells was evaluated by transferring heat-stressed cultures to 25 °C in the presence and absence of BFEx (10 µL per 1 mL of sample) at 5th, 7th, and 11th hours after inoculation. Statistical analysis was performed using Minitab software by two-way ANOVA and Tukey's HSD test. Growth curve at 25 °C exhibited distinct lag, log, stationary, and death phases over a 12-hour incubation period, indicating normal bacterial growth dynamics. The transition from lag to log phase occurred at the 5th hour, the active log phase at the 7th hour, and the transition to the stationary-to-death phase at the 11th hour. In contrast, the growth curve at 50 °C showed irregular fluctuations. Colony counts and metabolic activity were significantly lower ($p< 0.05$) in cultures maintained at 50 °C than in those maintained at 25 °C at all sampling time points, suggesting induction of the VBNC state at 50 °C. During recovery, BFEx-treated VBNC cultures showed significantly higher colony counts ($p< 0.05$) and metabolic activity at all time points than untreated cultures. These findings demonstrate BFEx's beneficial role in enhancing metabolic activity and promoting VBNC recovery.

Keywords: Growth curve, Heat stress, Metabolic activity, Reactivation

LS 44 ***Life Sciences***

ANTIMICROBIAL ACTIVITY OF METHANOLIC EXTRACT OF *Flacourtia indica* BARK

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Antimicrobial resistance is a growing concern worldwide that significantly affects global public health. As conventional antibiotics have become less effective against many diseases, the search for novel antimicrobial agents has become increasingly important. Nature can be an excellent source for identifying potential natural products with antimicrobial properties. In particular, plant-derived secondary metabolites exhibit antimicrobial activity and are pharmacologically active, making them valuable candidates for the synthesis of novel drugs. This study investigated the antimicrobial activity of methanolic extracts of *Flacourtia indica* bark prepared using two extraction methods: Soxhlet and sonication. Methanol (98% purity, w/w) was used as the extraction solvent to obtain extracts from dried bark material of *F. indica* using Soxhlet and sonication extraction methods. The crude extracts from both extraction methods were then tested against four bacterial strains (*Escherichia coli* ATCC25922, *Pseudomonas aeruginosa* ATCC27853, *Staphylococcus aureus* ATCC25923, *Bacillus cereus* ATCC14579) and one fungal strain (*Candida albicans* ATCC90028) using the well diffusion method on Muller-Hinton Agar, which was incubated at 37 °C for 24 h. After incubation, both extracts showed inhibition against all organisms tested. The *F. indica* crude extract obtained by Soxhlet extraction showed the highest activity against *P. aeruginosa* (28.4±1.25 mm) and the lowest against *S. aureus* (13.7±0.80 mm). In contrast, the sonication extract exhibited the highest activity against *C. albicans* (23.4±1.15 mm) and the lowest against *E. coli* (14.2±0.34 mm). However, the Soxhlet-extracted crude tended to yield larger inhibition zones than the sonication extract. The paired t-test performed on the inhibition zone measurements showed no statistically significant difference between the two extraction methods (p= 0.708). Hence, both methods demonstrated similar potential for extracting compounds with antimicrobial activity. This study reveals that these extracts may contain bioactive compounds that could be developed into new drugs.

Financial assistance from the Open University of Sri Lanka is acknowledged

Keywords: Antimicrobial activity, *Flacourtia indica,* Methanol extraction, Natural products, Soxhlet extraction

LS 45 ***Life Sciences***

ASSESSMENT OF ANTIMICROBIAL PROPERTIES AND BIOACTIVITY OF FRESH GREEN TEA LEAVES *(Camellia sinensis* L.*)* FROM VARIOUS AGRO-CLIMATIC REGIONS IN SRI LANKA

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Tea (*Camellia sinensis* L.) is a globally available beverage with a long history, and its flavor profiles are derived from its leaves. The value of tea comes not only from its unique flavors but also from its refreshing properties. The tea plant is rich in bioactive compounds that help the body metabolize nutrients more efficiently by breaking down secondary compounds such as caffeine and catechins. This study investigated the antimicrobial and antioxidant potential of fresh 'Mature leaves' collected from five regions (n=3) of Sri Lanka: Kandy, Ruhuna, Sabaragamuwa, Nuwara Eliya, and Dimbula, covering three elevations: Low, Mid, and High. Methanol-based extracts from each region were used to conduct tests for Total Phenolic Content (TPC), Total Flavonoid Content (TFC), Antioxidant activity, and *in vitro* antimicrobial assays (Disc Diffusion and Minimum Inhibitory Concentration) against two bacterial strains: *Staphylococcus aureus* ATCC 29213 and *Escherichia coli* ATCC 25922. Samples from the Ruhuna and Sabaragamuwa regions exhibited the highest levels of bioactive compounds, with total phenolic and flavonoid contents of 175.59 ± 33.4 mg GAE/g and 288.29 ± 4.1 mg QE/g, respectively. In contrast, the high-elevation tea sample from Nuwara Eliya demonstrated the strongest antibacterial activity against both Gram-positive and Gram-negative bacteria, with a minimum inhibitory concentration (MIC) of 50 mg/mL. These samples also showed the highest antioxidant capacity, recording the lowest absorbance value (0.015) at the highest tested concentration (25 µg/mL). Among the four solvent systems tested, 80% (v/v) aqueous methanol was identified as the most effective solvent for extracting phenolic and flavonoid compounds. Antimicrobial activity, ranked in descending order, was highest in extracts from Nuwara Eliya, followed by Sabaragamuwa, Dimbula, Kandy, and Ruhuna. These findings suggest that high-elevation tea extracts, particularly from Nuwara Eliya, hold promise as a potential natural, food-grade sanitizing agent, warranting further investigation into their formulation and large-scale applicability.

Keywords: Antioxidants, Bioactive compounds, Disc diffusion, Mature tea leaves, Tea extracts, Tea growing regions

Life Sciences

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IN SILICO VALIDATION AND *IN VITRO* FUNCTIONAL EVALUATION OF A MULTI-EPITOPE VACCINE CANDIDATE AGAINST FIMBRIAL VIRULENCE DETERMINANTS OF *Edwardsiella piscicida*

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The fimbrial biogenesis outer membrane usher protein, a conserved protein in *Edwardsiella piscicida*, represents a potential vaccine target against edwardsiellosis caused by this facultative pathogen. This study assessed the protective potential of an immunoinformatics-based multi-epitope vaccine targeting the FimD region of the fimbria/pilus outer membrane usher protein by integrating *in silico* immune validation with *in vitro* evaluation of immunogenic responses. A multi-epitope DNA vaccine candidate was designed by integrating three cytotoxic T lymphocyte, two helper T lymphocyte, and three B-cell epitopes into a single construct. Computational immune responses were predicted using the C-ImmSim platform. Protein-protein molecular interaction analysis was performed using PDBSum to assess binding with Toll-like receptor 4 (TLR-4; PDB ID: 3FXI). For *in vitro* evaluation, the codon-optimized gene was cloned into a GFP-expressing plasmid, transfected into fathead minnow (FHM) epithelial cells, and immune-related gene expression was assessed by qRT-PCR. In computational immune simulations, the vaccine was administered in two doses, with the booster producing a stronger and more persistent IgG response. Molecular interaction analysis revealed extensive contacts between the vaccine and TLR-4, including 4 salt bridges, 30 hydrogen bonds, and 255 non-bonded contacts, suggesting strong intermolecular interactions and structural stability of the receptor-vaccine complex. GFP expression at 24 h post-transfection confirmed successful translation of the multi-epitope DNA vaccine construct in FHM cells. Additionally, *Tnfα* and *Infgr1* mRNA expression tended to increase relative to untreated and vector controls, suggesting potential immunostimulatory activity. Overall, the DNA vaccine demonstrated immunomodulatory potential *in vitro*, supporting further *in vivo* evaluation of its immune responses and protective efficacy.

Financial assistance from the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (Grant No RS-2024-00347938) is acknowledged

Keywords: Antigenicity, Aquaculture, *Edwardsiella piscicida,* Multi-epitope vaccine, Outer membrane usher protein

LS 47 ***Life Sciences***

ASSOCIATION BETWEEN ORAL *Candida albicans* CARRIAGE AND DENTAL CARIES STATUS IN SRI LANKAN ADULTS: A CROSS-SECTIONAL STUDY

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Dental caries is the most common oral disease worldwide. *Candida albicans*, an emerging fungal pathogen, has recently been identified to possess cariogenic properties. This study aimed to investigate *C. albicans* carriage and its genotypic diversity among caries-active and caries-free adults in Sri Lanka. Dental plaque samples were collected from 121 participants aged ≥ 18 years after obtaining ethical clearance (ERC/FDS/UOP/I/2025/24) and written informed consent. Participants were divided into three groups: caries-free (n = 20, DMFT = 0), mild caries (n = 28, DMFT = 1-5), and severe caries (n = 73, DMFT ≥ 6). *C. albicans* was presumptively identified by colony characteristics on CHROMagar Candida. DNA was extracted and subjected to PCR for species confirmation and genotypic analysis targeting the *KER1* gene and the transposable intron region within the 25S rDNA, using established protocols. Statistical analysis was performed using R (version 4.4.2). Participants had a mean age of 32.2 years (range: 18-73), with 25.6% males and 74.4% females. All caries-free samples were negative for *C. albicans*, while 48.5% of caries-active participants were *C. albicans* positive. Fisher's Exact test showed a significant association between caries severity and *C. albicans* occurrence among caries-active participants (p = 0.015), with a higher detection rate in the severe caries group (56.2%) compared to the mild caries group (28.6%) (OR = 3.17, 95% CI: 1.15–9.45). Genotype A was predominant in both groups (mild caries: 62.5%; severe caries: 63.4%). These findings indicate that the presence of *C. albicans* is strongly and significantly associated with caries severity. Genotype A may possess possible ecological adaptation within cariogenic niches. As the first study to explore the relationship between *C. albicans* and dental caries in Sri Lankan adults, it highlights *C. albicans*' potential as a risk indicator for dental caries in this population.

Keywords: *Candida albicans*, Genotype, PCR, Sri Lankan adults, Tooth decay

LS 48 ***Life Sciences***

A BASELINE SURVEY OF PEST-PARASITOID ASSOCIATIONS IN CABBAGE, TOMATO, AND BEAN CROPS IN MAJOR VEGETABLE-GROWING AREAS OF SRI LANKA

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Beans, tomatoes, and cabbage are among the most widely consumed vegetables in Sri Lanka. Given the limited research on vegetable pest-parasitoid interactions in Sri Lanka, this study identified major pest species, associated parasitoids, and parasitization rates to support biological control. Five fields per crop were sampled once in Kandy, Matale, Badulla, and Nuwara Eliya from July to December 2025 using simple random sampling of 120 plants each for cabbage and tomato, and bean vines on 60 support stakes per field. Standard taxonomic keys were used to identify pests and parasitoids emerging from the collected samples. Molecular identification of parasitoid species was confirmed using partial sequences of the *cytochrome oxidase subunit* I (*COI*) gene. Among the cabbage pests, *Trichoplusia ni* was parasitized by the larval endoparasitoid *Cotesia vestalis* across all districts, representing the first documented record of this association in Sri Lanka, with the highest parasitism rate in Badulla (34.04%±1.27) and the lowest in Nuwara Eliya (10.20%±1.01). In Badulla, *Megaselia scalaris* parasitized 21.43% ±1.34 of *T. ni* pupae*,* representing the first such report in Sri Lanka. Of the three parasitoids of *Crocidolomia pavonana*, *M. prodeniae* recorded higher parasitism rates in Kandy (22.78%±0.83) and Matale (17.97%±1.45), while *Cotesia* sp. occurred only in Kandy (12.50%±2.50). *Plutella xylostella* and *Brevicoryne brassicae* were parasitized by *C. vestalis* and *Diaeretiella rapae*, respectively, while *Asaphes vulgaris* was recorded as a hyperparasitoid of *D. rapae* in Nuwara-Eliya, a first country record. The leafminer, *Liriomyza sativae,* on tomato and beans was parasitized by *Hemiptarsenus varicornis*. *Tuta absoluta* on tomato in Badulla was parasitized by *Bracon didemie* (6.50%±0.71). Additionally, *Habrobracon hebetor* parasitizing the bean pod borer, *Maruca vitrata*, was recorded only in Badulla (1.16%±2.00), representing a new host record for Sri Lanka. This study establishes baseline data on pest-parasitoid associations in major vegetable-growing regions of Sri Lanka, including several new records, laying the groundwork for future biological control research.

Financial assistance from the National Research Council, Sri Lanka (*Grant No. IDG 24-021*) *is acknowledged*

Keywords: Vegetable insect pests, Parasitoids, Biological control, Cabbage, Beans, Tomato

LS 49 ***Life Sciences***

RADIATION EXPOSURE FROM REPEATED PAEDIATRIC LOWER EXTREMITY PLAIN RADIOGRAPHY: A RETROSPECTIVE REPEAT ANALYSIS PROGRAM (RAP) STUDY USING DOSE AREA PRODUCT VALUES

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Pediatric patients are more sensitive to ionizing radiation due to their increased risk for radiation-induced stochastic effects. Thereby, the unnecessary cumulative radiation exposure that occurred due to repeated examinations in pediatric lower extremity plain radiography needs special attention. This study aims to use a repeat analysis program (RAP) approach to evaluate the frequency of repeat examinations in pediatric lower-extremity plain radiography and quantify their impact on the cumulative patient dose. Ethical approval was obtained for this study, and the data were collected from August 2025 to March 2026 at a major children's hospital in Sri Lanka, where a digital radiographic system is used. The number of repeat exposures, the initial exposure value (DAP in mGy cm^2), the total cumulative DAP after repeated exposures, and the exposure parameters (kVp and mAs) were recorded. Patients were stratified into five age groups as <1 year, 1-<5 years, 5-<10 years, 10-<14 years, and ≥14 years. To ensure reliable data for cases with two exposures, the second exposure for each patient was designated as the accepted image, and the first as rejected. The overall impact, individual dose multiplier ($DAP_{Total}/DAP_{Accepted}$), and individual wasted dose percentage were calculated. Overall repeat rate was 11.5% (out of 374 exposures). The lateral projections showed the highest tendency for repeats, with repeat rates ranging from 27.8% to 50%, whereas standard anteroposterior (AP) views achieved technical success with no repeats. Even though the dose waste remains low (5.68%), the repeat examinations inflated the individual pediatric radiation burden by an average of 59%. Analysis of different age groups revealed that younger age cohorts (< 10 years) experienced higher rates of repetition and greater average dose inflation. Preventing this unnecessary cumulative radiation exposure requires special attention and further optimization.

Keywords: Dose-area product, Dose optimization, Multiple exposures, Pediatric lower extremity plain radiography, Radiation protection

LS 50 ***Life Sciences***

COMMUNITY PERCEPTIONS AND USAGE PATTERNS OF RIVER WATER ALONG SELECTED SITES OF THE RIVER KALU, SRI LANKA

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Deterioration of river water quality from human activities is a major environmental and socio-ecological concern. This study assessed community perceptions of water quality, use, and health concerns in relation to the microbiological and physicochemical characteristics of the River Kalu in Sri Lanka. A cross-sectional survey was conducted via face-to-face interviews (n=180), with 30 respondents at six purposively selected sites representing a gradient of anthropogenic influence, from less-disturbed upstream areas to locations with mining, fishing, hospitals, tourism, and industry near the mouth. One resident per household within 1 km of the river was interviewed; children were excluded. Data covered water-use patterns, perceptions, and health concerns. *E. coli* was enumerated by multiple-tube fermentation, and physicochemical parameters were assessed in 168 samples collected twice during pluvial and non-pluvial periods, including Sri Pada. Direct consumption has ceased due to poor quality. The river remains used for bathing (80±1.3%), washing (70±1.4%), fishing (21±1.4%), mining (43±1.5%), and recreation (60±1.5%). No severe health issues were reported except itching, while >90% considered the water unsuitable for drinking. Findings were corroborated by *E. coli* detection, lowest at the origin (98.5 ± 144.3/100 mL) and highest at the mouth (708.6 ± 744.2/100 mL). Turbidity and suspended solids also increased. Results highlight growing community concern and the need for integrated river management, including pollution control, monitoring, and community participation, to sustain water use.

Postgraduate Institute of Science, University of Peradeniya (Grant No PGIS/2022/06) is acknowledged.

Keywords: Anthropogenic activities, Community perceptions, River Kalu, River water usage, Water quality

LS 51 ***Life Sciences***

DNA BARCODING-BASED IDENTIFICATION AND GENETIC DIVERSITY OF *Plutella xylostella* FROM UPCOUNTRY CABBAGE-GROWING AREAS OF SRI LANKA

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Plutella xylostella (Diamondback moth) is the most destructive pest of *Brassica oleracea* (cabbage), causing major harvest losses. Larvae feed exclusively on cruciferous crops. In Sri Lanka, infestations are severe in upcountry regions where cabbage is widely cultivated. Molecular characterization of local *P. xylostella* populations, vital for pest management, remains limited. This study molecularly identified samples from cabbage fields in Badulla, Kandy, and Nuwara Eliya, which had previously been confirmed morphologically, and assessed preliminary phylogenetic placement relative to global populations using mitochondrial *COI* barcoding. A cytochrome c oxidase subunit I marker was amplified from 11 samples. Sequences were aligned with GenBank references from China, South Korea, Australia, Turkey, and Sweden, as well as two outgroups. Relationships were analyzed via Neighbor-Joining trees in MEGA 11 using the Kimura 2-parameter + Gamma model, with bootstrap support across 1000 replicates. All samples were confirmed as *P. xylostella*, clustering apart from outgroups (*Leucoptera malifoliella*, *Prays oleae*). They did not form a monophyletic group, spreading across clades, mainly grouping with the China and South Korea populations. District-specific clustering was absent. Polymorphism statistics (DnaSP v6) revealed high haplotype diversity (Hd = 0.964) and low nucleotide diversity (π = 0.00636), indicating a recently expanded population. Preliminary phylogenetic analysis suggests genetic connectivity between Sri Lankan and Asian populations. Findings highlight the importance of advanced molecular studies to better understand the genetic structure, haplotype diversity, and dispersal dynamics of *P. xylostella* in Sri Lanka.

Financial assistance from Multidisciplinary Grants 2025 (Grant No 09) is acknowledged.

Keywords: *COI* barcoding, Genetic diversity, Neighbor-joining, Phylogenetic analysis, *Plutella xylostella*

LS 52 ***Life Sciences***

SYNERGISTIC EFFECT OF *Phyllanthus amarus* AND *Cocos nucifera* HAUSTORIUM ON CALCIUM OXALATE CRYSTALLIZATION AND DISSOLUTION: AN *IN VITRO* STUDY

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Renal calculi are among the most prevalent urological disorders, affecting approximately 12% of the global population. *Phyllanthus amarus* and *Cocos nucifera* haustorium are traditionally used medicinal plants with antiurolithiatic and synergistic activity that remains scientifically underexplored. This study aims to evaluate the individual and synergistic *in vitro* antiurolithiatic activity of the compounds using phytochemical profiling, crystallization inhibition, and crystal dissolution assays for calcium oxalate crystals. Methanolic extracts of *P. amarus* and aqueous extracts of *C. nucifera* were prepared using sequential extraction. The extracts were subjected to crystallization, followed by dissolution of the crystals in an egg membrane assay. Qualitative phytochemical screening was then conducted to identify the major bioactive compounds present in the extracts. A series of both extract concentrations ranging from 200-1000 µg mL^{-1} was prepared for individual and combined samples of 1:1, 1:2, and 2:1 ratios for crystallization assays. 100-1000 µg mL^{-1} series were prepared with the above ratios for the dissolution assay. The reaction mixture was incubated at 37 °C for 30 min, and absorbance was measured at 620 nm using a UV spectrophotometer. All experiments were duplicated. Crystals generated in both samples were observed under the light microscope. In the crystallization assay, individual extracts inhibited crystal formation in *P. amarus* (47.98%±1.74%) and coconut haustorium (28.71%±1.72%). In the dissolution assay, both extracts were evaluated for their dissolution effect on pre-formed crystals and showed different dissolution effects at different concentrations. Statistical differences were evaluated by measuring the turbidity of the reaction solutions; $p< 0.05$ was considered significant compared with the control. Based on the results, the highest inhibitions were observed at 1000 µg mL^{-1}. This study provided evidence that *P. amarus* and coconut haustorium, combined in a 2:1 ratio, have significant antiurolithiatic potential as inhibitors of crystallization and crystal dissolution in the treatment of renal calculi, compared with individual and other ratios.

Keywords: Coconut haustorium, Crystallization, *Phyllanthus amarus*, Synergistic effect

LS 53 ***Life Sciences***

EFFECTS OF DIFFERENT CONTEMPORARY TRAINING PROGRAMS ON CARDIOVASCULAR AND OXYGENATION RESPONSES IN RECREATIONALLY TRAINED MALE ATHLETES

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Contemporary training approaches, Complex Training (CT) and High-Intensity Resistance Circuit Training (HIRC), differ in exercise structure, intensity, recovery intervals, and training density. These differences may produce distinct cardiovascular responses and adaptations. As a result, their comparative impacts require further examination in recreationally trained athletes. Thus, this study aimed to compare the effects of CT and HIRC on resting heart rate (RHR) and peripheral oxygen saturation (SpO_2) in recreationally trained male athletes. Twenty recreationally trained male athletes (n = 20) were randomly assigned to the CT (n = 10) and HIRC (n = 10) groups, and they underwent supervised training three times a week for six weeks as part of a quantitative randomized experimental design. RHR and SpO_2 were measured at pre-test and post-test using standardized procedures. The study population was described using standard descriptive statistics. The interaction effect and significant differences were examined using a mixed analysis of variance with repeated measures and Bonferroni post hoc testing. The main results show a significant interaction effect on RHR, $F(1, 18) = 15.849$, $p < 0.05$. However, no significant between-group main effect or post hoc comparisons were detected for any measured variables. Interestingly, significant main time effects were detected only in RHR ($p < 0.05$) following both training protocols. Significant reductions in RHR ($p < 0.05$) were detected in the post hoc comparison following CT (1.29 Δ%) and HIRC (4.03 Δ%), while SpO_2 showed no change. These results show that both CT and HIRC significantly lowered RHR. However, HIRC exhibited a larger drop in RHR, which could be attributable to increased exercise intensity and cardiovascular stress during HIRC. Although physiological adjustments may have improved cardiorespiratory fitness, they may not have led to a significant shift in resting SpO_2 levels.

Keywords: Cardiovascular adaptation, Complex training, High-intensity resistance circuit training, Peripheral oxygen saturation, Resting heart rate

LS 54 ***Life Sciences***

COMPUTATIONAL DISCOVERY OF NOVEL ANTI-AGING PHYTOCHEMICAL TYROSINASE INHIBITORS VIA MACHINE LEARNING AND MOLECULAR DOCKING VALIDATION

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Tyrosinase hyperactivity, causing hyperpigmentation and skin aging, is a major cosmetic and dermatological concern, a challenge further exacerbated by the severe systemic toxicities associated with current clinical alternatives like mercury and hydroquinone. To overcome this challenge, this study employed a rational drug discovery strategy, using machine-learning predictions to identify novel, safe anti-aging compounds that inhibit tyrosinase, the master metalloenzyme regulator of melanogenesis. Successful inhibition of tyrosinase prevents the prevention of localized melanin overproduction, offering a natural approach that avoids the severe cellular damage caused by conventional chemical agents. A machine learning pipeline was created using Random Forest, Support Vector Machines (SVMs), and Artificial Neural Networks (ANNs) within the KNIME platform to predict tyrosinase inhibition potential in a library of curated phytochemicals and chemicals (test data) from different sources. As training data, 100 known tyrosinase inhibitors were curated from the published literature. RDKit fingerprints and MACCS keys were used as molecular descriptors for this prediction. CHEMBL3317807 was identified as the consensus hit because it emerged as a potential candidate across all three predictive models with the highest predictive scores. Subsequent static molecular docking yielded highly favorable binding affinities against both the binuclear zinc active site of human TYRP1 (-7.064 kcal/mol) and a homologous copper-containing mushroom tyrosinase model 2Y9X (-7.854 kcal/mol), significantly outperforming the standard inhibitor, kojic acid. (-5.710 kcal/mol (TYRP1),-5.574 kcal/mol(2Y9X)). By integrating multi-model machine-learning predictions with structural docking validation, this study highlights CHEMBL3317807 (SMILES: Cc1cccc2nc (-c3ccc(C(=O) N/N=C/c4cccs4)cc3)[nH]c12) as a highly promising chemical candidate for tyrosinase inhibition and underscores a robust computational virtual-screening framework for discovering safe cosmetic alternatives.

Keywords: Anti-aging, Hyperpigmentation, Machine learning, Molecular docking, Tyrosinase inhibitors

LS 55 ***Life Sciences***

IN VITRO BIOACTIVITY EVALUATION OF HOT WATER LEAF EXTRACT FROM *Psidium guineense* SW.

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Psidium guineense Sw. (*Embul Pera*), an edible medicinal plant of the Myrtaceae family, is traditionally used in Sri Lanka for diverse therapeutic applications. Despite its ethnomedical importance, scientific evidence on its biological activities remains limited. This study evaluated the antioxidant, antidiabetic, antiurolithiatic, and cytotoxic properties of a hot-water leaf extract of *P. guineense*. Fresh leaves were collected from Keppetipola, Sri Lanka, and extracted in ultrapure water at a plant-to-water ratio of 2:10 (w/v). The resulting mixture was promptly heated to 70°C and maintained at 70 ℃ for 30 minutes, followed by filtration and freeze-drying. Antioxidant activity was assessed using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging and ferric reducing antioxidant power (FRAP) assays. Antidiabetic potential was evaluated via an α-amylase inhibition assay. Antiurolithiasis activity was determined using calcium oxalate crystal nucleation and aggregation assays, and cytotoxicity was assessed using the brine shrimp (*Artemia salina*) lethality assay. The extract demonstrated significant antioxidant activity, as evidenced by a DPPH radical scavenging IC_{50} of 36.10 ± 1.01 mg L^{-1}, in contrast to 7.90 ± 0.10 mg L^{-1} for ascorbic acid. In the FRAP assay, the crude extract showed a reducing power of 3.19±0.04 mmol Fe^{2+} g^{-1}, comparable to that of Trolox (3.98±0.04 mmol Fe^{2+} g^{-1}). Moderate α-amylase inhibitory activity was recorded at 1000 mg L^{-1} (34.81 ± 1.33%), compared to 88.82 ± 1.86% for acarbose. The extract inhibited calcium oxalate crystal nucleation by 49.21 ± 6.64% and aggregation by 44.75 ± 0.30% at 1000 mg L^{-1}. Notably, aggregation inhibition exceeded that of the positive control, Cystone (27.82 ± 0.59%), although its nucleation inhibition remained lower than that of Cystone (62.87 ± 0.79%). The extract exhibited weak cytotoxicity in the brine shrimp lethality assay. These findings suggest that the hot water leaf extract of *P. guineense* exhibits promising antioxidant and anti-urolithiatic properties, along with moderate antidiabetic potency and low cytotoxicity. The results corroborate its traditional medicinal applications and underscore its potential as a source of natural bioactive compounds for future therapeutic applications.

Keywords: Antiurolithiatic, antioxidant, Brine shrimp lethality, *Psidium guineense* sw., α-amylase inhibition

LS 56 ***Life Sciences***

MOLECULAR DETECTION OF PATHOGENIC *Escherichia coli* O157:H7 AND THEIR ANTIMICROBIAL RESISTANCE PATTERNS IN RETAIL BEEF SHOPS, KANDY, SRI LANKA

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Foodborne diseases remain a significant public health concern worldwide, and contaminated meat products serve as important sources of zoonotic pathogens. Among these, *Escherichia coli* (*E. coli*) causes illnesses ranging from mild gastroenteritis to severe complications. *E. coli* O157:H7, a Shiga toxin-producing *E. coli* (STEC), is associated with numerous foodborne outbreaks and results in hemorrhagic colitis and hemolytic uremic syndrome (HUS). This study aimed to identify *E. coli* and *E. coli* O157:H7 in retail beef samples using phenotypic and molecular methods and to determine the antimicrobial susceptibility profiles of isolates. A total of 45 beef samples were collected from retail meat shops in Kandy District. Isolation and identification of *E. coli* were conducted in accordance with established procedures described in the literature. Subsequently, antimicrobial susceptibility testing was conducted using eight antimicrobial agents. Among the 45 samples analyzed, 31 isolates were phenotypically identified as *E. coli*. Molecular confirmation of the 16S rRNA gene, which is unique to E. coli, verified that 30 isolates were *E. coli*. Thereafter, multiplex PCR targeting *eae A and fliC7* genes was performed to detect *E. coli* O157:H7. Results revealed 12 isolates carrying both genes, indicating the presence of *E. coli* O157:H7. 16 isolates were positive only for $fliC_{h7}$, suggesting non-O157:H7 *E. coli*, while two were positive only for *eae A,* reflecting *E. coli* O157. Antimicrobial susceptibility testing of *E. coli* revealed 100% susceptibility to amikacin and gentamicin, followed by ceftriaxone (97%) and ciprofloxacin (91%). Moderate susceptibility rates of 74% and 71% were shown for streptomycin and tetracycline, respectively, and 61% of isolates were susceptible to ampicillin. All 12 *E. coli* O157:H7 isolates showed complete susceptibility to amikacin, ampicillin, trimethoprim-sulfamethoxazole, ciprofloxacin, gentamicin, and ceftriaxone. The detection of antimicrobial-resistant and pathogenic *E. coli* O157 in retail beef highlights a food safety concern and underscores the need for continuous surveillance and improved hygiene practices to protect public health.

Financial assistance from URG/2023/36/V is acknowledged.

Keywords: *eae A*, *E. coli*, *E. coli* O157:H7, $fliC_{h7}$, *16sr*RNA.

LS 57 ***Life Sciences***

ISOLATION AND CHARACTERISATION OF PHOSPHATE-SOLUBILIZING FUNGI FROM AGRICULTURAL SOILS TOWARDS THE DEVELOPMENT OF BIOFERTILIZER

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Phosphorus deficiency limits agricultural productivity in tropical soils due to the prevalence of insoluble phosphate. In Sri Lanka, Eppawala Rock Phosphate (ERP) is available, but agricultural use is limited due to lower solubility. Conventional chemical processing is costly and environmentally unfavorable, highlighting phosphate-solubilizing fungi (PSF) as sustainable alternatives for enhancing phosphorus bioavailability through organic acid production. Although PSFs are widely studied, comparative evaluation of local isolates for ERP solubilization against conventional insoluble phosphate sources remains limited. This study was conducted to isolate and characterize PSF from agricultural soils collected at 8 different locations using composite sampling and to evaluate their ability to solubilize tricalcium phosphate (TCP) and ERP (5 g L^{-1} / 0.5% (w/v)). Fungi were grown on *Pikovskaya's* (PVK) agar, and three PSF isolates (PSF01, PSF02, and *Penicillium* sp.) were identified and compared, with an *Aspergillus* sp. strain serving as a positive control previously confirmed to be an efficient phosphate solubilizer (SI = 2.40-3.56). After seven days of incubation at 28 ^{0}C, phosphate solubilization indices (SI) showed that *Aspergillus* sp. had the highest SI (2.37), followed by PSF02 (2.21), PSF01 (2.20), and *Penicillium* sp. (1.76) for TCP. The vanadate-molybdate yellow method revealed that *Aspergillus* sp. had the highest TCP solubilization (56.41 mg L^{-1}), whereas PSF02 exhibited the best ERP solubilization (24.14 mg L^{-1}). A significant drop in broth pH to 3.29 indicated that organic acid production was the primary mechanism of phosphate solubilization. FT-IR spectroscopy supported this by showing the presence of carboxylic acid groups through characteristic C=O stretching (~1736 cm^{-1}) and broad O–H stretching (3200–3600 cm^{-1}). Specific organic acid species were not individually identified in this study. These findings highlight the strong potential of naturally occurring PSF02 to effectively solubilize ERP, supporting sustainable phosphorus nutrition and biofertilizer development for Sri Lankan agriculture.

Keywords: Biofertilizer, Phosphate-solubilizing fungi, *Pikovskaya's* agar, Organic acids, Sri Lanka

LS 58 ***Life Sciences***

A MACHINE LEARNING PIPELINE IDENTIFIES POTENTIAL SYNERGISTIC PHYTOCHEMICAL FABI INHIBITORS AND EVALUATION OF BIOFILM FORMATIONS IN UNIVERSITY ANIMAL FARM ENVIRONMENTS

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Bacterial enoyl-ACP reductase (FabI) is a key enzyme in fatty acid biosynthesis (FASII) that maintains the integrity of bacterial biofilm formations. Thus, it serves as a target for eradicating antibiotic-tolerant biofilms. Assessment of eight dairy farm sites using visual scoring and tissue culture plate assays (OD_{620}) revealed significant differences in biofilm burden (Kruskal–Wallis, $p = 0.001$); the Veterinary Farm Tank and Animal Science Farm Floor were identified as primary weakly adherent hotspots (ANOVA, $p < 0.001$; Tukey HSD, $p < 0.05$). An automated quantitative structure–activity relationship (QSAR) pipeline was constructed in KNIME using 166-bit MACCS structural fingerprints trained on curated ChEMBL FabI inhibition data. Supervised machine learning models (Random Forest, RProp MLP, and SVM RBF Kernel) achieved 99.7%-99.9% predictive accuracy in 10-fold stratified cross-validation. Virtual screening of 1,858 phytochemicals ($p \geq 0.50$), followed by Lipinski's Rule of Five and Small Molecule Rule (SMR 40–130) filtering in KNIME, identified two top quinolone derivatives: CHEMBL 4849380 and CHEMBL 4867555. Machine learning predictions indicated potential synergistic effects for both potential phytochemical candidates when combined with kanamycin. *In silico* PyRx molecular docking showed higher binding affinities for CHEMBL 4867555 (ΔG = -7.5 kcal mol^{-1}) than triclosan (ΔG = -6.8 kcal mol^{-1}), and it stabilizes within the *Staphylococcus aureus* FabI catalytic cleft through key hydrogen bonds with catalytic Tyr157, Lys164, and the NADP+ cofactor, alongside supporting hydrophobic interactions with Met99 and Phe204. Pharmacotoxicological profiling using ProTox 3.0 predicted favorable safety profiles (LD50 $\geq$ 3000 mg kg^{-1}), with CHEMBL 4867555 demonstrating potential low neurotoxicity. This integrated pipeline prioritizes potential FabI inhibitors for subsequent *in vitro* antimicrobial and anti-biofilm validation.

Keywords: Biofilms, FabI inhibitors, KNIME, Machine learning, Molecular docking

LS 59 ***Life Sciences***

KNIME INTERGRATED CNN-BASED DETECTION OF PHOSPHORUS DEFICIENCY IN CHILI PLANTS FROM MOBILE IMAGES: A PROOF-OF-CONCEPT STUDY

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Phosphorus (P) deficiency is widespread in chili (*Capsicum annuum* L.) grown on tropical soils and causes stunted growth, anthocyanin-driven purple discoloration of older leaves, and delayed flowering. Early diagnosis of this is difficult because these symptoms overlap with other disorders, and manual assessment is slow and subjective, creating a need for a rapid, non-destructive, scalable field-level diagnostic tool. To address this, we developed a KNIME (Konstanz Information Miner)-integrated CNN framework to detect P deficiency in chili using RGB images of the upper expanded leaf surface, captured at a fixed distance of 10 cm under natural daytime lighting with a Samsung rear camera (3000×4000 resolution). Most images came from P-deficient plants grown on washed coco peat supplied with a complete nutrient medium lacking only P. In contrast, others were sourced directly from fields showing visible symptoms. The dataset (43 images: 21 deficient, 22 healthy) was resized to 128×128 pixels, normalized via per-channel min-max scaling, and split 70:30 (29 training, 14 testing). The CNN comprised one convolutional layer (32 filters, 3×3, ReLU), 2×2 max-pooling, a flatten layer, a dense layer (128 units, ReLU), and a linear output layer, trained with Adam (lr = 1.0×10^{-4}) using categorical cross-entropy for 100 epochs; inference used the Keras Network Executor and Scorer nodes. The model achieved 85.71% test accuracy (12/14 correct; 2 false positives, 0 false negatives), 80% precision, 100% recall (likely reflecting the small size of the deficient-class sample rather than robust performance), an F1-score of 88.89%, and Cohen's kappa of 0.696, indicating substantial agreement beyond chance. With n = 14, one misclassification shifts accuracy by ~7%, so validating results at scale is a priority, alongside data augmentation, k-fold cross-validation, Grad-CAM interpretability, and bench marking against SVM/Random Forest. This study, therefore, represents a preliminary proof of concept that, upon further validation, could support P status assessment in chili as a complementary approach to conventional nutrient management.

Keywords: Crop health monitoring, Keras 2D CNN, KNIME image processing, Phosphorus deficiency

LS 60 ***Life Sciences***

ANALYSIS OF CHALLENGES FACED BY PHARMACISTS IN THE RETAIL CHAIN PHARMACIES IN SRI LANKA AND THE IMPACT OF THOSE CHALLENGES ON CUSTOMER SATISFACTION

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Retail chain pharmacies are a critical component of Sri Lanka's private healthcare system, yet the pharmacists who operate these outlets encounter complex challenges that compromise both service quality and commercial performance. This study aimed to identify the key challenges faced by pharmacists in retail chain pharmacies across Sri Lanka and to assess their impact on customer satisfaction. A descriptive cross-sectional study was conducted among 200 registered pharmacists using a validated, self- administered online questionnaire (Cronbach's $\alpha = 0.85$). Supply chain disruptions, demand forecasting difficulties, and limited automation were identified as the most significant operational challenges, followed by staff shortages and financial constraints. A statistically significant positive correlation was found between the frequency of medicine stock-outs and customer complaints ($r = 0.143$, $p = 0.043$), confirmed by chi-square analysis ($\chi^2 = 4.71$, $p = 0.030$), demonstrating that product unavailability directly undermines customer satisfaction and sales revenue. One-way ANOVA revealed that pharmacists with greater experience (>15 years) reported significantly fewer difficulties managing operational challenges ($F(4, 195) = 4.949$, $p = 0.001$). Pharmacists recommended expanding the product range (82%), investing in continuous staff training (63.5%), and adopting automated inventory management systems (51.5%) as priority interventions. These findings provide the first systematic, quantitative evidence on this topic in the Sri Lankan context, offering actionable guidance for pharmacy management, policymakers, and healthcare administrators seeking to strengthen the performance of retail chain pharmacies.

Keywords: Customer satisfaction, Operational challenges, Pharmacists, Retail chain pharmacies, Supply chain

LS 61 ***Life Sciences***

VIRUS VARIANT-INFORMED *IN SILICO* EPITOPE PREDICTION FOR A MULTI-EPITOPE CHIKUNGUNYA VACCINE TAILORED TO THE SRI LANKAN POPULATION

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Chikungunya, caused by the Chikungunya virus (CHIKV), is a re-emerging arboviral disease transmitted by *Aedes aegypti* and *Aedes albopictus* mosquitoes. It causes debilitating polyarthralgia, with the possibility of a chronic phase. Following the 2024-2025 Sri Lankan outbreak caused by a distinct Indian Ocean Lineage strain harboring novel mutations, and given the withdrawal of the IXCHIQ® vaccine and the short-lived seroresponsiveness of the VIMKUNYA® vaccine, a safe, effective vaccine tailored to currently circulating strains is urgently needed. Furthermore, current multi-epitope vaccine constructs typically use a single reference sequence and global Human Leukocyte Antigen (HLA) profiles, limiting their coverage in the Sri Lankan population. This study aims to address these gaps by predicting virus variant-informed epitopes specifically for the Sri Lankan population. It uses data from multiple CHIKV sequences spanning two epidemics in the country (2006-2008, 2024-2025) and focuses on high-frequency HLA alleles in the Sri Lankan population. Epidemic-specific consensus sequences were constructed from CHIKV sequences retrieved from NCBI GenBank. Proteins were screened for antigenicity using VaxiJen v2.0. Linear B-cell epitopes were predicted for proteins E1 and E2 using a dual BepiPred 2.0/3.0 consensus approach. MHC-I and MHC-II epitopes were predicted using NetMHCpan 4.1 and NetMHCIIpan 4.3, respectively, restricted to Sri Lanka-specific HLA alleles extracted from the Allele Frequency Net Database. The resulting candidates were filtered for antigenicity, non-allergenicity, and non-toxicity and underwent human homology screening using BLASTp. From 159,322 hits, 26 epitopes, computationally deemed safe, were identified in this process, pending experimental validation: Two B-cell (from E2 receptor binding domain), five MHC-I (Capsid: 2; E2: 1; nsP2: 2), and 19 MHC-II (spanning nsP2, E1, E2, and Capsid). The top MHC-II epitope bound 19 alleles found in the Sri Lankan population, demonstrating promiscuity. This study lays the groundwork for designing an *in silico* multi-epitope vaccine construct tailored against CHIKV in Sri Lanka.

Keywords: Chikungunya virus, Immunoinformatics, Multi-epitope vaccine, Population-specific, Sri Lanka

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IN-SILICO IDENTIFICATION OF *Carica papaya* PHYTOCHEMICALS AS POTENTIAL INHIBITORS OF CHIKUNGUNYA VIRUS nsP2 PROTEASE

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Chikungunya virus (CHIKV) is a mosquito-borne virus that causes severe joint pain, for which no specific antiviral treatment is currently available. The non-structural protein 2 (nsP2) protease is essential for viral polyprotein processing and replication, making it a potential antiviral drug target. This study explored phytochemicals from *Carica papaya* leaves for their potential to inhibit CHIKV nsP2 protease using computational methods. A library of 51 phytochemicals identified from published GC–MS profiles of *C. papaya* leaf extracts was compiled and evaluated for drug-likeness and pharmacokinetic properties using SwissADME based on Lipinski's Rule of Five. Nineteen compounds were selected for further analysis. The three-dimensional structure of CHIKV nsP2 protease (PDB ID: 3TRK) was prepared for docking using PyRx 0.8 with a grid box covering the entire protein (center: x = 14.2506, y = 25.5553, z = 22.3811), enabling assessment of binding at active and secondary regulatory sites. Fifteen compounds showed predicted binding affinities of ≤ −5.0 kcal/mol. Carpaine and quercetin showed the strongest binding, with docking scores of −8.3 and −7.8 kcal/mol, respectively. Both compounds were predicted to interact with residues in the catalytic region, including Cys1013 and His1083, suggesting potential interference with nsP2 protease function. Overall, carpaine and quercetin emerged as promising *C. papaya*-derived lead candidates for CHIKV antiviral research. Molecular dynamics simulations and subsequent *in vitro* and *in vivo* studies are required to validate binding stability, antiviral activity, and therapeutic potential.

The University Research Council (URC) Multidisciplinary Grant No. 516, University of Peradeniya acknowledged for providing funds for this research.

Keywords: *Carica papaya*, Carpaine, Chikungunya virus, Quercetin, Molecular docking, nsP2 protease

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IN SILICO PREDICTION OF ANTI-*Helicobacter pylori* ACTIVITY IN *Shorea* sp.: A MACHINE LEARNING APPROACH

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Helicobacter pylori is a gastric pathogen that induces the inflammation of the gastric mucosa, gastritis, and peptic ulcers. Identifying new antimicrobials is needed to address the growing global problem of antibiotic resistance. The genus *Shorea* (*Dipterocarpaceae*) has a rich history of traditional medicinal use and a diverse chemical profile of bioactive flavonoids, which is an unexploited source for drug discovery. The aim of this pilot study was to develop a machine-learning workflow to predict the anti-*H. pylori* potential of phytochemicals from *Shorea* species. A benchmark dataset of 50 reference compounds (26 active, 24 inactive against *H. pylori*) was compiled from literature-reported activity data, with molecular structures represented as SMILES. Molecular descriptors, including molecular weight, lipophilicity, rotatable bonds, ring count, heavy atom count, and fraction Csp3, were calculated using RDKit. Descriptors were standardized prior to model development. Random Forest, Support Vector Machine (SVM), and XGBoost classifiers were evaluated using a 70:30 train-test split with a five-fold cross-validation. The SVM model demonstrated the strongest predictive performance, achieving 80% test accuracy and an ROC-AUC of 0.965, and was subsequently applied to a library of 23 *Shorea*-reported phytochemicals compiled from published phytochemical literature, including flavonoids, stilbenoids, and alkaloids. Naringenin, luteolin, quercetin, myricetin, and fisetin were prioritized, with predicted probabilities of 93% for anti-H. *pylori* activity. This study represents the first computational application of machine learning to screen *Shorea* phytochemicals for activity against *H. pylori*. The prioritized candidates provide a basis for subsequent molecular docking and experimental validation, demonstrating the utility of computational screening for further ant-*H. pylori* investigation.

Keywords: Antimicrobial resistance, Flavonoids, *Helicobacter pylori*, Machine learning, *Shorea*

LS 64 ***Life Sciences***

EVALUATION OF *IN VITRO* ANTI-BACTERIAL ACTIVITY OF *Leucas zeylanica* AQUEOUS EXTRACT AGAINST *Staphylococcus aureus* AND *Escherichia coli*

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The problem of antimicrobial resistance is becoming a serious international health concern and is driving the search for new antibacterial compounds from natural sources. *Leucas zeylanica* (L.) is a plant species used in traditional medicine in Sri Lanka and India to treat skin infections, febrile conditions, and wounds. However, scientific research on the plant's antibacterial activity is limited, particularly for its aqueous extract. The antibacterial activity of the *L. zeylanica* (whole plant) aqueous extract was evaluated against Gram-positive and Gram-negative bacteria, namely Staphylococcus aureus (ATCC 29213) and Escherichia coli (ATCC 25922). The antibacterial activity was demonstrated using zones of inhibition from agar well diffusion, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) determined by broth microdilution. Two-fold serial dilutions (range: 10 to 0.0195 mg mL^{-1}) were prepared using ciprofloxacin as the positive control. The MIC and MBC of both organisms were the same (2.5 mg mL^{-1} and 5 mg mL^{-1}, respectively). The inhibition zones increased in a concentration-dependent manner, with *S. aureus* consistently showing larger zones than *E. coli* due to the additional outer membrane and lipopolysaccharide barrier of Gram-negative bacteria. The data for each concentration group were significantly different ($p < 0.001$). Notably, despite the membrane-induced difference in zone size, the MIC was the same for both organisms in liquid broth. The results indicated that the aqueous extract of *L. zeylanica* has potent antibacterial activity against both Gram-positive and Gram-negative bacteria, suggesting good potential as a natural source for developing new antibacterials effective against both types.

Keywords: Antibacterial, Aqueous extract, *Escherichia coli*, *Leucas zeylanica*, *Staphylococcus aureus.*

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PRELIMINARY EVALUATION OF A PHAGE SUSCEPTIBILITY TEST (PST) FOR THE EVALUATION OF BACTERIOPHAGE ACTIVITY AGAINST ANTIBIOTIC-RESISTANT BACTERIA

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Antimicrobial resistance (AMR) is a major global health concern, necessitating alternative strategies for controlling multidrug-resistant (MDR) bacterial infections. Bacteriophages have gained renewed interest as antimicrobial agents because of their ability to specifically infect and lyse bacterial hosts. However, unlike Antimicrobial Susceptibility Testing (AST), no universally standardized method exists for determining bacterial susceptibility to bacteriophages. This study aimed to isolate lytic bacteriophages from environmental sources and develop a laboratory-based Phage Susceptibility Test (PST) analogous to conventional AST. Wastewater samples were collected from the Gatambe water treatment plant and processed for phage isolation using *Escherichia coli* ATCC as the host. Phages were isolated, propagated, and confirmed using a spot assay. AST of four field *E. coli* isolates was performed by disk diffusion according to CLSI guidelines. PST was developed by spotting purified phage lysates onto bacterial lawns and categorizing lytic activity as Sensitive, Intermediate, or Resistant. Four field isolates were classified as MDR, showing resistance to tetracycline, ampicillin, and trimethoprim-sulfamethoxazole. Despite MDR status, all isolates were susceptible to at least two bacteriophages. Among the five phages, P2 and P3 demonstrated the broadest host range, producing complete lysis across all isolates (100%), while P4 lysed 75% of isolates. P1 and P5 showed limited activity. A cocktail of P2, P3, and P4 provided the broadest coverage against MDR isolates. These findings demonstrate the feasibility of a simple, rapid assay for assessing isolate-specific phage susceptibility and preliminary selection of candidate phages. However, the proposed PST requires optimization and validation with larger, more diverse collections of bacterial isolates and phages, including assessment of reproducibility and the use of defined interpretation criteria, before standardization.

Keywords: Antimicrobial Susceptibility Testing (AST), Bacteriophages, *Escherichia coli,* Multidrug-resistant bacteria, Phage Susceptibility Test (PST)

LS 66 ***Life Sciences***

USE OF MULTIPLEX PCR FOR DETECTION OF *E. coli* O157:H7 IN FRESH CHICKEN SAMPLES

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Accurate detection of *Escherichia coli* O157:H7 in poultry is critical for food safety surveillance, given its potential to cause severe foodborne diseases and pose significant public health risks. This study investigated the presence of *E. coli* O157:H7 in fresh chicken using multiplex PCR (m-PCR). Gut, neck, and liver samples were collected from 15 freshly slaughtered chickens in Kandy District, Sri Lanka, yielding 45 samples, and analyzed for *E. coli* using conventional methods, followed by PCR targeting the 16S *rRNA* gene, which is unique to *E. coli.* Confirmed *E. coli* isolates were screened on CT-SMAC agar, with colorless, non-sorbitol-fermenting colonies considered presumptive *E. coli* O157:H7. m-PCR targeting the *eaeA* and $fliC_{h7}$ genes was performed on all confirmed *E. coli* isolates to confirm molecular identity. AMR profiling was conducted against eight different antibiotics using the Kirby-Bauer disk diffusion method. *E. coli* ATCC 25922 and a previously characterized O157:H7 isolate were used as positive controls. 30 (66.67%) isolates were confirmed as *E. coli* by PCR. Two isolates (4.44%) were presumptively identified as *E. coli* O157:H7 based on CT-SMAC characteristics; one was positive only for $fliC_{h7}$, while the other was positive only for *eaeA*. Among other genetically confirmed *E. coli* isolates [28/45 (62.22%)], 28.89% were positive for both target genes, indicating the presence of O157:H7-associated genetic markers. Among the samples, 20.00% were positive for a single target gene, and 13.33% were negative for both markers, indicating diverse gene patterns. Overall detection rates of *eaeA* and $fliC_{h7}$ were 46.67% and 31.11%, respectively. AMR profiling revealed high resistance to tetracycline (86.67%), ampicillin (83.33%), sulfamethoxazole (63.33%), and ciprofloxacin (50%), with distinct multidrug resistance (MDR) patterns. However, high susceptibility was observed to gentamicin (96.67%), ceftriaxone (93.33%), and streptomycin (56.67%). These findings highlight the importance of molecular surveillance of O157:H7-associated markers and antimicrobial resistance in chicken.

Financial assistance from URG/2023/36/V is acknowledged.

Keywords: AMR profiling, CT-SMAC, *E. coli* O157:H7, Multiplex PCR

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GRADED REPLACEMENT LEVELS OF FISH MEAL WITH MEAT AND BONE MEAL IN DIETS OF GIFT TILAPIA: EFFECTS ON GROWTH, BODY COMPOSITION, AND DIGESTIBILITY

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The growing demand for fish meal and constraints on its supply have intensified the need for sustainable alternative protein ingredients in aquafeed formulations. Meat and bone meal (MBM), a widely available livestock processing by-product, offers a viable alternative due to its high protein content, rich mineral profile, and absence of plant-derived anti-nutritional factors. To evaluate its efficacy, we hypothesized that replacing up to 50% of imported fish meal with MBM would maintain growth performance, feed utilization, and physiological health in Genetically Improved Farmed Tilapia (GIFT) fingerlings (*Oreochromis niloticus*) while reducing reliance on fish meal. Six isonitrogenous (34% crude protein) and isolipidic (7% crude fat) diets were formulated by replacing imported fish meal on a weight-for-weight basis at 0% (Control, 38% fish meal), 10% (MBM10), 15% (MBM15), 20% (MBM20), 25% (MBM25), and 50% (MBM50; 19% fish meal). Each diet was assigned in triplicate, with 12 fish per tank. Over a 112-day trial, parameters were evaluated using one-way ANOVA and Tukey's pairwise test ($p < 0.05$). Statistical comparisons revealed no significant differences or dose-dependent trends in final body weight, body length, specific growth rate, feed conversion ratio, protein efficiency ratio, survival rate, hepatosomatic index, viscerosomatic index, and most hematological parameters ($p < 0.05$). However, the apparent digestibility coefficient (ADC) of protein was significantly lower across all MBM diets than in the control ($p < 0.05$). Muscle crude fat exhibited a progressive, dose-dependent decrease as MBM inclusion increased ($p < 0.05$), while body protein content remained unchanged. Qualitative histological evaluations revealed no adverse structural alterations in liver hepatocytes or intestinal architecture. Overall, MBM can replace up to 50% of fish meal by weight without compromising short-term growth or health in GIFT tilapia. However, given the reduced protein digestibility, long-term feeding impacts, amino acid balance, and economic feasibility, further evaluation is warranted.

Keywords: Body composition, GIFT tilapia, Meat and bone meal, Nutrient digestibility, Sustainable aqua-feeds

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HIGH PREVALENCE OF ENTERIC PATHOGENS IN RETAIL FOODS FROM COLOMBO, SRI-LANKA: IMPLICATIONS FOR ONE HEALTH-BASED FOOD SAFETY SURVEILLANCE

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Enteric bacteria are major causes of foodborne illness worldwide, yet information on retail food contamination in Sri Lanka remains limited. This study assessed the occurrence of *Salmonella* spp., *Shigella* spp., and *Escherichia coli* in fresh vegetables and raw meat obtained from selected supermarkets and street vendors within the Colombo District, Sri Lanka. A total of 96 samples comprising cabbage, carrot, tomato, gotukola, chicken, and fish were analyzed using culture-based isolation methods. Additionally, 28 presumptive *E. coli* isolates were screened by polymerase chain reaction (PCR) for the virulence-associated genes *stx*1, *stx*2, and *eae*. Among vegetable samples, supermarket produce showed occurrence rates of 60.7% for *Salmonella*, 39.3% for *E. coli*, and 7.1% for *Shigella*, while street-vendor vegetables recorded rates of 50.0%, 25.0%, and 10.7%, respectively. Raw meat samples exhibited substantially higher contamination levels, with *Salmonella* and *E. coli* detected in 95% and 85% of supermarket meat samples, respectively, and in 100% of street-vendor meat samples. *Shigella* spp. were detected in 25% of supermarket meat samples and 20% of street-vendor meat samples. Co-occurrence of multiple enteric bacteria was frequently observed, particularly in chicken and fish samples. Although contamination levels were generally higher among street-vendor meats, widespread bacterial contamination was evident across both retail sectors. None of the 28 presumptive *E. coli* isolates screened by PCR carried the virulence-associated genes *stx*1, *stx*2, or *eae*. The high prevalence of enteric bacterial contamination in commonly consumed foods highlights significant food safety concerns and underscores the need for improved hygienic handling practices, Hazard Analysis and Critical Control Point (HACCP)-based control measures, and integrated One Health surveillance systems to reduce the burden of foodborne diseases in Sri Lanka.

Keywords: *Escherichia coli*, foodborne pathogens, *Salmonella* spp., *Shigella* spp., One health

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MOLECULAR DETECTION OF ANTIBIOTIC RESISTANCE AND VIRULENCE GENES IN *Escherichia coli* ISOLATED FROM EDIBLE FISH IN THE KELANI RIVER, SRI LANKA

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Antimicrobial resistance (AMR) in aquatic environments is an increasing public health concern, particularly in rivers affected by domestic, agricultural, and industrial activities. Fish may harbor antibiotic-resistant and pathogenic bacteria, posing risks through handling and consumption. This study investigated antibiotic susceptibility and selected virulence and resistance genes in *Escherichia coli* isolated from edible *Oreochromis mossambicus* and *Oreochromis niloticus* collected from the Kelani River, Sri Lanka. Isolates underwent susceptibility testing at selected concentrations of Cefotaxime (CTX), Ciprofloxacin (CIP), Tetracycline (TET), Gentamicin (GEN), and Piperacillin (PIP), followed by PCR detection of species-specific, virulence, and resistance-associated genes. The *uidA* gene identified *E. coli*, while *intI*1 indicated class 1 integrons associated with horizontal gene transfer. Among 22 isolates, growth at the highest concentrations occurred for CTX in 3/22 (14%) at 128 µg mL^{-1}, CIP in 4/22 (18%) at 32 µg mL^{-1}, TET in 2/22 (9%) at 128 µg mL^{-1}, and GEN in 1/22 (5%) at 64 µg mL^{-1}, whereas no growth occurred with PIP at 512 µg mL^{-1}. Virulence analysis detected *stx*2 in 4/4 (100%) gill and 1/1 (100%) gut isolates, while *eae* was most prevalent in skin isolates (4/5, 80%); *stx*1 was not detected. Among resistance genes, *qnrB* occurred in all gill (4/4), skin (5/5), and gut (1/1) isolates, while *blaTEM* occurred in all gill isolates (4/4). The occurrence of virulence and resistance determinants in *E. coli* associated with edible fish highlights the potential role of aquatic food chains in AMR dissemination and the need for routine surveillance and improved management of riverine pollution to protect public health.

Research Council of the University of Sri Jayewardenepura, Sri Lanka (Grant No: RC/URG/SCI/2024/34), and Hayleys Fabric PLC, Sri Lanka, are acknowledged.

Keywords: Antibiotic resistance genes, Antimicrobial resistance, *Escherichia coli*, Kelani River, Virulence genes

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EVALUATION OF THE WOUND HEALING POTENTIAL OF BABY COCONUT (*Cocos nucifera*) EXTRACT USING AN *IN VIVO* ANIMAL MODEL

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Wound healing is a complex biological process that is challenged by microbial infections, oxidative stress, and the side effects of synthetic drugs. This has increased interest in natural therapeutics, which may offer fewer side effects, antimicrobial benefits, and a broader range of bioactive compounds. Various parts of *Cocos nucifera* (coconut) are recognized for their medicinal value, and in traditional Sri Lankan practice, baby coconuts (3–6 weeks after pollination) have been used for wound dressings. However, its therapeutic potential remains insufficiently validated. This study evaluated the wound-healing properties of baby coconut extracts. Dry baby coconut powder was extracted with hot water by reflux for 3 h, and with cold water and water: acetone (1:1) by maceration (24 h × 3). The animal study was approved by the Animal Ethics Committee of the University of Peradeniya. Extracts were incorporated into topical formulations and evaluated *in vivo* using *Mus musculus* Balb/c mice. Animals were divided into six groups (n=6): positive control, negative control, base cream, hot-water extract, cold-water extract, and water: acetone extract. Mice were anesthetized with ketamine/xylazine, depilated, and 5-mm dorsal wounds were created using biopsy punchers. Treatments were applied once daily until day 21, and wound contraction and histopathological changes were assessed. Baby coconut extracts significantly enhanced wound healing. After 21 days, wound contraction was highest in the positive control (99.77%), followed by hot water extract (99.75%), cold water extract (99.62%), and water: acetone extract (95.63%), all significantly exceeding the base cream (87.28%) and negative control (85.57%) (p<0.05; ANOVA). Histology confirmed increased collagen deposition and re-epithelialization in the hot-water extract group. These findings demonstrate the promising wound-healing activity of baby coconut extracts, potentially linked to bioactive phytochemicals, thereby supporting traditional use and warranting further pharmaceutical investigation.

Financial assistance from the Faculty of Science, University of Peradeniya, AHEAD grant (Grant No AHEAD/RA3/UBL/PDN/OVAA/20 - wound healing) is acknowledged.

Keywords: Animal study, *Cocos nucifera,* wound healing

LS 71 ***Life Sciences***

ANTIOXIDANT CAPACITY AND BIOACTIVE PROFILING OF CYANOBACTERIAL STRAINS ISOLATED FROM DIVERSE ECOSYSTEMS ACROSS SRI LANKA

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Research on natural antioxidants has predominantly focused on plants, leaving cyanobacteria from biodiverse tropical regions largely unexplored. This study profiled six cyanobacterial strains isolated from distinct Sri Lankan ecosystems, including an unidentified mat-forming filamentous cyanobacterium designated C74. Antioxidant activity was assessed using DPPH radical-scavenging and ferric-reducing antioxidant power (FRAP), while total phenolic content (TPC) and carbohydrate content were measured as complementary biochemical parameters. Clear functional differences were observed among the dry crude extracts. *Cylindrospermopsis raciborskii* showed the highest FRAP value (34.28 ± 1.56 mg Fe^{2+}/g dw, $p < 0.001$), nearly five times higher than C74 (7.15 ± 0.62 mg Fe^{2+}/g dw). In contrast, C74 contained the highest phenolic content (31.38 ± 0.05 mg GAE/g, $p < 0.01$), exceeding all identified strains, including *Phormidium irrigum* (20.66 ± 0.23 mg GAE/g). Higher phenolic content did not necessarily correspond to stronger radical-scavenging activity. *P. irrigum* showed the strongest DPPH activity (38.78 ± 4.60 mg TE/g) despite lower phenolic content than C74, whereas *Spirulina subsalsa* showed the lowest DPPH activity (18.96 ± 0.35 mg TE/g) despite no detectable phenolics. Thus, phenolic content alone may not reliably predict antioxidant capacity. Carbohydrate content also varied considerably; *Chrooccodiopsis* sp. had the highest level (38.46 ± 14.17% w/w, $p < 0.05$) and moderate antioxidant activity. One-way ANOVA confirmed significant inter-strain differences in FRAP ($F(4,10) = 607.61$, $p < 0.001$), DPPH ($F(5,12) = 29.49$, $p < 0.001$), and TPC ($F(4,10) = 6937.62$, $p < 0.001$), with Tukey's HSD identifying specific differences. These differences suggest that habitat and growth form may influence bioactive compound production. For nutraceutical applications, *C. raciborskii* provides strong reducing power, while C74 offers a phenolic-rich candidate for further taxonomic and metabolomic investigation. Future work should focus on purification and structural characterization of bioactive compounds from these strains.

Keywords: Antioxidant activity, *Cylindrospermopsis,* cyanobacterial bioactive compounds, phenolic content

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MICROPLASTIC CONTAMINATION IN RICE CULTIVATION: EFFECTS AND BIOFILM BIOFERTILIZER-BASED REMEDIATION STRATEGIES

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Microplastics (MP) contamination, particularly from polyethylene-derived microplastics (PE-MP), poses a growing threat to agricultural productivity and soil health. This study aimed to evaluate the effects of PE-MP on rice (*Oryza sativa* L.) cultivation and to assess the potential of biofilm biofertilizer (BFBF) as a sustainable remediation strategy. A greenhouse pot experiment was conducted using two PE-MP concentrations, *i.e.*, 0.1% and 0.2%, with a control of 0% W/W, in triplicate, under two fertilizer practices, viz. (a) 100% chemical fertilizer (CF) (Department of Agriculture recommendations) and BFBF (50% CF + 2.5 L ha^{-1} of BFBF). Plant growth, soil physicochemical properties, microbial abundance, and arbuscular mycorrhizal fungi (AMF) colonization were evaluated. The data were analyzed with a two-way ANOVA in Minitab 21. Means were compared using Tukey's Honestly Significant Difference (HSD) test at $p < 0.05$. FTIR spectroscopy was used to assess the presence and breakdown of PE-MPs in soil after three months of rice cultivation. Results revealed that the chlorophyll content ($p = 0.081$) and shoot length ($p = 0.097$) were higher with 0.2% PE-MP concentration under BFBF practice. Moreover, in the BFBF practice, the characteristic FTIR diagnostic bands of PE-MP were reduced by 99.65% and 62.97% under the 0.1% and 0.2% treatments, respectively, indicating a substantial apparent reduction in detectable PE. AMF colonization also increased with the application of BFBF. These findings demonstrate that the BFBF has potential in remediating PE-MP contamination in paddy agroecosystems. Further research should be conducted under field conditions to confirm the efficacy of the BFBF.

Keywords: AMF, BFBF, Microplastics, Rice, Paddy cultivation



Physical Sciences

PS 01 ***Physical Sciences***

PREDICTING THE AVERAGE ATMOSPHERIC NITROGEN DIOXIDE CONCENTRATIONS IN SELECTED AREAS OF KANDY, SRI LANKA USING INVERSE DISTANCE WEIGHTED TECHNIQUE

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Urbanization and the ongoing increase in traffic flow have badly affected air quality in Sri Lanka's urban areas. Kandy, a major administrative and heritage hub, stands out as one of the most affected areas due to its unique topography and high vehicle density. Vehicular emissions represent a primary contributor to ambient air pollution; therefore, monitoring atmospheric Nitrogen Dioxide (NO_2) concentrations is essential for effective environmental management. This study aimed to develop a spatial interpolation framework to estimate annual average atmospheric NO_2 concentrations at unsampled locations in Kandy using available data. Monthly NO_2 observations recorded in 2022 were obtained from the National Building Research Organization (NBRO), and the annual average NO_2 concentration was calculated for the monitoring stations using the available monthly observations. Data from ten monitoring stations were used for spatial interpolation analysis. The Inverse Distance Weighting (IDW) technique was applied to estimate the NO_2 concentration level at forty-seven selected unsampled locations. The IDW method was selected because it is a simple, widely used deterministic interpolation technique suitable for estimating values at unsampled locations from limited monitoring data. This study also provides a spatial interpolation framework to estimate annual average NO_2 concentrations and identify pollution hotspots in Kandy using available monitoring data. The model's predictive performance was evaluated using Absolute Error via Leave-One-Out Cross-Validation (LOOCV). The results showed that the estimated concentrations closely followed the observed values, yielding a low absolute error, indicating the suitability of the IDW method for this study. The estimated annual average NO_2 levels ranged from $32.46\ \mu gm^{-3}$ to $58.63\ \mu gm^{-3}$. These spatial insights provide a solid scientific framework for urban planners and environmental authorities to implement data-driven pollution mitigation strategies in Kandy.

Keywords: Air pollution, Inverse distance weighting, Kandy, Nitrogen dioxide, Spatial interpolation

PS 02 ***Physical Sciences***

DEVELOPMENT OF A NOVEL PACKED COLUMN CHROMATOGRAPHIC STATIONARY PHASE USING THE STEM OF *Tephrosia purpurea* (KATHURUPILA) PLANT POWDER

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A novel plant-derived stationary phase was developed and evaluated from *Tephrosia purpurea* (Kathurupila) stem powder in a preliminary study, demonstrating its potential for separating low-molecular-weight dyes and closely polar organic analytes. The powder material was obtained by collecting, drying, grinding, washing, and sieving the stems into particles below 300 µm and 500 µm. Characterization was carried out by Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Thermogravimetric Analysis (TGA), Energy Dispersive Infrared Spectroscopy (EDS), and Gas Chromatography (GC). Results obtained from the FTIR spectra revealed the presence of hydroxyl, carbonyl, aromatic, and glycosidic functional groups. The SEM images showed surface porosity and a rough surface texture, both favorable for adsorption. The TGA confirmed thermal stability up to 250 ℃. The EDS indicated a carbon-to-oxygen ratio of approximately 1.04 due to a plant matrix rich in hydroxyl groups. The chromatographic performance was evaluated using colored dyes (azo violet, metanil yellow, and alizarin red S) and organic compounds with slightly polar differences (naphthalene and anthracene), with benzene as the non-retained solute. Separations were performed using an acetonitrile: distilled water (9:1, v/v) mobile phase, with silica gel as the control packing material. The optimized system yielded retention factors for the colored dyes in the range of 2.72-4.09, selectivity factors of 1.14-1.31, and separation efficiencies of 78%-81% at a particle size of 300 µm, with a *Tephrosia purpurea* packing density of 0.375 g/cm^3. Naphthalene and anthracene exhibited retention factors between 0.27 and 1.10, with a selectivity factor of 4.83, demonstrating excellent selectivity for low-molecular-weight colorless organic compounds and ≈90% GC recovery, compared with 2.87 selectivity on silica gel. The finding suggests that *Tephrosia purpurea* stem powder has cost-effective, biodegradable, sustainable, and stationary-phase potential as a green alternative to conventional silica gel stationary phase.

Keywords: Adsorption, column chromatography, green chemistry, stationary phase, *Tephrosia purpurea*

PS 03 ***Physical Sciences***

PERFORMANCE ENHANCEMENT OF DYE-SENSITIZED SOLAR CELLS USING POLYANILINE AND EGGSHELL MEMBRANES

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Dye-sensitized solar cells (DSSCs) offer a low-cost and environmentally friendly alternative to conventional photovoltaics but often face a trade-off between achieving high efficiency and long-term stability. Bio-derived materials can enhance durability but often compromise electrical performance, whereas conductive additives improve charge transport at the expense of stability. This study addresses this challenge by developing a multi-layer TiO_2 photoanode that integrates the durability of biogenic eggshell membranes (ESM) with the conductive functionality of polyaniline (PANI). PANI was synthesized, and the formation of its conductive emeraldine salt form was confirmed using X-ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR). A six-layer photoanode architecture was designed with 1 wt.% PANI into the fourth layer and 10 wt.% ESM into the top layer, relative to the weight of TiO_2, positioning PANI within the electron transport pathway to lower series resistance while the ESM layer suppressed interfacial recombination, as confirmed by impedance spectroscopy. The resulting cell (TE-PANI) was compared to two control cells: a standard six-layer TiO_2 cell (T) and a six-layer cell containing a TiO_2/ESM composite in the top layer (TE). The cells were assembled using N719 dye-sensitized photoanodes, a Pt counter-electrode, and a binary salt gel-polymer electrolyte. The TE-PANI cell achieved a peak power conversion efficiency of 3.69%, with a short-circuit current density of 7.53 mA cm^{-2}, an open-circuit voltage of 0.73 V, and a fill factor of 0.67. This represents a 19% improvement over TE (3.11%) and approaches the pure TiO_2 benchmark (3.86%). During a 3-hour operational stability test, both TE-PANI and TE demonstrated excellent durability, maintaining or slightly enhancing their performance, whereas the standard T cell showed a significant decrease. This work presents a validated multilayer design strategy that integrates conductive polymers into a stable biogenic framework, offering a promising pathway toward efficient, durable bio-hybrid DSSCs.

Financial assistance from PGIS (Grant No: PGIS/2022/12) is acknowledged.

Keywords: Bio-hybrid materials, Dye-sensitized solar cells, Eggshell membranes, Polyaniline

PS 04 ***Physical Sciences***

CHARACTERIZATION OF PREMIUM BLACK TEA GRADES BASED ON POLYPHENOL, CATECHIN, AND CAFFEINE COMPOSITION

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Total polyphenols (TPP), catechins (CT), and caffeine (CF) are key bioactive compounds in *Camellia sinensis* (tea) that influence key quality attributes, including astringency, bitterness, taste, and aroma. Their concentrations, therefore, serve as important indicators of tea quality and are closely associated with commercial value. This study investigated the variation of these contents among premium and off-grade black teas in Sri Lanka. Using a stratified sampling approach, 200 samples from independent production batches comprising five premium-grade categories and off-grade teas were collected from 74 tea factories across high-, low-, and mid-grown regions. This includes long leaf family orthodox (n = 46), hybrid family orthodox (n = 44), orthodox-rotorvane (n = 40), pekoe family orthodox (n = 10), Crush-Tear-Curl (n = 10), and off-grade (n=50) teas. TPP was determined by following ISO 14502-1, and CT and CF were analyzed according to the ISO 14502-2 (2005) method. Statistical analysis using Welch's two-sample t-test revealed significant differences between premium and off-grade teas for all parameters. Premium teas exhibited higher TPP (18.31 ± 3.70 vs. 16.17 ± 2.46), CT (4.65 ± 1.58 vs. 3.52 ± 1.08), and CF (3.30 ± 0.79 vs. 2.89 ± 0.49); all values in % (all $p < 0.001$), likely reflecting superior leaf quality and careful processing practices. The statistical analysis further revealed no distinct clustering among the five premium tea categories based on these contents. All samples exceeded the minimum threshold of 9% specified in ISO 3720:2011, indicating consistently high biochemical quality across the samples analyzed. Overall, this study establishes a chemical reference profile for premium Sri Lankan black teas and demonstrates that the investigated chemical markers, individually and collectively, have limited discriminatory power in differentiating tea grades, suggesting that grade classification is influenced by factors beyond chemical composition alone.

Keywords**:** Caffeine, Catechin, Chemical profiling, Polyphenol, Sri Lankan premium tea grades

PS 05 ***Physical Sciences***

MICROWAVE-ASSISTED SYNTHESIS OF ZINC OXIDE (ZnO) PARTICLES VIA SIMPLE CHEMICAL METHOD FOR APPLICATION IN SOLAR CELLS

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This study presents a microwave radiation-assisted chemical method for preparing different ZnO structures to customize the performance of dye-sensitized solar cells (DSSCs). For this purpose, $Zn(OH)_2$ precursors were prepared through dropwise addition to a solution with capping agents, followed by microwave irradiation to produce ZnO particles. The test electrodes consisted of three spin-coated TiO_2 layers and a buffer layer (fourth layer) coated using synthesized ZnO. The characterizations were carried out using a current-voltage measurement setup, a solar simulator, a scanning electron microscope (SEM), and a UV-visible spectrometer. SEM analysis revealed that microwave power significantly affected ZnO morphology and particle size, resulting in irregular plate- and flake-shaped structures and nonuniform grain sizes. Cells prepared with ZnO and capping agents exhibited poor performance due to residual grains from the capping agents within the structure. The highest power conversion efficiency (PCE) of 1.49% was achieved with small flake-shaped ZnO microparticles (average particle size: length 1.1 μm, diameter 282.3 nm, and bandgap 2.41 eV) compared with 1.44% by irregular plate-shaped structure. However, PCE was low due to a thick layer of micrometer-sized ZnO flakes on TiO_2. Intermediate traps by oxygen vacancies reduced the band-gaps of the flakes, as reported in previous studies. Both PCE and current density improved with decreasing particle sizes. In contrast, irregular plate-shaped ZnO exhibited the maximum short-circuit current density of 3.17 mA cm^{-2} (bandgap 3.21 eV). Notably, the photoelectric performance was highly dependent on the morphology of the ZnO particles in the buffer layer, underscoring the method's potential to optimize low-cost DSSC photoanodes.

Financial assistance from the PGIS grant (Grant No: PGIS/2022/12) is acknowledged.

Keywords: Bandgap, Buffer layer, Current density, Photoanode, Power conversion efficiency

PS 06 ***Physical Sciences***

COMPARATIVE ANALYSIS OF ROOM-TEMPERATURE GAS SENSING PERFORMANCE OF NATURAL AND SULFUR-DOPED GRAPHITE FOR AMMONIA, ETHANOL, AND ACETONE DETECTION

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Gas sensing technologies are increasingly important for ensuring safety, environmental sustainability, and public health by rapidly detecting hazardous volatile compounds. Nevertheless, achieving efficient gas sensing at room-temperature remains a significant challenge due to limited sensitivity and slow response-recovery characteristics. In this study, the gas sensing performance of a 2 wt.% A sulfur (S)-doped Sri Lankan natural graphite-based sensor was investigated for sensing ammonia (NH_3), ethanol (C_2H_5OH), and acetone (C_3H_6O) vapors under ambient conditions. Prior to preparing the coating mixture, the graphite sample was manually ground for 45 minutes to obtain a more uniform, finely dispersed graphite. The composite was then formulated into a paste by mixing it with 75 wt% C_3H_6O and distilled water. Then, thin films were deposited on indium tin oxide substrates using the doctor-blade technique, followed by thermal treatment at 100 ℃ to ensure complete evaporation of distilled water and C_3H_6O. Structural characterizations were conducted using X-ray diffraction (XRD) and UV-visible absorption spectroscopy. Gas-sensing performance was evaluated at room temperature using 1000 mgL^{-1} concentrations of NH_3, C_2H_5OH, and C_3H_6O vapors. UV–visible spectra revealed that the optical band gap of the S-doped graphite was approximately 2.507 eV. Compared with undoped natural graphite, the 2 wt.% S-doped sensor exhibited enhanced sensitivity of 7.93%, 8.38%, and 24.49% towards NH_3, C_2H_5OH, and C_3H_6O, respectively, corresponding to improvements of 24.29, 17.04, and 2.13%. Furthermore, the response times were reduced by 27.27, 48.39, and 20.00% while the corresponding recovery times decreased by 60.87, 9.09, and 27.27% for NH_3, C_2H_5OH, and C_3H_6O, respectively. The results demonstrate that S-doping significantly enhances both sensitivity and response-recovery characteristics compared to the natural graphite gas sensor. The improved performance highlights the potential of S-doped natural graphite sensors as an efficient, low-cost material for room-temperature gas sensing applications.

Keywords: Doctor blade method, Gas sensitivity, Gas sensors, Sulfur-doped graphite, Sri Lankan graphite

PS 07 ***Physical Sciences***

MECHANICAL CHARACTERIZATION AND MICROMECHANICAL MODELING OF *Hibiscus tiliaceus* (BELLY-PATTA) BAST-FIBER REINFORCED POLYESTER COMPOSITES FOR LIGHTWEIGHT AUTOMOTIVE BODY-PANEL APPLICATIONS

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Sustainable mobility has renewed interest in plant-derived reinforcements for lightweight polymer composites. This study characterized the tensile behavior and micromechanics of chopped *Hibiscus tiliaceus* (Belly-Patta) bast fibers in an unsaturated polyester matrix for non-structural racing-car body panels. Fibers were extracted from mature stems by solar drying, alkali mercerization (1 M NaOH, 1 h at 80 °C, covered, stirred bath), sodium sulfite bleaching, deionized water rinsing, and manual splicing with coconut oil lubricant. Aspect ratio (≈50–60) was measured by optical microscopy on 50 fibers. Fibers were dispersed in polyester at Vf ≈15% and cured at ambient temperature with 3 vol.% MEKP; staged addition under continuous shear ensured uniform dispersion, confirmed by polished cross-sections. ASTM D3039 random-discontinuous coupons (250 mm length, 25.0 × 2.5 mm cross-section, 138 mm gauge length) were tested quasi-statically (n = 6). Mean tensile strength was 20.03 ± 1.65 MPa, Young's modulus 1.96 ± 0.15 GPa, and strain-at-failure 2.25 ± 0.19%. Compared with neat polyester (15.20 ± 0.80 MPa; 1.35 ± 0.05 GPa), two-tailed Student's t-tests confirmed gains of 31.8% in strength (t = 7.19, p < 0.001) and 44.8% in stiffness (t = 9.79, p < 0.001), with Cohen's d ≥2.9. Strength followed a two-parameter Weibull model (m ≈14.2, R^2 = 0.96), estimated by least-squares regression using median-rank probabilities. Among Voigt, Reuss, Halpin–Tsai, and modified rule-of-mixtures models (η = 3/8), the modified model predicted EC = 1.82 GPa, within 7.6% of experiment. SEM revealed incompletely separated fiber bundles and lumen porosity, limiting load transfer. *H. tiliaceus* is a credible low-cost reinforcement for non-load-bearing automotive panels.

Financial assistance from CodeGen International (Pvt) Ltd is acknowledged.

Keywords: Alkali treatment, bast fiber, *Hibiscus tiliaceus*, rule of mixtures, Weibull Statistics

PS 08 ***Physical Sciences***

EVALUATION OF TOTAL PHENOLIC CONTENT, TOTAL FLAVONOID CONTENT, AND FERRIC REDUCING ANTIOXIDANT POWER OF *Pityranthe verrucosa* EXTRACTS

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Pityranthe verrucosa Thw. is an endemic plant in Sri Lanka, which is found predominantly in the dry zone. However, P. verrucosa remains underexplored in terms of phytochemical profiling and bioassay studies. Therefore, this study aimed to evaluate the total phenolic content (TPC), total flavonoid content (TFC), and ferric reducing antioxidant power (FRAP) of dried leaves and bark of the P. verrucosa. Sequential extraction with hexane, ethyl acetate, and methanol, and separate hot- and cold-water extractions were performed. The TPC, TFC, and FRAP were analyzed using standard assays. All analyses were performed in triplicate (n = 3), and data were analyzed using one-way ANOVA followed by Tukey's test at $p < 0.05$. TPC varied considerably, with the highest value observed in the cold-water bark extract (76.99 ± 19.12 mg GAE/g) and the lowest in the methanol leaf extract (2.18 ± 0.19 mg GAE/g); TPC was not quantifiable in the hexane and ethyl acetate extracts under the assay conditions. Methanol extracts (13.77 ± 0.01 mg CE/g) exhibited the highest TFC values, followed by the Ethyl Acetate extracts (7.53 ± 0.01 mg CE/g – 10.03 ± 0.01 mg CE/g), while the hexane extracts (0.54 ± 0.70 mg CE/g – 4.41 ± 0.53 mg CE/g) showed the lowest. Between the parts, leaves showed higher TFC than bark (leaves > bark) in hexane and hot water extracts, while bark > leaves in methanol and ethyl acetate extracts. The FRAP assay results showed the highest values for methanol extracts among all the extracts at 1000 ppm; leaves (2.73 ± 0.08 mmol FeSO4/g) < bark (6.88 ± 0.03 mmol FeSO4/g). Both values were significantly lower ($p < 0.05$) than Trolox (7.46 ± 0.09 mmol $FeSO_4$/g). These results emphasize the significant effect of solvent polarity and plant part on the phytochemical yield and antioxidant capacity of Pityranthe verrucosa extracts, highlighting their potential as a source of natural antioxidant compounds for future pharmaceutical and nutraceutical applications.

Financial assistance from SLCARP (Grant No IIMD/2025/NIFS/01) is acknowledged.

Keywords: Ferric reducing antioxidant power, *Pityranthe verrucosa*, Total flavonoid content, Total phenolic content

PS 09 ***Physical Sciences***

LOW-ENERGY SUSTAINABLE BRICKS INCORPORATING SAWDUST WASTE UNDER FIRED AND CHEMICAL HARDENING

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Growing environmental concerns over fired clay bricks have increased demand for sustainable waste-based construction materials. This study investigates sawdust bricks produced by firing and chemical hardening. The objective was to evaluate the effect of sawdust content on their physical, mechanical, and thermal properties. Sawdust partially replaced clay at 5–20% in fired bricks and 25–75% in chemically hardened bricks. Mahogany sawdust was used as powder (1.0 mm mesh) and small pieces (2.4 mm sieve). Fired bricks were sintered at 850 °C, while chemically hardened bricks used a water-based styrene-acrylic binder and were cured for one week at room temperature, enabling binder-film integration and fusion. Higher sawdust content reduced firing time, while chemical hardening eliminated the need for firing. Water absorption and porosity were determined from the dry, wet, and submerged masses after 24 h of immersion in water. Thermal conductivity was measured using a hot-plate method based on heat transfer and ice-melting rate. Chemically hardened bricks with 25% and 50% sawdust achieved compressive strengths of 9.98 MPa and 12.05 MPa, respectively, exceeding commercial clay bricks (5.87 MPa). Thermal conductivities decreased from 0.91 W m^{-1} K^{-1} for commercial bricks to 0.56 W m^{-1} K^{-1} and 0.33 W m^{-1} K^{-1} for 25% and 50% sawdust bricks, respectively, indicating enhanced insulation. Increasing sawdust content reduced density and thermal conductivity while increasing porosity. Sawdust pieces produced lower thermal conductivity than powder, with greater reductions at higher contents, attributed to increased pore formation and reduced heat-transfer pathways. Among fired samples, the 5% sawdust brick exhibited the highest strength consistent with densification, while higher-waste bricks are suited for lightweight and insulation applications. A cement coating was applied to reduce water penetration and exposure to adverse environmental conditions, thereby improving durability. Overall, high-waste, chemically hardened sawdust bricks provide a low-energy, time-efficient, and sustainable alternative with enhanced mechanical strength and thermal insulation.

Keywords: Chemical hardening, Compressive strength, Pore Formation, Sawdust bricks, Thermal insulation.

PS 10 ***Physical Sciences***

PREPARATION AND PERFORMANCE EVALUATION OF ACTIVATED CARBON – ACETYLENE CARBON BLACK COMPOSITE BASED ELECTRODES FOR SUPERCAPACITOR APPLICATION

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Activated Carbon (AC) has become a material of great interest due to its microporous structure, which results in an extremely high surface area per unit mass compared to other materials. However, for applications of this material in supercapacitors, the graphite-like nature has to be enhanced to achieve better device performance. In this study, it was investigated whether the graphite-like nature of AC could be improved by compositing it with Acetylene Carbon Black (ACB). During preparation, the total mass of the carbon composite was fixed at 0.2 g, and the masses of AC and ACB were mixed in weight ratios relative to ACB. Polyvinylpyrrolidone (PVP) was used as the binder, and the mass was kept constant at 0.02 g throughout the study. The assembled supercapacitor was then characterized electrochemically using Cyclic Voltammetry, Electrochemical Impedance Spectroscopy, and Galvanostatic Charge/Discharge tests, with a filter paper-based separator and 4M KOH as the electrolyte. These results clearly showed that supercapacitor performance depended on the amount of ACB in the carbon composite. The optimal specific capacitance was 7.68 F g^{-1} at 0.3 V, and a scan rate of 25 mV s^{-1} was achieved at 30% (w/w) ACB. Further characterization of the optimized system was performed using Raman spectroscopy and SEM. The Raman spectroscopy results revealed a higher degree of graphitization in the composite than in pure AC. In addition, SEM images showed a highly porous nanoscopic structure, indicating that the high surface area of AC was preserved without significant adverse effects. The combination of enhanced graphitization and high surface area suggests that the developed composite exhibits superior properties compared to AC alone and has strong potential for further development as a cost-effective alternative to expensive materials-based supercapacitor applications.

Keywords: Acetylene carbon black, Activated carbon, Supercapacitor, Electrodes

PS 11 ***Physical Sciences***

PREPARATION AND CHARACTERIZATION OF CASSAVA STARCH/ POLYCAPROLACTONE ELECTROSPUN FIBER MATS

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Cassava starch has gained increasing attention as a biodegradable, renewable material for the development of environmentally friendly polymer composites. Because of the high surface area, porosity, and eco-friendly nature, biodegradable electrospun fiber mats are suitable for applications in filtration, biomedical engineering, and wastewater treatment. The direct fabrication of cassava starch fibers through electrospinning is challenging. Therefore, this study focused on the preparation and characterization of electrospun composite fiber mats based on cassava starch, with improved structural and functional properties achieved by incorporating polycaprolactone (PCL). PCL was dissolved in dichloromethane, and cassava starch was dissolved in 90% formic acid. Cassava starch and PCL solutions were blended in various ratios (3:1, 1:1, and 1:3) and electrospun by optimizing different parameters. The fiber mats were characterized using Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), thermogravimetric analysis (TGA), and tensile strength analysis to evaluate their chemical composition, morphology, thermal behavior, and mechanical properties, respectively. FTIR spectra verified the presence of characteristic functional groups of both cassava starch and PCL, confirming successful incorporation of starch into the polymer matrix. SEM analysis confirmed the formation of continuous, randomly oriented fibers with an average diameter of 17.79 μm and fewer beads, indicating successful electrospinning of the composite solution. Fiber mats with smooth surfaces and a minimum number of beads were obtained when the ratio of cassava starch to PCL was 1:3. TGA demonstrated that the composite mats exhibited improved thermal stability compared to pure cassava starch. According to the data of mechanical property testing, a higher value for Young's modulus was obtained for cassava starch/PCL fiber mats (23.06 MPa) compared to PCL fiber mat (14.84 MPa). Therefore, the incorporation of PCL significantly improves the electrospinnability and mechanical performance of cassava starch-based fiber mats, and cassava starch/PCL electrospun composite mats show promising potential for applications in environmentally friendly materials and wastewater treatment technologies.

Keywords: Biodegradable composites, Cassava starch, Electrospinning, Fiber mats, Polycaprolactone

PS 12 ***Physical Sciences***

FABRICATION OF DYE AND GRAPHENE QUANTUM DOT CO-SENSITIZED PHOTO SUPERCAPACITORS USING *Mimosa pigra* BASED ACTIVATED CARBON

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This research investigates the synergistic integration of graphene quantum dots (GQDs) and activated carbon (AC) electrodes with dye-sensitized solar cells (DSSCs) to enhance photo-supercapacitor (PSC) efficiency. Commercial N719 dye and self-synthesized GQD photo-sensitizers were combined with *Mimosa pigra* (YN) plant-based AC electrodes. Supercapacitor (SC) and DSSC components were initially benchmarked individually and subsequently integrated into PSC prototypes. GQDs were synthesized using the dry-ice quenching method and characterized by X-ray diffraction, Raman spectroscopy, and UV-Visible spectroscopy, while PSCs were evaluated using a solar simulator (PEC-L01). The highest efficiency of 0.718% was obtained for TiO_2/N719 dye/GQDs/gel polymer electrolyte (GPE)/AC/KOH/AC, with an open-circuit voltage (V_{OC}) of 0.303 V, short-circuit current density (J_{SC}) of 9.28 mA cm^{-2}, and fill factor (*FF*) of 0.240. The control PSC without GQDs achieved 0.628% efficiency, with V_{OC} = 0.284 V, J_{SC} = 8.81 mA cm^{-2}, and *FF*= 0.251. Cyclic voltammetry (CV) showed a specific capacitance of 101.49 F g^{-1} for the co-sensitized TiO_2/N719 dye/GQDs/GPE/AC/KOH/AC system, compared with 43.49 F g^{-1} for the dye-only TiO_2/N719 dye/GPE/AC/KOH/AC system. Galvanostatic charge-discharge (GCD) analysis further revealed a specific capacitance of 58.24 F g^{-1} and an energy density of 2.45 Wh kg^{-1} for the GQD-integrated system, compared with 34.58 F g^{-1} and 2.77 Wh kg^{-1} for the dye-only system. These findings demonstrate the potential of combining AC electrodes with dye- and GQD-co-sensitized photoanodes to develop cost-effective energy conversion and storage devices.

Financial assistance from the Faculty of Science Research Committee is acknowledged.

Keywords: Activated carbon, Dye-sensitized solar cells, Graphene quantum dots, Photo-supercapacitors, Sustainable energy

PS 13 ***Physical Sciences***

A PAPER-BASED MICROFLUIDIC DEVICE WITH REDUCED GRAPHENE OXIDE-MODIFIED GRAPHITE ELECTRODES FOR SEPARATION AND DETECTION OF LEAD(II) AND CADMIUM(II) IONS

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Exposure to toxic heavy metals through environmental and food sources can pose serious risks to human health, emphasizing the need for effective monitoring strategies. A portable, paper-based, electrochemical microfluidic analytical device (μPAD) was developed for the rapid and sensitive detection of toxic heavy metal ions, as an alternative to expensive laboratory-based techniques such as atomic absorption spectroscopy and ICP-MS. The device used chromatography paper as the microfluidic separation platform and a 6B graphite pencil electrode modified with reduced graphene oxide (rGO) synthesized by the Hummers method as the working electrode. FTIR and UV–Visible spectroscopic analyses confirmed successful reduction of graphene oxide, while cyclic voltammetry and amperometry with potassium ferrocyanide were used to evaluate electrode performance. The fabricated rGO-modified electrodes exhibited a stable electrical resistance of (6.45 ± 0.52) kω, with an inter-device relative standard deviation of 3.52% (n = 10), indicating good reproducibility and fabrication consistency. Compared with unmodified electrodes, the rGO-modified electrodes exhibited higher peak currents and lower background interference, indicating enhanced electrochemical activity and sensing performance. Among the three μPAD designs evaluated, the strip-based configuration showed the best simplicity, stability, and reproducibility. Cobalt(II) and nickel(II) were initially selected as model analytes because they enable both electrochemical detection and direct visual inspection via color bands, providing dual verification of separation performance prior to analyzing cadmium(II) and lead(II). Further investigations demonstrated successful separation with migration times of approximately 100 s and 310 s and detection of cadmium(II) and lead(II) ions over the 0.0625 – 1.00 mM range, with correlation coefficients of 0.82 and 0.92, respectively. The developed μPAD offers a low-cost, portable, and field-deployable platform for on-site monitoring of heavy metal contamination in environmental and food samples.

Financial assistance from the Postgraduate Institute of Science, University of Peradeniya (*Grant No. PGIS/2024/10*) *is acknowledged.*

Keywords: Electrochemical detection, Graphite pencil electrode, Heavy metal detection, Paper-based microfluidic device (μPAD), Reduced graphene oxide (rGO)

PS 14 ***Physical Sciences***

DEVELOPMENT OF LOW-COST SILICA GEL FROM RICE HUSK ASH FOR COLUMN CHROMATOGRAPHY

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Column chromatography is a useful technique for separating and purifying the components of a mixture. Commercially available column silica is considerably costly as it is derived from non-renewable sources and also involves complex manufacturing processes. The objective of this research was to extract silica from rice husk ash (RHA) and develop a stationary phase material for column chromatography. To this end, we developed a new methodology by modifying the conventional sol-gel process to extract silica from RHA. The preparation of silica (SiO_2) from RHA involved a sequential process. The RHA was acid-treated using 1 M HCl. Sodium silicate was extracted by reacting the acid-treated ash with 3 M NaOH using a microwave-assisted process. Subsequently, the silica gel was precipitated with 1 M HCl to adjust the pH to 2.5, and the solution was then neutralized again with 1 M NaOH. The resulting silica gel was aged, filtered, dried, and ground into a fine powder. The resulting silica powder was sieved and calcined at 550 ^{0}C to obtain the synthesized column silica. The XRD pattern showed a dominant broad peak around $2\theta \approx 20\text{-}25$ °, indicating the amorphous structure of the synthesized silica. The EDX spectrum confirmed the elemental composition of the homemade column silica, with strong Si and O peaks. FT-IR characterization showed that the homemade, calcined column silica possessed functional groups that closely resembled those of commercial silica. SEM analysis revealed dense packing and agglomeration of silica particles, while subsequent chromatographic testing demonstrated high resistance to solvent flow and an increased time required for separation. However, it successfully resolved distinct bands for mixtures of nitroanilines, nitrophenols, and dyes. Research is currently underway to further functionalize the column silica using surfactants.

Keywords: Column Chromatography, Rice husk ash, Sol-gel process

PS 15 ***Physical Sciences***

HYDROTHERMAL SYNTHESIS AND CHARACTERIZATION OF Fe_3O_4–GRAPHENE OXIDE NANOCOMPOSITES FOR POTENTIAL GLUCOSE SENSING APPLICATIONS

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The development of efficient electrochemical glucose sensors requires advanced nanocomposite materials with enhanced conductivity, surface functionality, and stability. In this study, Fe_3O_4–graphene oxide (Fe_3O_4–GO) nanocomposites were synthesized via a hydrothermal method by systematically varying temperature (80–160 °C) and reaction time (6–24 h) to determine optimal conditions for glucose sensing applications. Comprehensive characterization demonstrated that the physicochemical properties of the Fe_3O_4–GO nanocomposites were strongly influenced by synthesis temperature and reaction time. UV–Visible spectroscopy showed a characteristic absorption peak at 230 nm (π–π* transition of GO) and a shoulder near 300 nm (n–π* transition), indicating enhanced electronic interaction and charge transfer between Fe_3O_4 nanoparticles and GO sheets. FTIR spectra confirmed strong interfacial bonding with peaks at 580 cm^{-1} (Fe–O), 3400 cm^{-1} (–OH), 1720 cm^{-1} (C=O), and 1050–1220 cm^{-1} (C–O–C), providing active functional groups for enzyme immobilization. XRD patterns displayed the GO peak at 2θ - 10° along with Fe_3O_4 diffraction peaks at 30.1°, 35.5°, 43.2°, 53.5°, 57.1°, and 62.7°, confirming successful composite formation with preserved crystallinity. XPS analysis revealed C 1s (284.6, 286.5, 288.5 eV), O 1s (530–532 eV), and Fe 2p peaks (710.5 and 724.0 eV), indicating functionalized carbon structures and mixed Fe^{2+}/Fe^{3+} states that enhance electrocatalytic activity. Thermogravimetric analysis demonstrated good thermal stability, with distinct weight-loss stages corresponding to moisture removal, decomposition of oxygen-containing functional groups, and degradation of the carbon framework. Overall, the sample synthesized at 80 °C for 10 h exhibited the most favorable physicochemical properties, highlighting its potential as an efficient platform for sensitive and stable electrochemical glucose biosensors.

Keywords: Electrochemical glucose sensor, Fe_3O_4-graphene oxide nanocomposite, Glucose oxidase immobilization, Hydrothermal synthesis, Nanocomposite optimization.

PS 16 ***Physical Sciences***

METHYL GRAFTED NATURAL RUBBER BASED ELECTROLYTE IN DOUBLE-LAYER CAPACITORS

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Natural rubber (NR) is being considered as a green polymer host to serve as an electrolyte in diverse electrochemical devices. Many international research groups are investigating the potential candidacy of NR of countries like India and Malaysia. But Sri Lankan NR has not yet been properly exploited. In the present study, a polymer electrolyte was prepared using methyl-grafted Sri Lankan NR and magnesium trifluoromethanesulfonate (MgTF), and its performance in an electrochemical double-layer capacitor was investigated. Electrochemical impedance spectroscopy performed over the frequency range 0.001 Hz–400 kHz using a Metrohm-101 impedance analyzer revealed dominant capacitive features at low frequencies. A maximum specific capacitance, C_{sc} obtained from the Bode plots was 8.8 Fg^{-1}. Cyclic voltammetry tests at different scan rates were carried out to seek the dependence of specific capacitance on the scan rate. Higher performance was observed at low scan rates due to sufficient time for charge accumulation at the electrode-electrolyte interface. All cyclic voltammograms clearly evidenced the non-faradaic nature of the charge-storage mechanism by near-parabolic shapes and the absence of redox peaks. A galvanostatic charge-discharge test was performed at a constant current of 5×10^{-5} A for 10,000 cycles. The discharge capacitance remains more or less constant, showing its ability to withstand long-term operation. Even though the numerical values are smaller, the outcomes demonstrate the suitability of Sri Lankan NR for use in applications. Further modifications will fine-tune the properties and significantly improve performance.

Financial assistance from the National Research Council, Sri Lanka (Grant No. NRC17-006) is acknowledged.

Keywords: Electrochemical double-layer capacitors, Methyl-grafted natural rubber, Polymer electrolyte, Specific capacitance

PS 17 ***Physical Sciences***

DEVELOPMENT OF AN ACETYLATED *Tephrosia purpurea* (*KATHURUPILA*) STATIONARY PHASE AS A SUSTAINABLE ALTERNATIVE FOR PACKED COLUMN CHROMATOGRAPHY

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Conventional stationary phases such as silica gel and alumina are widely used in packed-column chromatography but may pose economic and environmental challenges, underscoring the need for sustainable, cost-effective alternatives. This study investigated a combined stem and root powder from *Tephrosia purpurea* (Kathurupila) as a low-cost, sustainable natural stationary phase. The combined stem–root powder was chemically modified by acetylation to alter its surface properties, improve chemical stability through ester functionality, and enhance chromatographic selectivity. Initially, the combined stem–root powder was treated with 10% (w/v) sodium hydroxide to remove impurities and increase the accessibility of surface hydroxyl groups. The pretreated material was subsequently acetylated with acetic anhydride via nucleophilic substitution. An approximately 13.58% increase in mass was observed following acetylation, while FTIR, SEM, TGA, EDS, and GC analyses collectively provided evidence of changes in functional groups, surface morphology, elemental composition, thermal behavior, and residual organic content. Chromatographic performance of the acetylated stem–root stationary phase was evaluated using colored dyes (azo violet, metanil yellow, and alizarin red S) and colorless analytes (naphthalene and anthracene), with benzene used as the non-retained solute under different mobile-phase conditions. For colored dyes, the acetylated stem–root stationary phase exhibited retention factors (k) of 3.35–4.97, selectivity factors (α) of 1.18–1.24, and separation efficiencies of 81.94–87.24%. For colorless analytes, it showed a higher selectivity factor ($\alpha = 4.03$ vs. 2.87) and separation efficiency (93.35–93.46% vs. 91.25–92.23%) compared with silica gel, indicating improved resolution. The acetylated stationary phase also maintained stable chromatographic behavior across different mobile-phase conditions. Overall, the findings demonstrate the potential of acetylated *T. purpurea* stem–root powder as a sustainable and cost-effective natural stationary phase for packed-column chromatographic applications.

Financial assistance from the *Postgraduate Institute of Science (PGIS) (Grant No:* PGIS/2022/07*) is acknowledged.*

Keywords: Acetylation, Packed column chromatography, Stationary phase, Surface modification, *Tephrosia purpurea*

PS 18 ***Physical Sciences***

SYNTHESIS OF HIGH-PURITY MAGNETITE NANOPARTICLES FROM IRON ORE OF BUTTALA, SRI LANKA FOR POTENTIAL APPLICATION IN CONDUCTIVE TONER POWDERS

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In conductive toner powders, magnetite nanoparticles (MNPs) serve as functional components contributing to magnetic transport and triboelectric charge generation during printing. While MNP synthesis commonly relies on synthetic precursors, natural mineral resources, such as iron sources, offer a pathway toward industrial-scale sustainability and value addition to the country's mineral-based industry. This study reports a sustainable approach to synthesizing MNPs from raw iron ore from Buttala via a hydrothermal method and evaluating their potential for conductive printing toner powders. The ore was initially crushed, ground, magnetically separated, and acid-leached. Hydrothermal synthesis was then performed using ascorbic acid and 5 M potassium hydroxide at 160, 180, and 200 °C for 6 and 12 h. The resulting samples were characterized using FTIR, SEM, XRD, PSA, and XRF. Chemical and mineralogical analyses confirmed that the raw ore mainly comprises magnetite (Fe_3O_4), hematite (Fe_2O_3), and goethite [FeO(OH)], with minor silicate and gangue minerals, indicating its suitability for magnetite synthesis. All synthesis conditions successfully yielded MNPs. Among the investigated conditions, the sample synthesized at 180 °C for 6 h exhibited the most favorable characteristics, with high elemental purity dominated by iron oxide (95.3%) and Fe–O vibrational bands consistent with magnetite. These MNPs showed nearly spherical morphology, well-defined boundaries, and moderate agglomeration. Particle size analysis indicated mean particle sizes of 49.44–673.30 nm, with the 180 °C, 6 h sample exhibiting the smallest mean size (49.44 nm). These findings demonstrate the potential of Buttala iron ore as a sustainable precursor for synthesizing MNPs for possible application in conductive toner powders.

Financial assistance from the National Research Council (*Grant No 22/127*) *is acknowledged.*

Keywords: Buttala iron ore deposit, Hydrothermal synthesis, Magnetite nanoparticles

PS 19 ***Physical Sciences***

KINETICS MODELING AND PROCESS OPTIMIZATION OF CONGO RED REMOVAL USING HCl-MODIFIED *Panicum maximum*

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Congo red (CR), a toxic, non-biodegradable organic pollutant, is frequently discharged by many industries. Among existing conventional methods, biosorption is recognized as an efficient and sustainable alternative for removing such pollutants from contaminated solutions. Despite a broad range of natural and synthetic adsorbents being investigated for CR removal, *Panicum maximum* (PM) has received limited attention. This study investigates the potential of an HCl-modified dry-leaf fibrous biosorbent from *Panicum maximum* (HPM), an abundantly available, low-cost, and eco-friendly invasive biomass in Sri Lanka, for the removal of CR from synthetic aqueous solutions. The biosorbent prepared by treatment with 0.10 mol L^{-1} HCl, followed by washing and drying, results in maximum adsorption capacity of 9.76 mg g^{-1}, achieved under the optimized conditions of 0.40 g dosage, 40.0 min shaking time, 10.0 min settling time (equilibrium time), and ambient pH, determined by varying the parameters of interest while keeping other parameters unchanged, based on triplicated batch adsorption experiments. A kinetic study suggested comparable fits of the pseudo-first-order and pseudo-second-order models during the initial adsorption period, based on similar regression coefficients (R^2), indicating that both physisorption and chemisorption contribute to the adsorption process. The intra-particle diffusion (IPD) model, investigated over a broad time interval, indicates that adsorption occurs through three main stages: film diffusion, IPD, and the equilibrium phase. The first linear region exhibits fast diffusion with a high-rate constant of 0.2059 mg g^{-1} $min^{-1/2}$, while the second phase shows slower diffusion with a rate constant of 0.0634 mg g^{-1} $min^{-1/2}$, due to a reduced concentration gradient and fewer active adsorption sites. Overall, HPM has emerged as an effective, low-cost, and sustainable biosorbent for CR removal, with potential extending toward large-scale applications through additional optimization steps under dynamic conditions.

Keywords: Adsorption, Congo red, Kinetics, Optimization, *Panicum maximum*

PS 20 ***Physical Sciences***

P2-$Na_{0.67}Mn_{0.7}Fe_{0.3-x}Ni_xO_2$ LAYERED TRANSITION METAL OXIDE CATHODES FOR HIGH PERFORMANCE SODIUM ION BATTERIES

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The growing demand for sustainable and cost-effective energy storage has strengthened research into sodium-ion batteries (SIBs). SIBs are considered sustainable alternatives to lithium-ion batteries (LIBs) due to the abundant availability and low cost of sodium resources. However, the development of cathode materials that simultaneously achieve high specific capacity, structural stability, and long-term cyclability remains a major challenge. In this study, Ni-substituted P2-type $Na_{0.67}Mn_{0.7}Fe_{0.3-x}Ni_xO_2$ (x = 0.15, 0.20, and 0.25; denoted MFN15, MFN20, and MFN25, respectively) layered transition-metal oxide cathodes were synthesized via a solid-state reaction, followed by annealing at 900 °C to investigate the effect of Ni^{2+} substitution on the electrochemical performance of SIB. Structural and morphological characterization was performed using powder X-ray diffraction (PXRD), field-emission scanning electron microscopy (FE-SEM), and energy dispersive X-ray spectroscopy (EDX). Electrochemical evaluation was conducted using galvanostatic charge-discharge (GCD) cycling and cyclic voltammetry (CV) on CR2032 coin-type half-cells over a voltage window of 1.5-4.2 V vs. Na/Na^+. PXRD confirmed a $P6_3/mmc$ layered structure, with unit-cell expansion observed as larger Ni^{2+} (0.69 Å) substituted for Fe^{3+} (0.645 Å). FE-SEM analysis revealed a progressive increase in particle size from 3-4 μm for MFN15 and 8-9 μm for MFN25. Electrochemical results revealed that MFN20 delivered the highest initial specific capacity of 147.31 mAh g^{-1} and superior capacity retention of 91.27% after 40 cycles. Extended cycling confirmed MFN20 retained 106.69 mAh g^{-1} (72.42%) after 100 cycles and 89.75 mAh g^{-1} (60.92%) after 150 cycles. These findings establish MFN20 as the optimal composition, confirming that precise tuning of Ni content in Mn-Fe-Ni layered oxides is an effective strategy for developing high-performance, stable cathode materials with a broad electrochemical voltage window for sodium-ion battery applications.

Financial assistance from the National Research Council (Grant No. NRC 24-113) is acknowledged.

Keywords: Nickel substitution, P2-type layered oxide, Sodium-ion batteries, SIB cathode materials, Transition metal oxides

PS 21 ***Physical Sciences***

STRUCTURAL MODIFICATION AND OPTICAL BAND GAP TUNING OF ZINC OXIDE NANOFLOWERS VIA NEODYMIUM-DOPED GRAPHENE QUANTUM DOTS INCORPORATION

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Zinc oxide (ZnO) nanoflowers have attracted attention for optoelectronic, sensing, and energy applications due to their high surface area, optical, and electrical properties. However, their performance is limited by charge carrier recombination and poor visible-light absorption. To overcome these limitations, structural modification and carbon-based heterostructure engineering have emerged as effective strategies. Neodymium-doped Graphene Quantum Dots (Nd-GQDs) are rare-earth-modified carbon nanomaterials with tunable optical properties and enhanced charge-separation capability. In this study, ZnO nanoflowers and Nd–GQD-modified ZnO nanoflowers were successfully synthesized via a hydrothermal method. To modify the structural and optical properties of ZnO nanoflowers, 32- and 256-mM Nd–GQDs were incorporated during the hydrothermal synthesis process. Then the synthesized samples were characterized by SEM, UV–Visible, and Raman spectroscopy. The SEM images confirmed the successful formation of flower-like ZnO nanostructures with a size of ~ 31 μm^2. UV–visible absorption spectra showed a red shift in the Nd–GQD modified ZnO nanoflowers compared to pure ZnO nanoflowers, with the 32 mM Nd–GQD sample showing the highest shift. Tauc plot of the optical absorption spectrum analysis confirmed a reduction in band gap from 3.19 eV for ZnO nanoflowers to ~3.14 and 3.15 eV for the 32- and 256-mM Nd–GQD-modified samples, respectively, demonstrating that Nd–GQDs effectively tune the optical properties of ZnO nanoflowers. Raman analysis confirmed the crystalline ZnO nanoflower structure through the characteristic ZnO peaks at 330 and 438 cm^{-1}. The peaks at 1196 cm^{-1} and the G band at 1586 cm^{-1} indicate successful incorporation of Nd–GQDs, while the 583 cm^{-1} peak suggests oxygen vacancies and defect states that enhance charge transfer and sensing performance. These results confirm successful Nd–GQD incorporation and improved optical properties of ZnO nanoflowers. Future work will explore gas sensing and related applications.

Keywords: Band gap, Graphene quantum dots, Hydrothermal synthesis, Optical and structural properties, ZnO nanoflowers.

PS 22 ***Physical Sciences***

POST-CONSUMER POLY (ETHYLENE TEREPHTHALATE) - BASED ELECTROSPUN FIBER MATS FOR THE CORROSION INHIBITION OF STAINLESS STEEL 304

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Poly(ethylene terephthalate) (PET) is widely used in beverage and food packaging, generating substantial non-biodegradable waste and environmental challenges. This study explores sustainable recycling by converting post-consumer PET water bottles into electrospun fiber mats and evaluating their potential as corrosion-protective coatings for Grade 304 stainless steel (SS304) in acidic environments. PET flakes were dissolved in a 1:5 (v/v) trifluoroacetic acid–dichloromethane solvent and fabricated into thin fibrous membranes by electrospinning. Optimized conditions included a flow rate of 0.5 mL h^{-1}, drum speed of 185–190 rpm, tip-to-collector distance of 10 cm, and voltage of 21–22 kV. SEM revealed smooth, bead-free, randomly oriented fibers with an average diameter of 310.3 nm, while FTIR confirmed characteristic PET functional groups. Contact-angle measurements showed that 45 min electrospinning produced the highest hydrophobicity, indicating limited interaction with ionic species and suitability for corrosion inhibition. SS304 coated with these PET films in 2.0 mol L^{-1} HCl achieved a 35.63% corrosion inhibition efficiency compared with uncoated specimens, as determined by mass-loss measurements. Polarization studies also showed reduced anodic current density, indicating inhibition of the anodic corrosion reaction. These findings demonstrate the potential of electrospun mats made from recycled PET as cost-effective, corrosion-resistant coatings. Further studies on metals of different compositions are needed to establish broader industrial applicability.

Financial assistance from the Postgraduate Institute of Science, University of Peradeniya (*Grant No PGIS/2024/11) is acknowledged.*

Keywords: Corrosion, Electrospinning, Fiber mats, Poly(ethylene-terephthalate), Stainless steel 304

PS 23 ***Physical Sciences***

BORIC ACID-MODIFIED CURCUMIN DYE FOR ENHANCED EFFICIENCY IN DYE-SENSITIZED SOLAR CELLS

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Natural dye-sensitized solar cells (DSCs) based on curcumin pigment typically suffer from a low power conversion efficiency (PCE) of 0.3% - 0.4%. In this study, curcumin was extracted using isopropanol and subsequently complexed with borate species to evaluate photovoltaic performance. The addition of borax to the extract increased the PCE to 0.5% but also raised the solution pH, which hindered the chemisorption of dye molecules onto the TiO_2 photoanode. However, modifying curcumin with boric acid maintained an acidic pH, thereby facilitating optimal dye adsorption on the photoanode. This refinement yielded a short-circuit current density of 446.8 $\mu A/cm^2$, an open-circuit voltage of 514.03 mV, and a fill factor of 0.653, achieving a PCE of 1.0%. Furthermore, UV-Visible spectroscopy confirmed a significant bathochromic shift from the UV region (curcumin extract) to the visible region upon complexation, with absorption peaks (λ_{max}) appearing at ~445 nm for the boric acid mixture and shifting further to ~505 nm upon addition of borax. This extension into the visible spectrum facilitates broader light harvesting, directly correlating with the observed increase in PCE. These findings suggest that curcumin extract combined with borax and boric acid can effectively improve the overall efficiency of the DSC, offering a promising pathway for low-cost, sustainable DSCs.

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Keywords: Dye-sensitized solar cells, Electrolyte, Photoanode, Power conversion efficiency

PS 24 ***Physical Sciences***

ADSORPTION OF Cr(III) FROM AQUEOUS SOLUTIONS USING *Piper nigrum* (BLACK PEPPER) STALK-DERIVED BIOSORBENT

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Heavy metal contamination of aquatic systems is a major environmental concern due to their toxicity, persistence, and bioaccumulation. Among heavy metals, chromium exists in two common oxidation states: Cr(III) and Cr(VI); the latter readily oxidizes to the more toxic Cr(VI) under oxidizing conditions, posing a serious risk and necessitating the development of efficient, low-cost removal methods. This study thus investigates the potential of a black pepper stalk-derived biosorbent for removing Cr(III) from aqueous solutions, focusing on adsorption optimization and equilibrium isotherm behavior. The biosorbent prepared from agricultural waste was subjected to batch adsorption experiments under varying conditions, namely particle size, dosage, contact time, settling time, initial Cr(III) concentration, and solution pH, with 10 mg L^{-1} Cr(III) solutions. The adsorption of Cr(III) was strongly influenced by solution pH, with maximum adsorption at pH 3.0. However, pH 5.0 was selected to better represent the ambient conditions. The optimum particle size range of 200-300 µm and an optimum biosorbent dosage of 0.02 g mL^{-1} were also selected. Maximum adsorption was observed at 30 min, suggesting rapid adsorption of Cr(III) by the biosorbent, beyond which a slight desorption of ~2% was observed up to 60 min, while no significant desorption occurred further over extended contact times. As equilibrium was reached within 30 min, an optimum settling time of 20 min was selected. Under optimum conditions, a maximum adsorption of 85.73% was achieved. Isotherm model analysis reveals that the Freundlich model fitted better, with a correlation coefficient (R^2) of 0.9701. The Freundlich constants n (1.76) and K_f(0.55) suggest surface heterogeneity of the biosorbent and favorable adsorption. These data establish pepper-stalk-derived biosorbent as a low-cost, efficient, and sustainable biosorbent for effective removal of Cr(III) from aqueous solution.

Keywords: Adsorption, Biosorbent, Chromium, Isotherm, Pepper stalk

PS 25 ***Physical Sciences***

BAND GAP ENGINEERING IN METAL-ORGANIC FRAMEWORKS VIA MOLECULAR ENCAPSULATION STRATEGIES

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Metal-organic frameworks (MOFs) hold significant promise for photocatalysis, chemical sensing, and solar energy conversion. However, their wide band gaps (>3.0 eV) restrict absorption largely to the ultraviolet region, limiting visible-light-driven applications. This study presents the first systematic and comparative investigation of vapor-phase molecular encapsulation as a post-synthetic strategy for engineering the band gaps of titanium- and zirconium-based metal-organic frameworks (MOFs). Three pyridine derivatives-pyridine,2-bromopyridine, and 4-aminopyridine were employed as molecular dopants to modify four structurally distinct MOFs: MIL-125(Ti), NH_2-MIL-125(Ti), UIO-66(Zr), and NH_2-UIO-66(Zr), synthesized via solvothermal, reflux, and room- temperature methods. The effects of molecular dopants on the electronic structure and band-gap properties of the MOFs were investigated, considering metal-node type, linker functionality, and synthetic conditions, using encapsulation efficiency as a metric. Powder X-ray diffraction confirmed phase purity and high crystallinity, particularly in hydrothermally prepared samples. Fourier-transform infrared spectroscopy confirmed successful linker coordination and dopant-framework interactions through characteristic shifts in carboxylate and metal-oxygen vibrational modes. UV-Vis diffuse reflectance spectroscopy coupled with Tauc plot analysis revealed wide band gaps for the pristine materials: 3.42 eV for MIL-125(Ti), 2.50 eV for NH_2-MIL-125(Ti), 3.97 eV for UiO-66(Zr), and 2.83 eV for NH_2-UiO-66(Zr). Vapor-phase encapsulation produced substantial band gap narrowing, with 4-aminopyridine producing the strongest red shift by reducing the band gap by (0.2–1.9 eV), lowering the band gaps to 1.52 eV for MIL-125(Ti), 1.50 eV for NH_2-MIL-125(Ti), 2.53 eV for UiO-66(Zr), and 2.14 eV for NH_2-UiO-66(Zr). Titanium-based frameworks exhibited superior tunability compared to zirconium analogs due to stronger metal-dopant orbital coupling. Amine-functionalized linkers enhanced sensitivity through electronic effects. Overall, vapor-phase molecular encapsulation demonstrated a low-cost, post-synthetic, and structure-preserving route to tailor the electronic properties of MOFs, providing fundamental insights into host-guest interactions and opening promising pathways for the design of visible-light-active MOF semiconductors for future solar-energy-harvesting and photocatalytic applications.

Keywords: Bandgap engineering, Metal-organic frameworks, Molecular encapsulation, Solar energy harvesting, Visible-light absorption

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IMPACT OF TiO_2 BLOCKING LAYER ON THE PHOTOVOLTAIC PERFORMANCE OF DYE-SENSITIZED SOLAR CELLS

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Dye-sensitized solar cells (DSCs) are promising third-generation solar cells due to their low cost and favorable performance under low-light conditions. The doctor-blade method is widely used to prepare TiO_2 photoanodes for DSCs due to its simplicity and uniformity. However, in doctor-blade TiO_2 films, porosity may leave undesired direct contact between the fluorine-doped oxide (FTO) substrate and I^-/I_3^- electrolyte. This promotes interfacial electron recombination, lowering charge collection efficiency. In this study, a spin-coated compact TiO_2 blocking layer was introduced into a doctor-bladed mesoporous TiO_2 photoanode prepared using polymer-assisted sol-gel paste to minimize direct FTO/electrolyte contact. The blocking layer was deposited on FTO by spin-coating a precursor solution containing titanium isopropoxide, acetic acid, and ethanol at 5000 rpm for 30 seconds, followed by drying at 130 °C for 5 minutes, repeated three times, and then sintering at 500 °C for 45 minutes. The mesoporous TiO_2 layer was deposited on the compact layer by the doctor-blade method using a polymer-assisted sol–gel TiO_2 paste prepared with diethylene glycol, then sintered at 500 °C for 30 minutes and immersed in N719 dye for 24 hours. Devices assembled with the dye-adsorbed photoanode, a platinum counter electrode, and I^-/I_3^- electrolyte, with an active area of 0.20 cm^2, were evaluated under AM 1.5G illumination (100 mW cm^{-2}). The cell incorporating the compact TiO_2 blocking layer achieved a short-circuit current density (Jsc) of 16.71 mA cm^{-2}, an open-circuit voltage (Voc) of 0.670 V, a fill factor (FF) of 0.619, and a power conversion efficiency (PCE) of 6.93%, compared with 12.64 mA cm^{-2}, 0.685 V, 0.727, and 6.29%, respectively, for the reference cell. These results demonstrate that the spin-coated compact TiO_2 blocking layer improves the photovoltaic performance of DSCs with doctor-bladed TiO_2 photoanodes, consistent with reduced interfacial recombination and electron back-transfer at the FTO/electrolyte interface.

Keywords: Blocking layer, Dye-sensitized solar cells, Spin coating, Titanium dioxide

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GREEN SYNTHESIS OF ZINC OXIDE NANOPARTICLES USING *Osbeckia octandra* L. LEAF EXTRACT AND THEIR ANTIMICROBIAL EVALUATION

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Antimicrobial resistance is an ever-escalating public health threat. It emphasizes the need for eco-friendly, cost-effective, novel antimicrobial agents. Osbeckia octandra (Heen Bovitiya), an endemic medicinal plant rich in bioactive phytochemicals, serves as a source of numerous stabilizing and capping agents, yet its application in zinc oxide nanoparticle (ZnO NP) synthesis remains unexplored. The current study aimed to synthesize ZnO NPs using O. octandra leaf extract and evaluate their antimicrobial efficacy. To examine the effect of precursor concentration on nanoparticle properties and antimicrobial activity, $Zn(CH_3COO)_2.2H_2O$ precursor solutions at four concentrations (0.050, 0.075, 0.100, 0.125 mol dm^{-3}) were used. The synthesized ZnO NPs were characterized using FTIR, XRD, SEM, and particle size analysis. FTIR confirmed capping by plant biomolecules. XRD analysis revealed crystals with a hexagonal wurtzite structure, with crystallite sizes of 10-14 nm. Particle size distributions ranged from 7 to 170 nm according to particle analyzer data. SEM results showed nanoscale particles ranging from 25 to 70 nm in diameter, with particle size increasing with precursor concentration. Antimicrobial activity was evaluated against Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Enterococcus faecalis, and Candida albicans using the agar diffusion method at two dosages (3 mg and 6 mg), compared against Ciprofloxacin as a positive control and distilled water, plant extract, and four precursor solutions as negative controls. ZnO NPs synthesized at 0.050 mol dm^{-3} precursor metal salt concentration exhibited the largest inhibition zone against C. albicans at 6 mg dosage (inhibition zone: (11.0 ± 0.5) mm), followed by S. aureus and P. aeruginosa (7.0 ± 0.5) mm, and E. coli (6.0 ± 0.5) mm. In contrast, E. faecalis showed resistance against all ZnO NPs. Inhibition zones were slightly increased as precursor salt concentration decreased. In conclusion, the current study demonstrates the successful synthesis of O. octandra-mediated ZnO NPs as a promising alternative for developing potent antimicrobial agents.

Keywords: Antimicrobial activity, antimicrobial resistance, Green synthesis, Osbeckia octandra, ZnO nanoparticles.

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CO-INCORPORATED FAUJASITE ZEOLITE FOR PHENOL VAPOR DEGRADATION

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Effective degradation of phenol vapor is essential for environmental remediation due to phenol's significant toxicity to ecosystems and human health. This study focuses on the synthesis of a Faujasite zeolite catalyst and its modification with Cobalt as a cocatalyst to enhance catalytic efficiency in phenol degradation. Faujasite zeolite was synthesized by the hydrothermal method and modified by cation exchange. The cobalt-modified catalyst was characterized using analytical techniques, including X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, Scanning Electron Microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDX). Analysis using these techniques demonstrates successful incorporation of metal ions into the zeolite framework. The modified catalyst was employed in the degradation of phenol under oxygen, moisture, and hydrogen peroxide conditions. Systematic investigations were conducted to evaluate catalytic performance by varying reaction time at 150 °C. The degraded products were analyzed using gas chromatography-mass spectrometry (GC-MS). Results of the analysis show increased phenol degradation in the presence of hydrogen peroxide (94%), with similar degradation under oxygen (64%) and Moisture (69%) conditions, which is better than under normal conditions. Major degradation products identified with hydrogen peroxide (H_2O_2) were formic acid (HCOOH), methylal ($C_3H_8O_2$), acetic acid (CH_3COOH), and acetone (CH_3COCH_3), while in the Oxygen condition and the Moisture condition were ethanol (C_2H_5OH), isopropyl alcohol (C_3H_8O), acetone (CH_3COCH_3), acetic acid (CH_3COOH), and hydroquinone ($C_6H_6O_2$). Analysis of products indicates that degradation proceeds via a redox reaction under oxygen, while a Fenton-type reaction mechanism operates under hydrogen peroxide and moisture conditions. Mechanisms have been proposed to elucidate the pathways underlying the formation of degradation products. Faujasite zeolite catalyst serves as a supporter of electron transfer while the metal cocatalyst modifies the acidity and pore size of the zeolite to improve catalytic efficiency. Overall, this research indicates that cobalt-modified faujasite is a promising catalyst for the removal of atmospheric phenol vapor.

Keywords: Phenol vapor degradation, Faujasite, Zeolite

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CORROSION INHIBITION OF STAINLESS-STEEL GRADE 202 BY ANIONIC SURFACTANT SODIUM DODECYLSULPHATE (SDS) IN HCl MEDIUM

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Corrosion is an electrochemical process in which metals undergo oxidation, resulting in the formation of various corrosion products. Although alloy formation, such as stainless steel (SS) is an option to mitigate corrosion due to the presence of Ni and Cr, SS undergoes corrosion attack under certain environments, limiting its applications. To mitigate such degradation, corrosion inhibitors are widely used as practical, economical approaches. However, surfactants, despite being a low-cost and eco-friendly alternative, have not been widely investigated as corrosion inhibitors. In this study, sodium dodecyl sulfate (SDS), a common anionic surfactant, was investigated as a corrosion inhibitor for SS Grade 202 using a multi-technique approach. Mass loss of SS Grade 202 rectangular specimens of dimensions 1.0 × 0.8 × 0.1 cm monitored throughout a period of one week in 0.10 mol L^{-1} HCl indicates that there is a significant decrease in mass loss in the presence of SDS when compared to the uninhibited system. The reduction in mass loss decreases at higher SDS concentrations, which may be attributed to changes in the adsorption and arrangement of SDS molecules on the steel surface, thereby affecting the formation and stability of the protective barrier layer. Electrochemical impedance spectroscopy (EIS) measurements performed in 0.1 mol L^{-1} HCl with varying SDS concentrations showed that the polarization resistance (Rp) increased from 48 Ω for the uninhibited system to 76 Ω in the presence of 0.08 mol L^{-1} SDS, indicating improved corrosion inhibition. The Tafel plot of the SS Grade 202 specimen, recoded in the same medium, also shows that 0.080 mol L^{-1} SDS resulted in the lowest corrosion current density, of 1.468×10^{-4} A cm^{-2}, indicating improved corrosion inhibition. Tafel polarization measurements showed that the corrosion rate decreased from 3.752 mm $year^{-1}$ for the uninhibited system to 1.705 mm $year^{-1}$ in the presence of SDS, corresponding to an inhibition efficiency of 54.56%. Overall, the results above conclusively demonstrate that SDS exhibits excellent corrosion resistance for SS Grade 202 in an HCl medium.

Keywords: Anionic surfactants, Corrosion, Electrochemical impedance spectroscopy, Stainless steel

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BIOSORPTION OF METHYLENE BLUE USING *Panicum maximum*: OPTIMIZATION AND KINETIC STUDIES

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Water pollution is a critical environmental concern due to the discharge of a broad range of pollutants into natural water bodies. Among various pollutants, synthetic dyes have become a significant environmental concern, with Methylene Blue (MB) being one of the most prevalent industrial dyes**.** MB is a synthetic dye widely used in textiles, medicine, and laboratory research. The release of untreated MB effluent into water bodies causes severe environmental and health issues. Among dye removal techniques, adsorption stands out as an efficient, cost-effective, and eco-friendly method. *Panicum maximum* (PM), an invasive plant species widely grown in Sri Lanka, has gained limited but growing attention as a promising fibrous biosorbent. This study investigates the potential of PM for MB removal, with a specific focus on the effects of particle size, dosage, shaking time, settling time, and kinetics. PM biosorbent, prepared from fresh leaves by washing, drying, and grinding into a fine powder, achieves a maximum MB removal of 96% under optimized parameter conditions: particle size < 200 µm, dosage 80 mg, shaking time 30 min, and settling time 30 min, under ambient temperature and pressure conditions. Adsorption kinetics data best fit the pseudo-second-order model (R^2 = 0.9675), indicating that the mechanism is governed by chemisorption, whereas the pseudo-first-order model (R^2 = 0.3068) is a much poorer fit. Moreover, the Weber-Morris intra-particle diffusion model exhibits three segmented linear relationships: the first segment shows the highest rate constant of 0.528 mg g^{-1} $min^{-1/2}$ implying fast transfer of MB through film diffusion; the second segment shows a lower diffusion rate constant of 0.288 mg g^{-1} $min^{-1/2}$ reflecting gradual diffusion of MB molecules; the third linear range indicates a much smaller diffusion rate constant of 0.005 mg g^{-1} $min^{-1/2}$ showing that the system has reached equilibrium due to the insufficient vacant sites. In conclusion, PM can be considered an effective and efficient biosorbent, providing a sustainable solution for removing MB from wastewater while controlling the effects of invasive PM.

Keywords: Adsorption, Kinetics, Methylene Blue, *Panicum maximum*

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ADSORPTION FREE ENERGY OF AMINO ACIDS ON A (6,6) SINGLE-WALLED CARBON NANOTUBE: AN ADAPTIVE BIASING FORCE MOLECULAR DYNAMICS STUDY

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Understanding how amino acids interact with carbon nanotubes (CNTs) is important for predicting protein adsorption behavior relevant to biosensing, drug delivery, and biocompatibility assessment. While adsorption free energies on flat graphene sheets have been previously studied computationally, quantitative data for small-diameter (<1 nm) CNTs remain limited. This study aimed to calculate the adsorption free energies (ΔG_{ads}) of all 20 standard amino acids on an infinite periodic (6,6) single-walled carbon nanotube (radius 4.08 Å) in explicit TIP3P water using adaptive biasing force (ABF) molecular dynamics (MD) with the CHARMM36 force field. This process involves high free-energy barriers that unbiased MD cannot efficiently cross within accessible timescales. The potential of mean force (PMF) was calculated along the radial distance between the CNT axis and each amino acid's center of mass at 300 K. The calculated adsorption free energies ranged from +0.57 kcal/mol for aspartic acid, which was the only amino acid that did not adsorb, to −4.25 kcal/mol for tryptophan. Three distinct adsorption regimes were identified: weak adsorbers including glycine, serine, alanine, and threonine ($|\Delta G_{ads}| < 1$ kcal/mol); moderate adsorbers including valine, isoleucine, leucine, proline, and cysteine (1.0–1.6 kcal/mol), whose adsorption is driven primarily by hydrophobic interactions and increases in strength with aliphatic carbon content; and strong adsorbers including methionine (−2.37 kcal/mol, attributable to sulfur–π interactions), phenylalanine, tyrosine, tryptophan (−3.48 to −4.25 kcal/mol, π–π stacking), and arginine (−3.48 kcal/mol, cation–π interaction). Experimental ΔG_{ads} data for amino acid-CNT systems are scarce, but the aromatic/cationic trend agrees qualitatively with prior MD and density functional theory (DFT) interaction-energy studies. Aspartic acid was the only non-adsorber, likely due to electrostatic repulsion between its negatively charged carboxylate group and the CNT π-electron system. These residue-level free energies may serve as benchmarks for peptide and protein interactions with small-diameter CNTs, and could lead to improvements in protein engineering.

Keywords: Adaptive biasing force, Amino acid adsorption, Carbon nanotube, CHARMM36, Molecular dynamics

OPTIMIZATION OF RICE HUSK INCORPORATION IN FIRED CLAY BRICKS BASED ON GEOTECHNICAL AND PHYSIO-MECHANICAL PROPERTIES: A PRELIMINARY STUDY

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The incorporation of agricultural waste into clay brick production is a sustainable strategy to reduce environmental impacts and improve brick performance. This study evaluated the influence of adding rice husk (RH) on the geotechnical properties of raw clay and the physical and mechanical performance of fired bricks to identify the optimum RH content for lightweight bricks with acceptable engineering performance and potential thermal benefits. Raw clay collected near the Gal Oya bridge in Ampara, Sri Lanka, was characterized using Energy-Dispersive X-ray Fluorescence (ED-XRF), X-ray Diffraction (XRD), and Fourier Transform Infrared Spectroscopy (FTIR), while geotechnical properties were assessed using the Atterberg limits. XRD indicated quartz as the dominant mineral phase, with minor feldspar and kaolinite. Fired bricks containing 0%, 2%, 4%, 6%, and 8% w/w RH were evaluated for bulk density, apparent porosity, water absorption, and compressive strength. Apparent porosity was calculated from water absorption and brick volume. RH incorporation increased liquid and plastic limits while reducing the plasticity index, improving workability, and reducing shrink-swell potential. Increasing RH increased porosity and water absorption while reducing bulk density and compressive strength. Porosity increased from 24.5% to 37.7%, density decreased from 1.66 to 1.22 gcm^{-3}, and compressive strength decreased from 17.66 to 3.01 MPa. Preliminary thermal assessment showed an increase in the final temperature difference from 55 °C to 64 °C and a decrease in the rate of temperature change from 0.60 to 0.30 °C min^{-1} as RH increased, indicating a slower thermal response. Considering the balance among workability, density, porosity, strength, and thermal response, 4% RH was identified as the optimum composition for lightweight, non-load-bearing bricks with acceptable engineering performance. These findings demonstrate the potential of rice husk as a sustainable agro-industrial additive for producing lightweight fired clay bricks with improved thermal response, supporting its potential for resource-efficient construction applications.

Keywords: Compressive strength, Geotechnical properties, Physio-mechanical properties, Porosity, Rice husk

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CHELATION-INDUCED ENHANCEMENT OF BIOLOGICAL ACTIVITY IN Ni(II) AND Zn(II) SCHIFF BASE COMPLEXES

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Schiff base metal complexes have attracted attention as antimicrobial metallodrugs due to increasing microbial resistance to conventional antibiotics. This study reports the antimicrobial, antioxidant, and toxicological properties of a Schiff base ligand (L) derived from para-hydroxybenzaldehyde and para-toluidine in a 1:1 molar ratio, and its Ni^{2+} and Zn^{2+} complexes synthesized using a 2:1 ligand-to-metal salt ratio and adopting tetrahedral geometry. The synthesized L, Ni(II)-L, and Zn(II)-L complexes were characterized by FT-IR, UV-visible spectroscopy, CHN elemental analysis, PXRD, and TGA. Antioxidant activity was evaluated using the DPPH radical-scavenging assay, with ascorbic acid as the positive control. IC_{50} values showed enhanced antioxidant capacity after metalation, with values of 450 ppm for Ni-L compared with 4500 ppm for L. Antibacterial activity was evaluated against two Gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*) and two Gram-positive bacteria (*Enterococcus faecalis*, *Staphylococcus aureus*) using the agar dilution method, while antifungal activity was screened against *Candida albicans*. Minimum inhibitory concentrations showed that the metal complexes were more active than L, with Zn(II)-L exhibiting the highest activity against *P. aeruginosa*. Enhanced antimicrobial activity may result from increased ligand lipophilicity following metal chelation. Toxicity was assessed using the brine shrimp lethality assay, showing the trend Ni(II)-L > Zn(II)-L > L, indicating increased toxicity upon metalation. Thus, although metalation enhances antimicrobial activity, it also increases toxicity toward the host. Further studies are needed to establish the relationship between antimicrobial activity and toxicity in these complexes.

Financial assistance from the University Research Council, University of Peradeniya (*Grant No. URC/14/2025*) *is acknowledged.*

Keywords: Antimicrobial, Antioxidant, Metallodrugs, Metal-complexes, Toxicity

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TRANSITION METAL-MEDIATED MODULATION OF ANTIMICROBIAL, ANTIOXIDANT, AND CYTOTOXIC PROPERTIES OF A SCHIFF BASE LIGAND

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Transition-metal Schiff base complexes have emerged as promising candidates against antimicrobial resistance through multiple mechanisms. This study reports a novel Schiff base ligand, 2-((E)-((2-(((E)-benzylidene)amino)phenyl)imino)methyl)-naphthalene-1-ol (L), synthesized by reflux condensation of benzaldehyde, *o*-phenylenediamine, and 2-hydroxy-1-naphthaldehyde in a 1:1:1 molar ratio using absolute ethanol. The ligand was coordinated with Cu(II), Ni(II), and Mn(II) ions. The ligand and complexes were characterized by FT-IR, UV–Visible, XRD, TGA, SEM, and CHN elemental analyses, confirming a tridentate NNO-donor system. Antimicrobial activity was evaluated against *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Enterococcus faecalis*, and *Candida albicans* using agar well diffusion and agar dilution methods. Cu(II)-L exhibited the greatest antimicrobial activity, particularly against *E. faecalis* (inhibition zone: 17 ± 0.5 mm; MIC: 128 ppm), while Mn(II)-L showed the highest activity against *S. aureus* (22 ± 0.5 mm; MIC: 640 ppm). The free ligand and corresponding metal salts showed minimal or no antimicrobial activity. DPPH antioxidant assays gave IC_{50} values of 24.8, 41.34, 64.9, and 139.5 ppm for L, Cu(II)-L, Ni(II)-L, and Mn(II)-L, respectively, indicating that antioxidant capacity decreased upon metal coordination. Brine shrimp lethality assays ranked cytotoxicity as L > Ni(II)-L > Cu(II)-L > Mn(II)-L. Overall, metal complexation reduced antioxidant capacity and cytotoxicity but significantly enhanced antimicrobial activity, likely through increased membrane permeability and interactions with microbial targets.

Financial assistance from PGIS, University of Peradeniya (Grant No PGIS/2024/09) is acknowledged.

Keywords: Coordination, Synthesis, Microscopic, Crystallographic, Tridentate

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SYNTHESIS AND CHARACTERIZATION OF A GRAPHITE OXIDE-CUPRIC OXIDE COMPOSITE DERIVED FROM SRILANKAN NATURAL VEIN GRAPHITE

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The strategic combination of materials can yield more advantageous composites. Accordingly, Cupric oxide (CuO) and Graphite oxide (GO) based composites have received significant attention for applications such as energy storage, sensing, and catalysis. CuO, which acts as the functional phase of the composite, is a p-type semiconductor, and its catalytic activity, low cost, and chemical stability make it more advantageous. However, its performance is limited by particle agglomeration and relatively low active surface area. The incorporation of GO as the matrix of the composite can improve the physical and chemical properties of CuO by providing a high surface area, more oxygen-containing functional groups, and improving particle dispersion. Natural vein graphite (NVG) from Sri Lanka, with high purity and crystallinity, represents an attractive precursor for the synthesis of GO. Therefore, this study aimed to synthesize and characterize a GO-CuO composite derived from NVG. GO was synthesized from NVG with a particle size of 53 μm using a modified Hummers method. GO-CuO composite containing 0.12 g of GO was synthesized via a co-precipitation method. GO was dispersed in distilled water, then $CuSO_4$ was added. NaOH was then added dropwise while stirring to facilitate the formation of CuO particles. The resulting suspension was heated to 55 °C and stirred overnight. The precipitate obtained was washed until a neutral pH was reached. Precipitate was then dried. X-ray diffraction (XRD) analysis revealed the successful incorporation of CuO into the GO matrix while maintaining the CuO crystal structure. Fourier transform infrared spectroscopy (FTIR) exhibited GO-related functional groups and Cu-O vibrational bands with noticeable peak shifts, indicating interactions between GO and CuO. Raman spectroscopy further confirmed the coexistence of GO and CuO characteristic bands, while scanning electron microscopy (SEM) analysis revealed CuO particles distributed on GO sheets. These findings demonstrate the successful synthesis of the GO-CuO composite.

Keywords: Composite, Copper oxide (CuO), Graphite oxide (GO), Vein graphite.

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ENHANCING THE ELECTROCHEMICAL PERFORMANCE OF ACTIVATED CARBON SUPERCAPACITORS USING PRE-CHEMICALLY EXPANDED, REDUCED GRAPHENE OXIDE

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Biomass-derived activated carbon (AC) is considered a promising electrode material for sustainable energy storage devices due to its high surface area and porous structure. Low electrical conductivity of AC can limit the overall performance of supercapacitors. This study uses reduced graphene oxide (rGO) synthesized via a novel method, mixed with coconut shell-derived AC. The rGO synthesis involved a three-step process: graphite was initially expanded via chemical expansion to increase interlayer spacing, oxidized using a modified Hummers' method, and subsequently converted to rGO by chemical reduction. For electrode fabrication, titanium plates were initially preheated at 150 °C for 10 minutes. A composite slurry containing 0.5 g of AC, 0.01 g of rGO, 5% of polyvinylpyrrolidone (PVP) as the binder, and 10 ml of isopropanol as the solvent was prepared and coated onto titanium substrates using the spray pyrolysis technique. The coated electrodes were then annealed at 200 °C for 20 minutes. For comparison, electrodes fabricated using only AC under the same conditions were also prepared. Symmetric supercapacitor cells were assembled using filter paper as the separator and 2.5 M $H_2SO_{4(aq)}$ as the electrolyte. The electrical resistivity of materials was measured using a four-probe method, and the materials and electrodes were characterized by Raman spectroscopy and cyclic voltammetry (CV). Raman analysis revealed that the rGO-AC composite exhibited an I_D/I_G ratio of 0.87, lower than the 1.07 of raw AC, indicating increased structural ordering and graphitic networks. The electrical conductivity was calculated to be 22.72 S m^{-1} and 1.5 S m^{-1} for the rGO-AC composite and AC, respectively. Consequently, the rGO-AC cell delivered a specific capacitance of 102.85 F g^{-1}, representing a 100% improvement over the 51.36 F g^{-1} achieved by raw AC. Chemically expanded rGO from local graphite effectively overcomes the conductivity limits of biomass-derived carbon, offering a scalable, low-cost route to high-capacitance, sustainable supercapacitor electrodes.

Keywords: Activated carbon, Composite, rGO, Supercapacitors

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UNIVERSAL DENDRIMER BUILDER: A GUI-DRIVEN COMPUTATIONAL PLATFORM FOR MULTI-TYPE DENDRIMER CONSTRUCTION, PARAMETERIZATION, AND MOLECULAR DYNAMICS

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Dendrimers are tree-like hyperbranched nanoscale polymers with controllable size, surface chemistry, and internal void volume. Their unique structure enables applications in drug delivery, gene therapy, and coatings. However, building accurate 3D models across chemically distinct dendrimer families remains computationally challenging. The Universal Dendrimer Builder (UDB) addresses this by providing a unified, open-source graphical platform for constructing, parameterizing, characterizing, and setting up molecular dynamic's simulations of dendrimer architectures. The tool can generate nine common dendrimers (PAMAM, PPI, Triazine, Carbosilane, PLL, Phosphorus, Polyester, Polyglycerol) across different generations by default, and can generate any custom dendrimer with coordinate input from the user. Monomers are placed via a seven-stage engine using golden-ratio azimuthal spacing on a branching cone whose spread angle widens progressively across generations to prevent crowding. Van der Waals clashes are detected via a K-Dimensional Tree accelerated search and resolved by simulated annealing over all possible orientations. Post-generation passes include a rotational sweep and a steepest-descent energy-minimization step to further refine each generation before output. Per-generation characterization reports solvent-accessible surface area, van der Waals volume, radius of gyration, hydrodynamic radius, sphericity, and molecular density for both as-built and minimized geometries. Parameterization via AmberTools assigns partial charges to structures, and partial minimization at each stage is performed via Sander in AmberTools. Subsequently, structures can be exported in commonly used coordinate formats or can be interfaced with molecular dynamics codes such as NAMD. The tool is applicable to structure and activity relationship studies, drug delivery modeling, antiviral dendrimer design, and biodegradable materials research.

Keywords: Dendrimers, Drug delivery, Nanoscience, Molecular dynamics

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INFLUENCE OF ROTATIONAL ACCELERATION ON THE INTERFACIAL POLYMERIZATION OF MULTI-WALLED CARBON NANOTUBE THIN FILM NANOCOMPOSITE MEMBRANES

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The growing demand for clean drinking water has intensified research into high-performance membrane technologies for desalination. To overcome the limitations of conventional membranes, nanomaterial-incorporated thin-film nanocomposite (TFN) membranes have emerged as promising alternatives. Among these, multi-walled carbon nanotubes (MWCNTs) offer unique structural and physicochemical properties that can enhance membrane performance when incorporated into the polyamide (PA) active layer. During TFN fabrication, interfacial polymerization of m-phenylenediamine (MPD) and trimesoyl chloride (TMC) is strongly influenced by spin-coating conditions, affecting active layer formation, nanomaterial dispersion, and membrane characteristics. This study investigates the role of rotational acceleration (20–100 rpm s^{-1}) in fabricating TFN membranes containing MWCNTs synthesized via single-stage floating-catalyst chemical vapor deposition (SS-FCCVD). FTIR and Raman analyses confirmed the chemical structures and the successful incorporation of MWCNTs into the PA layer. Variations in the Raman intensity ratio I_{1153}/I_{1587} indicated that rotational acceleration influenced MWCNT–PA interactions and dispersion. Zeta potential analysis supported these findings, showing that an increase in oxygen-containing functional groups resulted in a more negatively charged surface. This enhanced electrostatic repulsion, contaminant rejection, surface hydrophilicity, and water permeability. SEM revealed that rotational acceleration significantly affected active-layer thickness and morphology. An optimal acceleration of 60 rpm s^{-1} produced the thinnest active layer (~179 nm) with larger surface pores (~1.66 μm), whereas 80 rpm s^{-1} produced denser, more uniform pores (~1.09 μm). These findings provide insights into optimizing spin-c

Keywords: Carbon nanotubes, Centrifugal force, Nanofiltration, Spin coating, Water purification

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SYNTHESIS AND CHARACTERIZATION OF BORON AND PALLADIUM MODIFIED FAUJASITE ZEOLITES FOR TUNABLE CATALYTIC FUNCTIONALITY

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The tunable acidity and structural stability of faujasite (FAU) Y-type zeolites are essential for developing selective catalytic materials, yet modifying acid sites without damaging the FAU framework remains challenging. This study aimed to synthesize boron (B) and palladium (Pd) modified faujasite zeolites as structurally tailored materials for future catalytic applications. Faujasite zeolites with B/Al (w/w) ratios of 0.00, 0.50, and 0.75 were prepared by hydrothermal crystallization and converted into protonic HY/B-HY forms through ammonium ion exchange and calcination. Pd functionalized derivatives were then obtained by post-synthetic aqueous palladium nitrate treatment followed by drying and calcination. The synthesized materials were characterized using Fourier transform infrared spectroscopy, Raman spectroscopy, scanning electron microscopy, and energy-dispersive X-ray spectroscopy. FTIR spectra showed characteristic faujasite framework vibrations and hydroxyl bands, indicating that the faujasite framework was retained after B modification and Pd functionalization, confirming preservation of the FAU structure after both B modification and Pd loading. Raman analysis further supported the retention of the FAU framework, while band broadening and changes in intensity in Pd/B-HY suggested alterations in the local vibrational environment due to Pd-zeolite interactions, with no evidence of framework collapse. SEM images showed aggregated zeolite particles without severe morphological damage after modification, and EDX confirmed Pd incorporation in Pd/B-HY, with Pd detected at 1.13 and 0.22 wt.%. Overall, this study established a reproducible route for synthesizing B-HY and Pd/B-HY zeolites, demonstrating that B and Pd can modify the local chemical environment while maintaining the structural identity of faujasite for subsequent catalytic evaluation.

Keywords: Calcination, Faujasite, Hydrothermal crystallization, Ion exchange

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THE INFLUENCE OF SUBSTRATE MATERIALS ON THE GROWTH, MORPHOLOGY, AND PROPERTIES OF VERTICALLY ALIGNED CARBON NANOTUBES SYNTHESIZED VIA THE FLOATING CATALYST CVD METHOD

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Vertically aligned carbon nanotubes (VA-CNTs) have attracted significant attention in materials science owing to their high aspect ratio, excellent electrical and thermal conductivity, outstanding mechanical strength, low density, and large specific surface area. These unique properties make VA-CNTs promising for applications in field emission, energy storage, thermal management, sensing, filtration, and polymer nanocomposites. Among the various synthesis techniques, Single-Stage Floating Catalyst Chemical Vapor Deposition (SS-FCCVD) is considered a promising method because of its scalability, simplicity, and environmentally friendly operation. However, the influence of the base substrate on VA-CNT growth behavior and final nanotube quality in the SS-FCCVD process remains insufficiently understood. To address this knowledge gap, the present study systematically investigates the effect of different substrate materials on VA-CNT synthesis using a camphor–ferrocene precursor system. Here, ten distinct substrates, including four types of Sri Lankan ceramics (S01– S04), natural crystalline white and smoky quartz, synthetic white quartz, synthetic white sapphire, copper, and silicon (100) plates. All bare substrates were characterized using X-ray diffraction (XRD), thermal stability testing at 850 °C, surface energy measurements, surface pH analysis, and a novel optical roughness assessment method. Thermal stability investigations revealed that natural crystalline quartz substrates developed microcracks at elevated temperatures (850 °C), indicating significant limitations for large-scale industrial applications. In contrast, ceramic substrates, particularly S03 and S04, exhibited excellent thermal stability, near-neutral to slightly alkaline surface pH values (7.24–8.10), and superior VA-CNT growth rates ranging from 32 to 186 mg cm^{-2} h^{-1}. Scanning Electron Microscopy (SEM), XRD, and Raman confirmed the formation of dense, graphitized multi-walled CNTs, particularly on the S03 ceramic substrate, with outer diameters ranging from 32 to 100 nm and heights reaching up to 40 μm. Overall, this study clarifies the role of substrate–catalyst interactions in VA-CNT growth and provides a basis for substrate selection in the scalable production of high-purity CNTs.

Keywords: SS-FCCVD, Substrates, VA-CNTs

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RAPID SYNTHESIS OF MAGNETIC ACTIVATED HUMAN HAIR COMPOSITE (MAHC) FOR ENHANCED ADSORPTION OF CADMIUM(II)

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Human hair is an increasingly abundant waste material that accumulates in the environment and landfills, raising the need to remove it. Additionally, heavy metal contamination from anthropogenic activities poses serious ecological and public health concerns. Both problems can be addressed simultaneously by valorizing human hair waste as a heavy metal adsorbent. Previous studies have shown that alkaline oxidation activation enhances the adsorption performance of human hair and that magnetite-functionalized hair materials enable magnetic recovery after adsorption, and that they can adsorb Cr(VI). Although the benefits of alkaline oxidation and magnetic functionalization have been independently demonstrated, their combined application remains unexplored. This study addresses this gap by combining these two modification strategies to develop the material, Magnetic Activated Human Hair Composite (MAHC). The MAHC was synthesized through rapid alkaline oxidation followed by in situ magnetite co-precipitation. The key innovations of this work are reducing oxidation time from 5 h to approximately 1.25 h by optimizing reaction conditions and magnetizing the oxidized hair. The resulting MAHC material demonstrated 98.2% removal of Cd(II) from a 10 mg L^{-1} solution at ambient pH and 31 ± 1 °C within approximately 40 min. Under identical conditions, Rapid Chemical Activated Hair (RCAH) achieved 96.9% removal. Pseudo-second-order kinetic fitting indicates adsorption capacities of 0.029 mmol g^{-1} and 0.031 mmol g^{-1} for MAHC and RCAH, respectively, and rate constants 17.120 g $mmol^{-1}min^{-1}$ and 11.934 g $mmol^{-1}min^{-1}$, respectively. These results indicate that incorporating magnetite improved the adsorbent's handling and recovery while maintaining high adsorption performance. Oxidation and magnetization were qualitatively confirmed by FTIR Spectroscopy and magnetic response, respectively. The developed material represents a low-cost, magnetically recoverable adsorbent with potential applications in industrial wastewater treatment. Further studies are in progress to elucidate adsorption mechanisms and optimize performance.

Keywords: adsorption, composite, hair, heavy-metal, magnetite

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CuO-TiO_2 COMPOSITE NANOPARTICLES FOR PHOTOCATALYTIC HYDROGEN GENERATION

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Photocatalytic water splitting using semiconductor metal oxides offers a sustainable route to green hydrogen production; however, rapid electron-hole recombination in single-component systems remains a critical limitation. This work demonstrates that the annealing-temperature-controlled particle size of CuO nanostructures directly governs their photocatalytic activity, offering a simple, tunable strategy to optimize CuO/TiO_2 heterojunctions for enhanced solar-driven hydrogen evolution. This study reports the synthesis of phase-pure monoclinic CuO nanoparticles (NPs) and nanocrystals (NCs) via an ice-temperature-controlled co-precipitation method, and the fabrication of CuO/TiO_2 heterojunctions by ultrasonic coating. The structural, morphological, and optical properties of all samples were characterized by XRD, Raman spectroscopy, FTIR, SEM, and UV-Vis diffuse reflectance spectroscopy. Annealing temperature was found to govern crystallinity and particle size (27-56 nm), whilst heterojunction formation was confirmed by Ti-O-Cu interfacial bonding and a widened optical band gap of 2.57 eV. Photocatalytic hydrogen evolution was evaluated under direct solar irradiation using a water-displacement technique. The CuO/TiO_2 composites significantly outperformed pristine CuO nanostructures, with the CuO (NPs)/TiO_2 heterojunction achieving the highest mass-normalized gas evolution rate of 14 mL $min^{-1}g^{-1}$. Enhanced performance is attributed to efficient *p-n* junction formation, which suppresses electron-hole recombination, extends visible-light absorption, and provides a porous morphology with a high density of reactive surface sites. These findings highlight CuO/TiO_2 heterojunctions as promising low-cost photocatalysts for solar-driven hydrogen generation.

Financial assistance from the *National Research Council, Sri Lanka (NRC-IDG:24-17) is acknowledged.*

Keywords: CuO nanostructures, p–n heterojunction, Photocatalysis, Hydrogen evolution, Water splitting.

PS 43 ***Physical Sciences***

HIGH COVERAGE AND FAST GROWTH PROCESSING OF AMORPHOUS BRIGHT-ORANGE Sb_2S_3 LAYER FOR SOLAR CELLS

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Achieving the theoretical efficiency of antimony sulfide (Sb_2S_3) solar cells, which have a non-toxic and abundant elemental composition, was limited due to recombination in deep-level defects in the Sb_2S_3 layer. The objective was to investigate the performance of solar cells fabricated with two passivation levels of Sb_2S_3 layers, producing white-orange and bright-orange amorphous phases after heating, and to further enhance efficiency through high coverage and a fast growth process. For this purpose, white-orange and bright-orange solar cells were fabricated according to previous studied FTO/TiO_2/Sb_2S_3/P3HT/carbon/FTO configuration. The modified process consisted of slow and fast spin-coating programs, a thiourea layer, and multiple Sb2S3 layers for high coverage, followed by a drying step, low heating temperature, fast annealing rate, and fast cooling rate for controllable, fast growth. Bright-orange fast growth solar cell achieved the highest efficiency 1.273% with short circuit current density (J_{SC}) 7.43 mA cm^{-2}, open circuit voltage (V_{OC}) 508 mV, fill factor 0.337, compared with white-orange slow growth (0.824%, 5.78 mA cm^{-2}, 458 mV, 0.311) and bright-orange slow growth (0.513%, 7.23 mA cm^{-2}, 265 mV, 0.268) solar cells. Even with bright-orange slow growth, efficiency was limited by low VOC; bright-orange fast growth solved this issue by exceeding all parameters compared to the other two solar cells. A bright-orange fast-growth solar cell outperformed a previously published device (4.03 mA cm^{-2}, 0.292) with the same configuration. The bright-orange fast-growth layer has better crystallinity than the slow-growth layer. The ideality factor of 1.87 in the V_{OC} versus intensity plot indicates trap-assisted recombination in the bright-orange fast-growth solar cell at 11 – 35 mW cm^{-2}, while it reduces to 1.21 at 40 – 100 mW cm^{-2}, indicating bimolecular recombination. Also, the exponential factor in the J_{SC}-dependent intensity plot confirmed that bimolecular recombination was low. Overall, fast growth with improved coverage of the Sb_2S_3 layer has increased crystallinity, reduced recombination, enhanced solar cell performance, and high repeatability.

Keywords: Bright-orange amorphous layer, Coverage, Crystallinity, Fast growth process, Sb_2S_3 solar cells

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THIOPHENE-BASED ALKYNYL COMPLEXES FOR SECOND-ORDER NONLINEAR OPTICS: A DFT STUDY

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Nonlinear optical (NLO) materials are of great interest in many technological applications, such as optical communications and optical switches. Metal alkynyl complexes featuring donor-bridge-acceptor architectures offer superior structural flexibility compared to traditional NLO materials. In these complexes, the π-conjugated bridge linking the metal donor and acceptor moieties generally comprises benzene or thiophene rings. While the NLO properties of phenylene-bridged complexes are well-documented, systematic studies evaluating the NLO efficacy of thienylene complexes with different linkers (-ene, -yne) against their phenylene analogs remain scarce. This study addresses these gaps by systematically investigating the second-order NLO properties of a series of Au, Fe, and Ru alkynyl complexes with the formula: $[M]-\equiv -X-Y-Z-NO_2$ (X= 1,4-phenylene/2,5-thienylene, Y= -ene/-yne/no-linker, Z= 1,4-phenylene/2,5-thienylene and [M] = Au (PH3), Ru(η5-C5H5) (dhpe), Fe(η5-C5H5) (dhpe)) using Density Functional Theory (DFT) and Time-Dependent (TD)-DFT calculations. Furthermore, molecular orbital calculations and conformational studies were performed to gain more insights into their NLO responses. Substituting 1,4-phenylene in the arylalkynyl bridge with the less aromatic 2,5- thienylene, increases the calculated static total first hyperpolarizability (β_{tot}) by ca. 25%. Insertion of bridging linkers (Y) between the two rings (X and Z) significantly affects the NLO data, with β_{tot} increasing in the order of no-linker < -yne < -ene, corresponding to a ca. 65% increase. Ruthenium outperforms both gold and iron. The TD-DFT analysis showed a strong correlation between the calculated β_{tot} values and energies of low-lying charge-transfer transitions. Conformational analysis emphasizes the necessity of molecular planarity for optimal NLO efficacy for the thiophene-based systems. Calculations on the oxidized species showed that these molecules hold promise as NLO redox switches, exhibiting large beta upon oxidation. These findings demonstrate the superior second-order NLO response of thiophene-based alkynyl complexes bearing linker groups, providing valuable insights into the rational design of high-performance NLO materials.

Keywords: DFT, First hyperpolarizability, Metal alkynyl complexes, Nonlinear optics, Thiophene

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IDENTIFICATION OF FURANONE COMPOUNDS FROM THE ENDOPHYTIC FUNGUS *Phyllosticta capitalensis* ISOLATED FROM *Syngonium angustatum* Schott. LEAVES

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Endophytic fungi are symbiotic microbial assemblages that colonize the internal tissues of living plants without causing any damage to the host plants. They enhance the physiological resilience of host plants by producing secondary metabolites. These metabolites show structural heterogeneity and possess great bioactivity potential. Thus, secondary metabolites of endophytic fungi have been recognized as an untapped source of drug discovery. The main aim of this study was to separate and characterize secondary metabolites produced by the endophytic fungus *Phyllosticta capitalensis* associated with the leaves of the phytoremediation and medicinal plant *Syngonium angustatum* Schott. Fungal cultures were identified using ITS rDNA sequencing and microscopic examination of spores. Two novel furanone structures (5-benzylidene-3-isopropyl-4-methoxyfuran-2(5H)-one and 5-benzylidene-3-(*sec*-butyl)-4-methoxyfuran-2(5H)-one) were isolated from the ethyl acetate extract of *P. capitalensis* by chromatographic separation and were identified using ^{1}H NMR and ^{13}C NMR spectra and confirmed based on the DEPT and 2D NMR (COSY, HSQC, and HMBC) data. Mass spectral data can be acquired for further confirmation. In addition, bioassay studies were suggested to assess the compounds' potential for bioactivity.

Keywords: Furanone, *Phyllosticta capitalensis*, *Syngonium angustatum*

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SUPERIOR CORROSION INHIBITION OF STAINLESS STEEL GRADE 202 BY ZnO NANOPARTICLES IN HCl MEDIUM

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Corrosion is the electrochemical degradation of metals through interaction with acidic and chloride-rich media. Corrosion inhibitors mitigate this by adsorbing onto the metal surface. Stainless steel, particularly Grade 202 (SS Grade 202), is widely used for its high mechanical strength, cost-effectiveness, and inherent corrosion resistance, which stems from the formation of a chromium-rich passive oxide layer. Nevertheless, SS Grade 202 is prone to corrosion in aggressive media, limiting its industrial applications. This study explores the corrosion inhibition performance of ZnO nanoparticles (NPs) on SS Grade 202 in HCl media. ZnO NPs were synthesized via a chemical precipitation method. The particles had an average size of 24.2 nm and exhibited characteristic bands in the Fourier transform infrared (FTIR) spectrum at 838 cm-1 and 696 cm^{-1}, corresponding to Zn-O stretching vibrations, confirming the formation of ZnO NPs. Further, corrosion inhibition performance evaluated through mass loss measurements, electrochemical impedance spectroscopy (EIS), and Tafel polarization techniques clearly shows the vulnerability of SS Grade 202 to pitting corrosion in acidic Cl^- media. Nyquist plots showed enlarged semicircles as NP concentration increased, indicating enhanced charge-transfer resistance (R_{ct}). The maximum R_{ct} value of 28.94 Ω cm^{-2} is about four times higher than that of the uninhibited system (7.64 Ω cm^{-2}). Tafel polarization studies depict that the highest concentration of ZnO NPs (0.40 mol L^{-1}) exhibits a corrosion current density of 1.39×10^{-4}A representing a significant reduction compared to the blank (5.50×10^{-4}A). The corrosion rate at the highest concentration of ZnO NPs is 0.80 mpy, which is also significantly lower than that of the blank (3.20 mpy). The highest concentration of ZnO NPs showed more than 75% inhibition efficiency relative to the blank. The study highlights the advantages of ZnO NPs as an efficient, low-toxicity, high-performance corrosion inhibitor, offering a viable pathway for developing corrosion inhibitors for industrial applications.

Keywords: Corrosion, EIS, Inhibition, SS Grade 202, ZnO NPs

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POLARON- INDUCED CHARGE CARRIER DYNAMICS IN REDUCED MnO_2 and Mn_xB_y FOR WATER SPLITTING

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Water splitting represents a promising strategy for harnessing solar energy to produce green hydrogen (H_2) sustainably. However, developing cost-effective, efficient, and environmentally friendly semiconductor materials has remained a challenge over the past few decades. The primary aim is to develop low-bandgap materials that increase light absorption and reduce charge-carrier recombination to improve water-splitting efficiency. This study explores defect-rich reduced MnO_{2-X} and Mn_xB_y, which were synthesized via thermal treatment of MnO_2 with $NaBH_4$ at 850 °C to introduce oxygen vacancies (V_o) and boron vacancies (VB), and to incorporate electrons into the lattice, thereby enhancing light absorption and charge-separation capability. Under visible-light irradiation, the catalyst exhibited an H_2 evolution rate of 628.7 mmol g^{-1} h^{-1}, which was 215.2% higher than under dark conditions, confirming its photoactivity. Optimization of the annealing temperature revealed that catalysts synthesized at 750 °C and 950 °C exhibited activities suppressed by 99.6 and 56.7%, respectively, relative to the optimal 850 °C sample. The prepared powder was characterized by using UV-visible diffuse reflectance spectroscopy (UV-Vis DRS) and powder X-ray diffraction (PXRD). UV-Vis DRS revealed that the band gap of pristine MnO_2 was 3.56 eV and decreased to ≈1.39 eV after $NaBH_4$ reduction at 850 °C. The XRD analysis indicates that the $NaBH_4$-treated MnO_2 samples annealed at 750, 850, and 950 °C became more amorphous, as evidenced by the reduced peak intensity and the appearance of new peaks at 2θ = 50.02° and 56.44° associated with Mn_2B and at 2θ = 45.8° and 61.3°, corresponding to MnB_2. This confirms the successful synthesis of defective MnO_{2-X} and Mn_xB_y with V_o and V_B. This work demonstrates that defect engineering via controlled thermal treatment and $NaBH_4$ reduction effectively enhances catalytic H_2 production.

Keywords: Boron vacancies, Manganese dioxide, Manganese diboride, Polaron, Water splitting

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ENHANCED DYE-SENSITIZED SOLAR CELL PERFORMANCE USING STAR-SHAPED AND ROD-SHAPED ZINC OXIDE NANOPARTICLES

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The morphology of semiconductor photoanodes is essential for charge transport, dye adsorption, and overall device efficiency in dye-sensitized solar cells (DSSCs). Direct evidence linking the three-dimensional branched structure of star-shaped ZnO to superior dye adsorption and photocurrent generation remains limited. Star-shaped ZnO nanoparticles outperform rod-shaped ones, achieving a higher power conversion efficiency (6.99% vs. 5.95%) through stronger dye–semiconductor interaction and enhanced light scattering. Star- and rod-shaped ZnO nanoparticles were synthesized via hydrothermal methods using zinc nitrate/CTAC and zinc acetate/ammonia precursors, respectively, followed by autoclave treatment at 140 °C for 10 h and calcination at 500 °C for 2 h. The resulting ZnO nanostructures were deposited onto FTO substrates, sensitized with dye, and assembled into DSSCs with a platinum counter electrode and iodide/triiodide electrolyte. The surface interactions between the dye molecules and ZnO nanostructures were characterized using Raman spectroscopy. The photovoltaic performance was evaluated by current density-voltage (J-V) measurements under simulated AM 1.5G illumination. Raman spectroscopy confirmed dye adsorption on both morphologies, but the intensity of the enhanced signal differed, pointing to a stronger dye–ZnO interaction in the star-shaped photoanode. The J-V measurements showed that the star-shaped ZnO-based DSSC had a power conversion efficiency (PCE) of 6.99%, and the rod-shaped device had 5.95%. The short-circuit current density followed the same trend: 16.18 mA cm^{-2} for the star-shaped and 13.62 mA cm^{-2} for the rod-shaped. Open-circuit voltage and fill factor were similar between the two designs, indicating differences in photocurrent generation and charge collection rather than in voltage losses or fill-factor degradation. The advantage stems from the branched, three-dimensional structure of star-shaped ZnO nanoparticles. More geometric surface area allows for more dye loading. The extending arms create significant light scattering and increase the optical path length in the active layer. Hence, engineering the morphology of ZnO nanostructures is an effective way to improve DSSC performance.

Keywords: Dye-sensitized solar cells, Morphology engineering, Photoanode, ZnO



Computer Science, Artificial Intelligence, Mathematics, and Statistics

CAMS 01

Computer Science, Artificial Intelligence, Mathematics & Statistics

GENERALIZED IN AR(1) MODEL FOR COUNT DATA

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Discrete-valued time series data are common in many real-world situations, such as daily accident counts and the number of patients treated in emergency departments. The Poisson distribution is often used in integer-valued autoregressive (INAR) models. However, the Poisson assumption implies that the mean and variance are equal, which is not always realistic. In practice, many datasets show overdispersion or underdispersion, making the standard INAR model inadequate. To overcome this limitation, this study proposes a first-order INAR (INAR(1)) model with a power-series thinning operator and power-series innovations. This framework offers more flexibility in handling different types of dispersion and includes well-known models, such as the Poisson INAR(1) and geometric INAR(1), as special cases. The main properties of the model, such as mean, variance, and autocorrelation function, are derived. Model parameters are estimated using Yule–Walker (YW), Conditional Least Squares (CLS), and Conditional Maximum Likelihood (CML) methods. A simulation study is conducted to evaluate the performance of these estimators across different parameter settings, sample sizes, and distributional assumptions (e.g., Poisson, geometric, and Bernoulli). The comparison is based on bias and mean squared error, and the results indicate that the CML method generally performs better than the YW and CLS methods. Finally, the proposed model is applied to two real-world datasets to demonstrate its practical applicability. Model performance is assessed using statistical measures such as Akaike Information Criterion (AIC), Root Mean Square Error (RMSE), and Mean Absolute Error (MAE). For the sex offences data, the Geometric INAR(1) model with Binomial thinning was selected as the best model, with an AIC of 302.5731, RMSE of 0.9896, and MAE of 0.7284. For the family violence data, the Poisson INAR(1) model with Binomial thinning was selected as the best model, with an AIC of 337.9031, RMSE of 0.8251, and MAE of 0.6742. Overall, the results show that the proposed framework provides a flexible and unified approach for analysing count time series with different levels of dispersion.

Keywords: Conditional maximum likelihood, Integer-valued autoregressive processes, Overdispersion, Power series innovations, Power series thinning operator

CAMS 02

Computer Science, Artificial Intelligence, Mathematics & Statistics

EFFICIENT AND INTERPRETABLE BREAST CANCER DETECTION USING PROPER ORTHOGONAL DECOMPOSITION (POD)-BASED FEATURE LEARNING ACROSS MULTI-SOURCE DATASETS

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Breast cancer remains a major global health concern, highlighting the need for accurate and efficient diagnostic methods. This study presents a Proper Orthogonal Decomposition (POD)-based feature learning framework for breast cancer classification across multi-source datasets. The hypothesis is that POD can reduce data dimensionality while preserving diagnostically relevant information, improving classification efficiency. The novelty lies in evaluating POD-based feature learning separately across benchmark and clinically collected datasets. The framework was evaluated using the Wisconsin Diagnostic Breast Cancer (WDBC), Wisconsin Breast Cancer (WBC), and a clinically collected histopathological dataset, with each analyzed independently. Preprocessing included missing-value imputation, interquartile range (IQR)-based outlier detection, feature standardization, and variance-threshold feature selection. To minimize data leakage, preprocessing parameters and transformations were determined using training data only and then applied to test data. POD was applied to extract dominant modes, with the optimal number determined using the elbow criterion based on cumulative explained variance. Reduced representations were evaluated using a Support Vector Machine (SVM) with an RBF kernel and grid-search hyperparameter tuning using a 70:30 train-test split. Results achieved 95.83% accuracy for WDBC using seven POD modes and 96.10% for WBC using four modes. The clinical dataset achieved 70.44% accuracy across 10 modes, with 81% sensitivity, 58% specificity, and F1-scores of 0.64 and 0.75 for the benign and malignant classes, respectively. Lower clinical performance may reflect noise, class imbalance, and greater real-world variability. Overall, POD shows potential for dimensionality reduction and feature learning while highlighting challenges in clinical generalizability. Future work will compare POD with established methods, including Principal Component Analysis (PCA), alternative classifiers, time-series representations, and hybrid approaches.

Keywords: Breast cancer detection; Dimensionality reduction; Feature learning; Proper Orthogonal Decomposition (POD); Support Vector Machine (SVM)

CAMS 03

Computer Science, Artificial Intelligence, Mathematics & Statistics

MODIFIED ANT COLONY OPTIMIZATION ALGORITHM TO SOLVE THE DETERMINISTIC TWO-STAGE ASSIGNMENT PROBLEM

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The Two-Stage Assignment Problem (T-SAP) extends the classic assignment problem in Operations Research by having decision-making occur through two interconnected stages. T-SAP has practical applications in logistics, production systems, and multilevel scheduling, where intermediate assignments influence the final outcome. It is challenging to solve because of its combinatorial nature. This study develops a novel Ant Colony Optimization Algorithm (ACOA) to address T-SAP. Unlike traditional ACOA-based methods, which use a single random number to determine the probabilistic path selection, the proposed model combines multiple random number selections with a cumulative probability approach. By comparing cumulative probability intervals with generated random numbers, a new path is filtered. This process is repeated iteratively until a unique assignment path is selected, enhancing decision-making stability. The ACOA is applied to T-SAP, and its performance and convergence behavior are evaluated. Despite a small increase in computational effort, the results indicate that the proposed method produces relatively stable and promising solutions compared with traditional ACOA approaches. The study contributes to the improvement of metaheuristic optimization algorithms by introducing an enhanced probabilistic technique for T-SAP. A critical feature is that first-stage decisions directly influence second-stage performance. The proposed method begins by determining the optimal first-stage allocation for the first agent using ACOA, and then identifies the corresponding second-stage cost structure. This helps evaluate the relationship between intermediate and final tasks. ACOA is then applied again to determine the optimal transition between the two stages. The procedure is sequentially repeated for all remaining agents to obtain the optimal assignment. The approach can be extended to stochastic T-SAP, where assignment costs are uncertain.

Keywords: Assignment problem, Ant Colony Optimization algorithm, Assignment cost matrix, Two-stage assignment problem

CAMS 04

Computer Science, Artificial Intelligence, Mathematics & Statistics

AN EXPONENTIAL AND GENERALISED LINDLEY FINITE MIXTURE DISTRIBUTION FOR HETEROGENEOUS LIFETIME DATA MODELING

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Statistical modelling of lifetime data is essential in many scientific fields, including actuarial science, reliability engineering, biomedical research, environmental science, and survival analysis. Common baseline lifetime distributions such as exponential, gamma, Weibull, and log-normal are widely used in practice. However, to effectively capture heterogeneity in real-world data, finite mixture models provide a more flexible framework. The Lindley distribution is a notable finite mixture with exponential and gamma components, and it has a simple mathematical form. Nevertheless, its single-parameter structure limits its flexibility in modelling diverse density shapes, hazard rate functions, and tail behaviours. To overcome these limitations, several extensions of the Lindley distribution have been proposed. Among them, the recently introduced two-component mixture, the New Generalised Two-Parameter Lindley Distribution (NG2PLD), has greater flexibility in skewness, kurtosis, and hazard rate patterns, including increasing, decreasing, constant, and bathtub shapes. To further enhance its modelling flexibility, this study proposes a new finite mixture model that combines the exponential distribution and NG2PLD within a Bayesian framework, yielding three underlying distributional components. Key statistical properties of the proposed model, including the density function, moments and related measures, survival and hazard rate functions, are derived. Model parameters are estimated using maximum likelihood estimation. Graphical analysis demonstrates the structural flexibility of the proposed distribution across various parameter settings. Further, its performance is evaluated using two real datasets, wind speed data and mechanical lifetime data, and compared with Lindley, NG2PLD, and Exponential–Lindley (ELD) distributions using Akaike information criterion and Kolmogorov–Smirnov statistics. Results show that the proposed model captures diverse density shapes (increasing, decreasing, unimodal, bimodal), accommodates diverse tail behaviours, and exhibits flexible hazard rate patterns. Therefore, the proposed exponential–NG2PLD finite mixture distribution provides a flexible and effective alternative for modelling lifetime data and can be applied in reliability analysis, survival studies, and environmental data modelling.

Keywords: Akaike Information Criterion, Finite mixture distributions, Kolmogorov–Smirnov statistics, Lindley distribution, Maximum likelihood method.

CAMS 05

Computer Science, Artificial Intelligence, Mathematics & Statistics

SPATIAL DISTRIBUTION OF ROAD ACCIDENTS IN KEGALLE DISTRICT (2023-2025)

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Road traffic accidents in hilly terrain present unique risk profiles shaped by topographic gradients, monsoon cycles, and high-density arterial corridors. This study analyses 782 accidents in the Kegalle District from 2023 to 2025, using spatial methods to identify patterns of severity. Descriptive analysis shows non-grievous injuries as the largest severity class (39.2%), followed by grievous injuries (34.9%), damage-only accidents (16.9%), and fatal accidents (9.0%). The fatal accident rate exceeded Sri Lanka's national fatality average of around 5.7%, consistent with elevated risk from hilly arterial road geometry. Circular statistics support a strongly non-uniform temporal distribution (Rayleigh $p = 1.40\times10^{-31}$), with mean accident time 15:06, mean resultant length $\bar{R} = 0.301$, and von Mises concentration $\kappa = 0.632$, indicating moderate clustering in the 15:00-20:00 evening rush hour. Moreover, severity-stratified analysis shows the latest mean time (15:45) and temporal dispersion ($\bar{R} = 0.284$) for fatal accidents, which may reflect factors such as reduced visibility or changes in traffic conditions. Accident counts are highly concentrated across the 573 Grama Niladhari (GN) divisions: the 110 divisions (19.2%) account for a disproportionate share of accidents (spatial Gini coefficient = 0.91), mostly within the A1 Colombo-Kandy Highway corridor in the northern district. The global Moran's I test confirmed the presence of significant positive spatial autocorrelation in the accident counts (Moran's $I = 0.250$, $Z = 56.108$, $p < 0.001$), indicating that accidents are spatially clustered and not randomly distributed, with high-count GN divisions concentrated along the A1 corridor. The findings support three priority interventions: time-targeted enforcement during the peak window of 15:00-20:00; infrastructure improvements, including road widening, guardrail installation, and improved roadway lighting at hotspot GN divisions; and spatially informed resource deployment guided by identified clustering patterns. Future work will include spatial line patterns to better model the accident density along road segments and spatial regression methods to account for the observed spatial dependence.

Keywords: Circular statistics, Grama Niladhari, Moran's I, Spatial analysis

CAMS 06

Computer Science, Artificial Intelligence, Mathematics & Statistics

FORECASTING THE TEMPORAL DISTRIBUTION OF LEISHMANIASIS IN FOUR MAJOR DISTRICTS OF SRI LANKA UNDER CLIMATIC DRIVERS

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Leishmaniasis is a vector-borne disease in Sri Lanka whose transmission is influenced by seasonal climatic and regional ecological conditions. The primary objective of this study is to forecast monthly leishmaniasis incidence in four high-burden regions of Sri Lanka (Anuradhapura, Hambantota, Kurunegala, and Polonnaruwa), where more than 2,500 cases were reported between May 2018 and December 2024, using time-series models incorporating meteorological factors. Weekly data published by Sri Lanka's Epidemiology Unit were aggregated into monthly observations. SARIMA, SARIMAX, and lagged SARIMAX models were developed to determine whether transmission was primarily driven by seasonal-temporal patterns, immediate climatic conditions, or delayed climatic effects. The SARIMA model was used as the baseline model to capture seasonal and temporal patterns, while SARIMAX incorporated concurrent climatic factors, and lagged SARIMAX incorporated delayed climatic variables with lags of up to six months to account for delayed environmental influences. All models were assessed using an 80:20 training-testing split, with performance metrics computed in R. Among the three models, the lagged SARIMAX model demonstrated the strongest statistical performance in all four districts, consistently achieving the lowest AIC values (Anuradhapura: 519.5, Hambantota: 542.5, Kurunegala: 549.6, Polonnaruwa: 501.1). Although RMSE and MAPE varied across regions, these variations reflect volatility and sharp fluctuations in monthly case reporting. Significant associations ($p < 0.05$) were observed between climate variables and disease occurrence across time lags, with temperature, humidity, and precipitation showing effects with lags of up to six months. This indicates that temperature, humidity, and precipitation influence leishmaniasis transmission and affect sand-fly larval development, which can take 30-90 days or more. These findings suggest that climatic factors do not have an immediate effect but influence disease occurrence through delayed biological processes, including vector maturation and parasite incubation. Short-term forecasts enable early detection, while long-term forecasts guide preventive interventions and support targeted public health planning in high-risk areas.

Keywords: Epidemiology, Fluctuations, Incubation, Leishmaniasis, Meteorological Factors.

CAMS 07

Computer Science, Artificial Intelligence, Mathematics & Statistics

A STUDY ON THE IMPACT OF EXCHANGE RATE ON TOURIST ARRIVALS IN SRI LANKA

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Tourism is one of the key foreign exchanges–earning sectors in Sri Lanka and is sensitive to macroeconomic conditions, particularly exchange rate movements. This study examines the impact of exchange rate fluctuations on tourist arrivals in Sri Lanka using monthly data from January 1996 to December 2024. Monthly tourist arrivals and monthly average Sri Lankan Rupee per US Dollar (LKR/USD) exchange rates were obtained from the Sri Lanka Tourism Development Authority (SLTDA) and the Central Bank of Sri Lanka (CBSL), respectively. To examine the dynamic relationship between exchange rates and tourist arrivals, a Vector Autoregression (VAR) model was developed. In addition, an Autoregressive Integrated Moving Average model with exogenous variables (ARIMAX) was developed to model and forecast tourist arrivals while accounting for exchange rate movements and seasonal effects. Both variables were transformed into logarithmic form, and unit root tests indicated that the series were integrated of order one. The VAR results revealed a bidirectional dynamic relationship between exchange rates and tourist arrivals, with significant effects at selected lags. The best-fitting ARIMAX model, ARIMAX $(1,0,3)(0,1,2)_{12}$, revealed a statistically significant negative relationship between exchange rate movements and tourist arrivals, with an estimated coefficient of −459.15. In terms of forecasting performance, the ARIMAX model achieved an RMSE of 14,660 and an MAE of 8,033, compared with an RMSE of 16,200 and an MAE of 9,100 for the VAR model, indicating better forecasting performance. Diagnostic tests indicated that both models were stable and that there was no serious serial correlation in the residuals. Overall, the findings indicate that exchange rate conditions are an important factor associated with tourist arrivals in Sri Lanka, while sustainable tourism development also depends on broader economic and external factors. These findings provide useful information for policymakers and tourism authorities when developing economic and tourism-related strategies.

Keywords: ARIMAX, Exchange rate, Sri Lanka, Tourist arrivals, Vector Autoregression

CAMS 08

Computer Science, Artificial Intelligence, Mathematics & Statistics

ON THE HOMOLOGY OF COMPLEMENTS OF CLOSED WEAKLY INFINITE DIMENSIONAL SUBSETS OF COMPACT HILBERT CUBE MANIFOLDS

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Hilbert cube $Q = I^{\infty}$, where $I = [-1,1]$ is a compact metric space which is universal in the class of all compact metric spaces. A compact Hilbert cube manifold, denoted as M is a compact separable metric space in which every point has a neighborhood homeomorphic to the Hilbert Cube. These spaces form a central class in infinite-dimensional topology, and understanding the structure of such manifolds after removing infinite-dimensional subsets is a subtle yet interesting problem. In infinite-dimensional topology, spaces are classified as strongly or weakly infinite-dimensional, depending on whether they have an infinite essential family. When strongly infinite-dimensional subsets are removed, the homology of the complement might change from that of the original space. In our research, we proved that when the removed subsets are closed and weakly infinite-dimensional, the homology of the complement is isomorphic to that of the original space. In loose terms, this means removing a closed infinite-dimensional space does not introduce new "holes" in a compact Hilbert cube manifold in any dimension. The proof follows from reducing the required statement, $H_k(M) \cong H_k(M \backslash A)\ \forall\ k$, to $H_k(M, M \backslash A)\ \forall\ k$, then using the long exact sequence and induction on the number of Hilbert cubes needed to cover M and using the relative Mayer-Vietoris sequence on the cover of M.

Keywords: Acyclic spaces, Closed weakly infinite-dimensional sets, Excision, Hilbert cube manifolds, Homology

CAMS 09

Computer Science, Artificial Intelligence, Mathematics & Statistics

LS-CATEGORY IN COARSE GEOMETRY

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Coarse geometry is the study of geometric spaces by examining their global structure and properties from a distance, while ignoring small-scale details. The Lusternik–Schnirelmann (LS) category is a classical topological invariant that measures the complexity of a space by the minimum number of contractible open subsets needed to cover it. Many classical topological invariants have analogous coarse-geometric counterparts; for instance, the coarse-geometric analog of classical dimension is asymptotic dimension, and the coarse-geometric analog of homology is coarse homology. In this research, we introduce a coarse geometric analogy for the classic LS-category using coarse homotopy. A coarse homotopy between two proper metric spaces X and Y is a coarse map $H: I_pX \to Y$ for some coarse map $p: X \to \mathbb{R}_+$ where $I_pX = \{(x, t) \in X \times \mathbb{R}_+: t \leq (x) + 1\}$ called the p-cylinder. A subset A of a proper metric space X is coarsely contractible if there exists a coarse map $f: A \to X$ with the image $f(A)$ is coarse homotopy equivalent to $\mathbb{R}_+$ and f is coarsely homotopic to the map 1_A. Using this notion of coarse contractibility, we can define the coarse LS-category c-cat(X) as the least number of coarsely contractible subsets required to coarsely cover X. In recent literature, we found that another approach has been made to generalise the LS-category to the coarse settings via coarsely categorical sets. We prove that these two approaches are equivalent. Additionally, we establish an upper bound relating the classical LS-category of the Higson corona νX to the coarse LS-category of X: $\mathrm{cat}(\nu X) \leq \text{c-cat}(X)$. This inequality highlights a connection between the large-scale structure of X and the topological complexity of its Higson corona.

Keywords: Coarse geometry, Coarse homotopy, Contractible, Higson corona, LS-category

CAMS 10

Computer Science, Artificial Intelligence, Mathematics & Statistics

PERFORMANCE COMPARISON OF ANT COLONY OPTIMISATION VARIANTS FOR THE VEHICLE ROUTING PROBLEM WITH CROSS-DOCKING

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Ant Colony Optimisation (ACO) is a metaheuristic algorithm inspired by the foraging behaviour of real ants to find near-optimal solutions for complex combinatorial optimisation problems. *The Vehicle Routing Problem with Cross Docking (VRPCD)* is a logistics Mixed Integer Linear Programming (MILP) model that integrates cross-docking into vehicle routing to minimise the flow time of commodities from suppliers to customers through a cross-dock. At the cross-dock, synchronisation of inbound vehicles is critical to reduce waiting time. However, as the scale of *VRPCD* increases, the problem becomes computationally challenging, making exact solutions impractical due to long computation times and necessitating a metaheuristic approach. This study investigates three *ACO* variants: *Ant System (AS), Ant Colony System (ACS),* and *Max-Min Ant System (MMAS)* in solving the *VRPCD* with varying numbers of suppliers and customers. The primary objective is to compare these variants in terms of solution quality, computational efficiency, and scalability as problem complexity increases. *AS, ACS,* and *MMAS* were executed on 56 instances, each replicated three times with predefined parameters, and their best-found costs and runtimes were recorded and benchmarked against exact optimal solutions obtained by solving the MILP model using the Branch-and-Bound algorithm for smaller-scale instances. The results demonstrate that all three *ACO* variants consistently yield high-quality, feasible solutions, often near-optimal, with significantly faster execution times than exact methods. While these methods exhibit excellent scalability, with runtimes increasing gradually with the number of nodes, *MMAS* and *ACS* generally offer slightly better solutions than the basic *AS,* though they require slightly more computational time, particularly in larger and more complex instances. This research highlights the practical applicability of *ACO* for efficient supply chain management in real-world *VRPCD* and shows that MMAS and ACS are promising methods for enhancing solution quality. Future research will enhance the *VRPCD* model by incorporating internal cross-dock operations, such as moving shipments and scheduling vehicles within the cross-dock, which are not considered in this study.

Keywords: Ant colony optimisation, Branch-and-bound, Cross-docking, Metaheuristics, Vehicle routing problem

CAMS 11

Computer Science, Artificial Intelligence, Mathematics & Statistics

GEOMETRIC EXTENSIONS OF A FIXED-POINT PROPERTY OF DEGREE-2 BLASCHKE PRODUCTS

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Finite Blaschke products are holomorphic self-mappings of the unit disc that extend continuously to the boundary of the disc and play a central role in complex analysis. Such a product of degree n has the general form $B(z) = e^{i\theta} \prod_{1\le k\le n} \left(\frac{z-a_k}{1-\overline{a_k}z}\right)$, where $a \in \mathbb{D}$ $\forall k = 1, 2, \cdots, n$ and $\theta \in [0, 2\pi)$ is a real number. They exhibit a striking geometric property on the unit circle. For example, for a finite Blaschke product of degree 2, distinct points of the unit circle having the same image lie on a line through a distinguished fixed point. This work investigates how this particular geometric phenomenon is transformed under conformal and nonlinear transformations, specifically the corresponding geometric properties of holomorphic self-mappings of the upper half-plane and the Riemann surface of $\sqrt{z}$. First, the degree-2 setting is transferred from the unit disc to the upper half-plane by Cayley transform $\frac{z-i}{z+i}$. The resulting maps are a specific class of rational Nevanlinna functions given by $f(z) = A + \frac{B_1}{z-r_1} + \frac{B_2}{z-r_2}$, where all parameters A, B_1, B_2, r_1, r_2 are real, $r_1 \neq r_2$ and $B_1, B_2 < 0$. The study proves that the collinearity of preimages of points on the unit circle is transformed into a concyclicity property in the upper half-plane: circles through two preimages of a point on the real line and $-i$ pass through a distinguished fixed point. The study then considered the map $z = w^2$ and the stereographic projection to relate the corresponding planar geometry to the compactified Riemann surface associated with the squaring map, which is identified with the Riemann sphere. Under the squaring map, chords of the unit disc are transformed into parabolic arcs in the complex plane. Their lifts to the compactified surface form a family of curves passing through the point at infinity, which are called spherical parabolas. The resulting correspondence provides a geometric extension of the equal-image-point property from the unit disc to the upper half-plane and to the associated compact Riemann surface. This shows that the fixed-point property of degree two Blaschke products can be extended to some Riemann surfaces through conformal equivalence.

Keywords: Blaschke products, Mobius transformations, Rational Nevanlinna functions, Riemann surface of $\sqrt{z}$, Stereographic projection

CAMS 12

Computer Science, Artificial Intelligence, Mathematics & Statistics

A STABILITY RESULTS FOR TOPOLOGICAL DATA ANALYSIS INTEGRATING PREDICTIVE MODELS IN TIME SERIES

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Time series are inherently noisy, and for a Machine Learning (ML) model trained on this data to be trustworthy on whether small input perturbations produce small output changes. This research presents a Lipschitz stability guarantee for a Topological Data Analysis (TDA) pipeline that transforms log return series into feature vectors suitable for training ML models. TDA works by extracting hidden geometric shapes and structures from data. To apply it to a time series, the data is converted into a point cloud using Takens' delay embedding, followed by computing H_1 persistent homology via Vietoris-Rips filtration. The resulting persistence diagrams are vectorised into Betti curve features (fixed-length numeric vector) that any ML model can use. The key question is whether this pipeline is stable: if two input series differ pointwise by at most ε in the l_∞ norm, how much can their output feature vectors differ? We address this by proving three chained propositions – Takens' embedding stability, the Cohen-Steiner persistence diagram stability, and Betti curve stability. We prove that the output Betti curve features differ by at most $2n\varepsilon\sqrt{d}$ in L_1 norm, where d is the embedding dimension and n is the number of persistence pairs. This confirms that the pipeline is Lipschitz continuous with constant $2n\sqrt{d}$. This means that imperfections in real-world data cause only a small, predictable change in the output features. This shows that TDA-based features are reliable enough for building ML models on noisy time series.

Financial assistance from the University Research Council (*Grant No 444*) *is acknowledged*

Keywords: Betti curve vectorisation, Lipschitz stability, Persistent homology, Time series.

CAMS 13

Computer Science, Artificial Intelligence, Mathematics & Statistics

REGULAR FOLIATIONS ON SMOOTH MANIFOLDS AS INVOLUTIVE PROJECTIVE SUBMODULES OF DERIVATIONS

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A foliation on a smooth manifold M decomposes it into layers of locally parallel lower-dimensional submanifolds, called leaves. Although classical approaches treat foliations using integrable tangent distributions and differential forms, the algebraic perspective remains less developed for derivation submodules. This study systematically treats regular foliations on M through the module of derivations $Der(C^{\infty}(M,R))$ on the algebra of smooth real-valued functions $C^{\infty}(M,R)$. The primary aim is to demonstrate that every foliation F on M determines, and is uniquely determined by, an involutive projective submodule of $Der(C^{\infty}(M,R))$. Here $Der(C^{\infty}(M,R))$ is the algebraic analog of the Lie algebra $X(M)$ vector fields on M, and the Lie bracket of derivations is simply the commutator, capturing the non-commutativity of directional derivatives on smooth functions. The study establishes an ideal-leaf correspondence showing that closed leaves of the foliation correspond to ideals of $C^{\infty}(M,R)$ preserved under the action of vectors tangent to leaves and demonstrates how the algebra A^F of leaf-constant functions encodes the leaf-space structure even when the quotient M/F is singular or non-Hausdorff. The contribution of this work is a systematic formulation of regular foliations within the Smooth Gelfand duality, employing the Serre–Swan theorem and identifying the precise mathematical limits. The study provides a translation of foliations into purely algebraic language, thereby opening foliation theory to the tools of Commutative Algebra and Algebraic Geometry.

Keywords: Foliations, Frobenius theorem, Lie algebras, Module of derivations, Smooth Gelfand duality.

CAMS 14

Computer Science, Artificial Intelligence, Mathematics & Statistics

A BENCHMARKING STUDY OF CONVOLUTIONAL NEURAL NETWORKS ON FER-2013 FOR ROBUST FACIAL EMOTION DETECTION

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Facial Emotion Recognition (FER) is a critical component of affective computing and human-computer interaction, yet achieving robust performance on challenging real-world datasets remains an open problem. This benchmarking study presents a comprehensive evaluation of convolutional neural network (CNN) architectures on the FER-2013 dataset, which contains 35,887 grayscale facial images across seven emotion classes (angry, disgust, fear, happy, sad, surprise, and neutral) collected in uncontrolled, in-the-wild environments. Through extensive experimentation, the study systematically investigates the effects of architectural depth, preprocessing techniques, class imbalance mitigation strategies, and regularization methods on model generalization performance. A key contribution of this work is the identification of a critical methodological issue: data leakage caused by applying oversampling prior to train-test splitting, which can substantially inflate reported accuracies. After correcting this issue and enforcing a leakage-free evaluation protocol with rigorous validation procedures, the proposed custom CNN architecture, consisting of five convolutional blocks with progressively increasing filter sizes (64-512), batch normalization, dropout regularization, and three fully connected layers, achieved a reliable test accuracy of 69.94% on the raw FER-2013 dataset. Several traditional machine learning, transfer learning, and deeper CNN models were also evaluated. While preliminary experiments produced higher accuracies, including 79.04% for Random Forest and 84.11% mean accuracy for deeper CNN architectures across multiple random seeds, these results were later found to be affected by data leakage resulting from oversampling prior to dataset partitioning, and therefore should not be considered directly comparable to the final leakage-free benchmark. The corrected results demonstrate that FER-2013 remains a highly challenging benchmark due to its class imbalance, low image resolution, and substantial intra-class variability. This study provides reproducible benchmarking guidelines, highlights the importance of proper validation protocols, and establishes a realistic performance baseline for future FER research on challenging real-world datasets.

Acknowledgment: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Keywords: Affective computing, Convolutional neural networks, Data leakage, Facial emotion recognition, FER-2013

CAMS 15

Computer Science, Artificial Intelligence, Mathematics & Statistics

AN EXTENSION OF THE RSA CRYPTOSYSTEM TO THE MATRIX RINGS OVER GAUSSIAN INTEGERS

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Cryptography is the process of encoding information so that only the authorised parties can access it. The classical Rivest-Shamir-Adleman (RSA) cryptosystem is a widely used public-key algorithm based on the factorisation of large prime numbers and modular arithmetic. Unlike symmetric-key encryption, RSA employs a pair of mathematically related keys: the public key for encryption and the private key for decryption. In the present study, we propose an extension of the RSA framework to matrix rings over the Gaussian integers, thereby extending the algebraic domain for cryptographic operations. The primary objective is to develop an alternative cryptographic algorithm using matrix exponentiation and modular arithmetic within $Z[i]/\langle\alpha\rangle$. The proposed cryptosystem shifts the domain to the ring of 3×3 upper triangular matrices over the finite quotient ring $Z[i]/\langle a + ib\rangle$, which contains exactly $a^2 + b^2$ distinct elements. During key generation, two large, distinct Gaussian primes π_1 and π_2 form the modulus $n = \pi_1\pi_2$. Unlike the classical RSA algorithm, our method replaces Euler's totient function with the least common multiple of the norms of primes $N_n = lcm\,(N(\pi_1)\,(N(\pi_1) - 1), N(\pi_2)\,(N(\pi_2) - 1)$ The encryption and decryption exponents are derived using N_n. Plaintext messages are partitioned into blocks of three, converted to numerical equivalents, and mapped to the non-diagonal entries of an upper-triangular matrix, with the diagonal elements assigned random Gaussian integers that are relatively prime to the modulus. Encryption and decryption are then performed using modular matrix exponentiation within the matrix ring. The use of randomly selected diagonal entries introduces additional algebraic complexity and enlarges the effective message space compared with the classical RSA framework. The proposed cryptosystem extends the classical RSA framework by shifting the domain from the matrix ring $M_3(Z_n)$ to the matrix ring $M_3(R)$, where R is the quotient ring of Gaussian integers $Z[i]/\langle\alpha\rangle$, while preserving RSA-type encryption and decryption mechanisms. The computational procedures are described and illustrated in a numerical example. Future research will investigate extensions to Eisenstein integer domains and continued fraction-based algebraic cryptographic constructions.

Keywords: Gaussian integers, Matrix rings, Public key cryptography, RSA cryptosystem, Upper triangular matrices.

CAMS 16

Computer Science, Artificial Intelligence, Mathematics & Statistics

INCORPORATING A TIME-VARYING TRANSMISSION RATE INTO A MOBILITY-BASED SIR MODEL: STABILITY ANALYSIS AND A CASE STUDY OF COVID-19 IN SRI LANKA

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Human mobility plays a key role in shaping disease transmission dynamics. Local stability analysis of epidemic models helps identify conditions under which a disease dies out or persists. In this study, stability analysis is performed for a mobility-based Susceptible–Infected–Recovered (SIR) model. A constant transmission rate is first considered to keep the system autonomous, allowing the disease-free equilibrium and its stability condition to be derived using the Jacobian approach. This provides a theoretical criterion for managing mobility levels to achieve a disease-free state in classical mobility-based SIR frameworks. However, disease transmission varies over time, making a constant rate insufficient. A time-varying transmission rate is therefore incorporated into the model, while human mobility is assumed constant. Several functional forms of time-dependent transmission rates are tested to reflect oscillatory patterns, exponential growth or decay, and outbreak peaks. Least-squares minimisation is used to identify the best-fitting transmission function to observed data. This approach extends beyond the SIR model to other compartmental epidemic frameworks. As a case study, the framework is applied to COVID-19 data from Sri Lanka's 2021 New Year Cluster. Results show that oscillatory and exponentially decaying transmission functions better capture observed dynamics. Although government interventions are not explicitly modeled, the numerical results suggest that time-varying transmission rates implicitly capture their effects more effectively than constant ones. The proposed framework offers policymakers insights into mobility-based intervention strategies for disease transmission.

Keywords: COVID-19, Least squares, Local stability, Mobility-induced transmission rate, SIR model

CAMS 17

Computer Science, Artificial Intelligence, Mathematics & Statistics

A COMPARISON OF INFLUENCE FUNCTION-BASED CONFIDENCE INTERVALS FOR CONDITIONAL VALUE-AT-RISK

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One important metric for evaluating tail risk in heavy-tailed financial data is Conditional Value-at-Risk (CVaR). However, accurately calculating a CVaR confidence interval can be difficult due to extreme observations, heavy tails, and outliers. The purpose of this study is to assess the statistical performance and accuracy of influence function-based confidence interval approaches for CVaR under a normal distribution. Furthermore, coverage probability and average length are used to evaluate the effectiveness of the influence function-based confidence interval techniques. For comparison, the influence function-based confidence intervals are evaluated using the Cornish-Fisher and classical methods. A portfolio of three Spanish stocks, Endesa (ELE), Banco Santander (SAN), and Banco Bilbao Vizcaya Argentaria (BBVA), is used to assess the effectiveness of various strategies. The portfolio covers the period from January 1, 2003, to January 17, 2011, with 2,025 trading days for each BBVA and SAN and 2,026 trading days for ELE. The results show that the Cornish-Fisher and classical techniques provide reliable and consistent CVaR estimates. In extreme market conditions, CVaR, derived from the Cornish-Fisher extension, provides a more reliable and conservative measure. For nominal confidence levels of 0.80–0.99, both the classical and Cornish-Fisher techniques produced empirical coverage probabilities ranging from 0.88 to 0.99, indicating generally excellent coverage performance across these levels. However, compared with the larger 0.5–20.0 interval obtained using the classical technique, the Cornish-Fisher approach yielded significantly shorter average confidence interval lengths, ranging from 0.1 to 0.3. The study concludes that although both the Cornish-Fisher and classical approaches yield reasonable CVaR estimates and are practically beneficial in helping financial institutions and risk managers make more trustworthy risk assessments and decisions in the face of uncertainty.

Keywords: Average length, Classical method, Conditional Value-at-Risk, Cornish-Fisher method, Coverage probability

CAMS 18

Computer Science, Artificial Intelligence, Mathematics & Statistics

OPTIMAL PULSE COMBINED IMMUNOTHERAPY AND CHEMOTHERAPY STRATEGIES FOR CANCER THROUGH A MATHEMATICAL MODEL

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A tumor is an abnormal mass of tissue. Some tumors grow uncontrollably and spread into surrounding tissues. They are called malignant tumors, which are cancerous. Immunotherapy, chemotherapy, and radiotherapy are commonly used treatments for cancer. Immunotherapy is a treatment that enhances the immune system's ability to combat disease. Since drugs are transported through the bloodstream, chemotherapy is considered systemic treatment. Therefore, it can eliminate cancer cells that have spread beyond the original tumor. Cancer cells are destroyed in radiotherapy using high doses of radiation. If two or more types of treatments are used together to treat a disease, it is called combined therapy. Based on clinical observations, immunotherapy is often used together with chemotherapy or targeted therapy. In some cases, a single treatment is not enough to control the growth of a cancerous tumor. Drug resistance is one such case. This research considers three types of treatments: single Immunotherapy, single chemotherapy, and combined therapy (Immunotherapy with chemotherapy) with their pulse effects. Pulse effects are embedded by impulsive terms in differential equation models. Current cancer treatments often rely on predefined dosage amounts and treatment timing without a rigorous optimisation framework. Therefore, the main aim of this work is to investigate optimal pulse treatment strategies for the three aforementioned treatment types, based on a mathematical model of cancer dynamics. The optimised drug amounts and drug release times are determined using optimisation techniques. The optimal treatment strategies are obtained by minimising predefined cost functionals using a time rescaling technique and Pontryagin's maximum principle. The results obtained for the same chosen parameters and initial values show that optimising drug release time is more effective than optimising the amount of drugs for each treatment. Furthermore, combined therapy plans are more effective than single treatment plans.

Keywords: Chemotherapy, Combined therapy, Immunotherapy, Impulsive optimal control

CAMS 19

Computer Science, Artificial Intelligence, Mathematics & Statistics

EMOTIONAL EXHAUSTION IN AGILE SOFTWARE DEVELOPMENT TEAMS IN SRI LANKA: THE MEDIATING ROLE OF NEGATIVE THINKING PATTERNS

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Agile software development has become a standard practice in Sri Lanka's rapidly growing IT industry. Despite its benefits in improving delivery speed, the fast-paced nature of agile sprints, characterized by frequent requirement changes, tight deadlines, high workloads, and constant uncertainty, creates intense workplace stress for developers. This stress is frequently associated with emotional exhaustion and reduced well-being. This study examined the mediating role of negative thinking patterns in the relationship between workplace stress and emotional exhaustion among agile software developers in Sri Lanka. The main objective is to determine whether maladaptive cognitive patterns, such as catastrophizing, self-blame, and overgeneralization, intensify the association between stress and emotional exhaustion. A quantitative cross-sectional survey is conducted using convenience sampling with purposive screening. Data are collected from 190 IT professionals working in agile teams via a structured online questionnaire with 5-point Likert scales. The study measures workplace stress triggers, negative thinking patterns, and emotional exhaustion. Statistical analysis including exploratory factor analysis (EFA), reliability testing, correlation analysis, multiple linear regression, and mediation analysis is conducted. Results revealed a strong positive correlation between workplace stress triggers and emotional exhaustion ($r = 0.736$, $p < .001$). Negative thinking patterns partially mediated this relationship (indirect effect = 0.182, $p < .001$). Workplace stressors ($\beta = 0.580$, $p < .001$) and negative thinking patterns ($\beta = 0.260$, $p < .001$) were significant predictors, explaining 61.1% of the variance in emotional exhaustion. Years of experience and the frequency of face-to-face interactions were significantly associated with lower levels of emotional exhaustion. The findings highlight that the way developers cognitively interpret stress is strongly associated with emotional exhaustion. The study suggests that organizational practices aimed at managing workplace stressors and supporting healthier cognitive responses may help improve the well-being of agile teams in Sri Lanka.

Keywords: Emotional exhaustion, Negative thinking patterns, Workplace stress, Agile software development, Mediation analysis

CAMS 20

Computer Science, Artificial Intelligence, Mathematics & Statistics

MODIFIED NUMERICAL APPROACHES FOR ROOT FINDING AND THEIR COMPARATIVE ANALYSIS WITH EXISTING METHODS

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Root finding for nonlinear equations is a fundamental problem in numerical analysis with wide-ranging applications in Applied Mathematics, Science, and Engineering. Classical methods such as the Bisection, False Position, Fixed Point Iteration, and Newton–Raphson methods are commonly used due to their simplicity and effectiveness. However, these methods may exhibit limitations related to convergence behaviour, numerical stability, and computational efficiency under certain conditions. Moreover, existing hybrid methods have not sufficiently explored the effect of combining the False Position and Newton–Raphson methods in different sequential orders. In this study, two modified root-finding approaches, namely the FN and NF, are proposed by combining the False Position and Newton–Raphson methods. The FN approach first computes a False Position step to obtain an intermediate approximation, then refines it with a Newton–Raphson correction. Conversely, the NF approach begins with a Newton–Raphson iteration and subsequently employs a False Position step to update the approximation. The proposed approaches are designed to enhance convergence performance while maintaining numerical reliability. Their performance is evaluated using four benchmark nonlinear equations and compared with the existing methods based on the number of iterations required for convergence and the corresponding absolute errors. The numerical results demonstrate that the proposed methods achieve improved convergence and accuracy compared with existing methods, indicating their potential as reliable alternatives for solving nonlinear equations.

Keywords: Bisection method, False position method, FN approach, Newton–Raphson method, NF approach

CAMS 21

Computer Science, Artificial Intelligence, Mathematics & Statistics

ENHANCEMENT AND COMPARATIVE ANALYSIS OF GENETIC ALGORITHM, PARTICLE SWARM OPTIMISATION, AND GREEDY METHODS FOR THE SET COVERING PROBLEM

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The Set Covering Problem (SCP) is one of the classical NP-hard combinatorial optimisation problems. It has a wide range of applications in facility location, scheduling, and resource allocation. However, given its computational complexity, exact methods are impractical for large-scale instances. Heuristic and metaheuristic methods are necessary to obtain high-quality, near-optimal solutions. This study focuses on improving the Greedy Heuristic, Genetic Algorithm (GA), and Particle Swarm Optimisation (PSO) methods for solving SCP and on comparing these algorithms. The proposed approach extends classical optimisation techniques by integrating feasibility-repair mechanisms, redundancy-elimination techniques, and cost-guided selection principles. The feasibility repair guarantees that all created solutions meet the covering constraints, and redundancy elimination removes redundant parts, thereby reducing solution cost without affecting feasibility. Furthermore, a Per-Element Cost (PEC) strategy is proposed to prioritise cost-effective selections and improve decision quality in the search process. In summary, these enhancements all contribute to a better optimisation process, ensuring it is more feasible, avoids redundancy, and is more cost-effective, leading to better convergence behaviour and higher-quality results. Experimental results show that the proposed algorithms generally outperform their baseline versions. Improved Greedy achieves lower objective values than Normal Greedy, while the improved PSO variants outperform standard PSO. Improved GA provides competitive and near-best solutions in several cases, but was not directly compared with a classical GA because the normal GA was not included. The results validate that embedding problem-specific improvement strategies within classical heuristic and metaheuristic approaches enhances solution quality, computational efficiency, and convergence behaviour for large-scale Set Covering Problems.

Keywords: Combinatorial optimisation, Genetic algorithm, Greedy heuristic, Particle swarm optimisation, Set covering problem

CAMS 22

Computer Science, Artificial Intelligence, Mathematics & Statistics

ANOMALY DETECTION IN E-LEARNING SYSTEMS USING A HYBRID MACHINE LEARNING FRAMEWORK

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E-learning has transformed educational delivery by providing flexible and accessible learning opportunities. However, student dropout remains a major challenge in online learning environments, which makes early identification of at-risk students essential for timely intervention. The proposed hybrid framework combines a supervised Gradient Boosting model for academic risk prediction with an unsupervised K-Means clustering model for behavioral anomaly detection. The framework integrates outcome-based academic risk and behavior-based anomaly signals through a Logistic Regression-based meta-classifier, providing a unified approach that combines academic outcome prediction with label-independent behavioral anomaly detection. The framework was evaluated using the publicly available Open University Learning Analytics Dataset (OULAD), which contains student demographic, assessment, and learning interaction data. Student demographics, assessment results, and Virtual Learning Environment (VLE) interactions were used to derive features for model development. Gradient Boosting was used for supervised prediction of academic risk, while K-Means clustering was used to identify behavioral anomalies. The hybrid framework achieved a recall of 0.852, precision of 0.912, F1-score of 0.881, and ROC-AUC of 0.946. These results indicate the framework's ability to combine complementary academic-risk and behavioral-anomaly signals to identify at-risk students. The proposed framework can support early-warning decision-making by helping educators identify students who are at academic risk and/or exhibit atypical learning behaviours.

Keywords: Anomaly detection, e-learning, Hybrid machine learning, Learning analytics, Student dropout prediction

CAMS 23

Computer Science, Artificial Intelligence, Mathematics & Statistics

APPLICATION OF AN IMPROVED FIREFLY ALGORITHM FOR THE STEP FIXED-CHARGE TRANSPORTATION PROBLEM

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The Step Fixed-Charge Transportation Problem (SFCTP) extends the classical transportation problem by incorporating variable and fixed costs, as well as step fixed charges incurred when transported quantities exceed thresholds. Nonlinear cost structures and integer allocation requirements make SFCTP a challenging optimisation problem. The objective is to minimise total transportation cost while satisfying supply and demand constraints. Exact optimisation techniques often struggle with medium- and large-scale instances, so metaheuristic approaches are widely used to obtain high-quality solutions efficiently. This study proposes an improved Firefly Algorithm to solve SFCTP with integer allocations and full constraint satisfaction. An initial population of fireflies is generated using a sigmoid-based probabilistic allocation mechanism, while solution quality is enhanced through a feasibility-repair procedure and a 2×2 pivot operation. During the iterative search, fireflies move toward brighter solutions, enabling effective exploration and exploitation. Performance was tested on two benchmark instances using heuristic optimisations based on the coefficient-matrix approach. Implemented in Python on an "Intel Core i3-1005G1 CPU (1.20 GHz) with 4 GB RAM," the method reduced transport costs from 860 to 850 and from 3140 to 3060 in 1.132s and 2.049s, respectively. Results confirm successful performance, though further studies with sensitivity analysis, large-scale instances, and stable environments are needed to validate robustness and comprehensiveness.

Financial assistance from the Postgraduate Institute of Science, University of Peradeniya, under grant number PGIS/2024/04 is acknowledged.

Keywords: Firefly algorithm, Heuristic method, Metaheuristic optimisation, Step fixed charge transportation problem

CAMS 24

Computer Science, Artificial Intelligence, Mathematics & Statistics

BILLSENSE: A PRIVACY-AWARE MOBILE PIPELINE FOR SUBSCRIPTION EMAIL CLASSIFICATION, WITH ON-DEVICE SANITISATION OF PERSONALLY IDENTIFIABLE INFORMATION, AND STRUCTURED INFORMATION EXTRACTION

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Most people pay for more subscriptions than they realize. Users estimate monthly spending at 86 USD but actually pay 219 USD, with 74% struggling to track recurring charges. Existing tools require bank credentials or manual entry, and none can read email content privately. This study presents BillSense, a Flutter mobile app that implements a seven-stage privacy-aware pipeline: on-device classification of subscription emails, hybrid sanitization of personally identifiable information (PII), cloud-based structured extraction, and bounded agentic notification generation, while keeping the raw email on-device. The pipeline is trained on 2,505 labeled emails across ten balanced subscription categories. The classifier is a fine-tuned DistilBERT model quantized to INT8 ONNX (64 MiB), chosen over TF-IDF and MobileBERT for out-of-distribution robustness. The sanitization layer combines regex with a fine-tuned DistilBERT NER model targeting five PII categories. The extractor is a fine-tuned BERT base cased token classifier, preferred over the spaCy CNN and the slower DeBERTa-v3. The notification layer uses a bounded Reasoning and Acting (ReAct) agent with Gemini-2.5-Flash. The classifier achieves a macro F1-score of 0.9869 and 90% non-subscription recall on OOD emails, a 40-point gain over baselines. The sanitization layer achieves a micro F1-score of 0.970, raising person-name detection from 0 to 0.96. The extractor achieves an F1-score of 0.883 ± 0.008 under five-fold cross-validation (n = 1,347). Full PII sanitization causes only +0.60% change in extraction F1-score on a stratified 200-email sample. Consistent sanitization typically degrades accuracy by less than 2.2%; our result falls within this range, showing privacy protection incurs no measurable cost to extraction performance.

Keywords: Agentic AI, Mobile machine learning, Named entity recognition, On-device NLP, Privacy-utility trade-off

CAMS 25

Computer Science, Artificial Intelligence, Mathematics & Statistics

AN UNSUPERVISED HIERARCHICAL FRAMEWORK FOR EVALUATOR BEHAVIOUR CLASSIFICATION IN FRAGMENTED ACADEMIC EVALUATION SYSTEMS

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Ensuring fairness and reliability in academic evaluation systems remains challenging due to evaluator bias and inconsistency. Evaluators may exhibit strict, lenient, or unstable scoring behaviours that distort assessment outcomes. Existing approaches face limitations in fragmented panel-based settings where evaluator types are unknown. This study proposes an unsupervised hierarchical clustering framework for classifying evaluator behaviour using bias- and variance-based statistics derived from raw scores. A synthetic dataset was generated to simulate fragmented panel-based environments with strict, fair, lenient, and inconsistent evaluators. Evaluator behaviour was represented using estimated bias and variance measures, and a two-stage Gaussian Mixture Model (GMM) was developed. In the first stage, variance-based clustering identified inconsistent evaluators, while the second stage applied bias-based clustering to classify consistent evaluators as strict, fair, or lenient. The framework was evaluated under varying panel sizes using 100 Monte Carlo simulations and compared with rule-based clustering, K-Means, single-step GMMs, and HDBSCAN. It achieved a mean classification accuracy of 82.35% in the most challenging setting (panel size = 1), demonstrating effectiveness even with limited observations. Accuracy improved rapidly with larger panels, exceeding 99.7% for size ≥4 and reaching perfect classification for size ≥10. Across categories, mean F1-scores exceeded 0.94 with low variability; the inconsistent category achieved the strongest performance (Precision = 0.992, Recall = 0.963, F1 = 0.972), confirming the effectiveness of the inconsistency detection stage. While the results may reflect simulation characteristics, the framework successfully identifies inconsistent evaluators and maintains high classification performance across strict, fair, and lenient categories, offering a practical approach to analyzing evaluator behavior in fragmented academic environments.

Keywords: Bias–variance clustering, Evaluator behaviour classification, Gaussian mixture models, Unsupervised learning

CAMS 26

Computer Science, Artificial Intelligence, Mathematics & Statistics

APPLICATION OF MODIFIED DIFFERENTIAL TRANSFORM METHOD TO AIRY EQUATION AND A NON-LINEAR HEAT EQUATION

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Finding accurate solutions to second-order differential equations with variable coefficients or non-linear terms remains a significant challenge in Applied Mathematics. The Differential Transform Method (DTM) and its variants are semi-analytical techniques that turn a differential equation into algebraic recurrence relations, giving a series solution without the need for symbolic differentiation. This study applies DTM and its variants to two selected second-order boundary value problems and compares their performance. The first problem is the Airy equation, $y'' - xy = 0$, a linear ordinary differential equation with a variable coefficient arising in quantum mechanics and optics, whose solution has been found only as a two-series solution (A_i-type and B_i-type). Using the DTM single series solution has been obtained, which will be very useful when dealing with the solution. DTM combined with Padé approximation (DTM-Padé) was also applied to both solutions and compared with the exact Airy functions. Near the origin, both methods gave highly accurate results, but as we moved away from the origin, plain DTM performed better than DTM-Padé. The second problem is a two-dimensional non-linear heat equation, $u_{\mathrm{t}} = u_{\mathrm{xx}} - 2u^3$, which models heat conduction with a cubic reaction term. The equation has been solved using 2D-DTM combined with two-dimensional Padé approximation (2D-DTM+2D Padé), and the Laplace Differential Transform Method (LDTM). The results were compared with the existing two-dimensional DTM (2D-DTM). Among the methods examined, 2D-DTM+2D Padé gave the best results because the Padé form fit the exact solution directly, whereas LDTM was more accurate near the origin but degraded faster than 2D-DTM further out, making it the least accurate of the three overall. All methods were implemented in MATLAB and validated against exact solutions whenever possible. The results show that selecting the most suitable DTM variant depends on the problem's mathematical structure.

Keywords: Airy equation, A_i-type and B_i-type solutions of the Airy equation, Differential transform method, Non-linear heat equation, Padé approximation

CAMS 27

Computer Science, Artificial Intelligence, Mathematics & Statistics

MULTI-CROSSING NUMBER OF KNOTS

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Knots are intricately connected to nearly every area of Science and Mathematics. The literature has predominantly focused on double-crossing projections, leading to the classical crossing number. To expand upon these classical invariants, this study investigates the multi-crossing numbers of knots, in which more than two strands intersect at a single crossing point. Our primary objective is to understand and derive theoretical approaches to establish multi-crossing numbers, denoted $c_n(K)$, for specific families of knots and to examine their relationships with classical knot invariants such as the crossing number, bridge number, übercrossing number, and petal number. Using a purely theoretical and diagrammatic methodology, we study $n-$crossing projections and apply constructive techniques to transform classical knot diagrams into multi-crossing projections while preserving knot equivalence by Reidemeister moves. Throughout this study, the Alexander-Briggs notation has been used to identify and classify knots. Several key results are established. It is shown that once the übercrossing number of a knot is attained, all higher multi-crossing numbers take their minimum possible values. Upper bounds for the number of triple crossings have been obtained for knot families of the forms $2m_1$ and $(2m+1)_1$. A general lower bound for the $m-$crossing number is proved for any nontrivial knot. Furthermore, exact petal numbers $p(T_{r,2r+1}) = 3r+1$ are established for odd torus knots $T_{r,2r+1}$, thereby connecting arc-index results to multi-crossing representations. These results establish new bounds and open pathways for further investigation into the combinatorial structure of knot invariants. This work supports further development of multi-crossing theory and provides a foundation for future research in knot theory and its applications.

Keywords: Knot invariants, Multi-crossing number, Petal number, Torus knots, Übercrossing number

CAMS 28

Computer Science, Artificial Intelligence, Mathematics & Statistics

DYNAMIC PROGRAMMING APPROACH FOR OVER-BY-OVER BOWLING STRATEGY OPTIMISATION IN T20 CRICKET

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In T20 cricket, bowling strategy is an important tactical component that captains must balance to achieve both run prevention and wicket-taking while allocating bowlers throughout the innings. This research presents a dynamic programming approach for determining optimal bowling strategies in a T20 match. The objective is to minimise a cost function that incorporates bowlers' economy rates and wicket-taking probabilities, with a weighting parameter λ controlling the trade-off between run prevention and wicket-taking. Two models are considered. The first model is a base model in which each bowler has a constant economy rate and wicket probability throughout the innings. The second model is an extended over-by-over model in which these performance measures vary across overs, allowing bowling effectiveness to change with the stage of the innings. In both cases, the dynamic programming formulation determines the optimal bowling sequence subject to practical cricket constraints, including a maximum number of overs per bowler and the restriction that a bowler cannot bowl consecutive overs. Results for different values of λ show that increasing the importance of wicket-taking leads to changes in the bowling sequence and over-allocation. For the Australian case study, the selected bowling group changed between $\lambda = 5$ and between $\lambda = 6$, illustrating the sensitivity of the optimal strategy to the weighting parameter. The over-by-over model is more flexible and adaptive than the baseline model, as it captures variations in bowling effectiveness across different stages of the innings. Overall, the proposed framework provides a systematic approach for developing adaptive bowling strategies in T20 cricket.

Keywords: Bowling strategy optimisation, Dynamic programming, Resource allocation, Sports analytics, T20 cricket

CAMS 29

Computer Science, Artificial Intelligence, Mathematics & Statistics

REASSESSING SPECKLE NOISE IN CONE-BEAM COMPUTED TOMOGRAPHY THROUGH PHYSICS-BASED ANALYSIS OF IMAGE FORMATION AND STOCHASTIC DEGRADATION

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Granular intensity variations in reconstructed Cone-Beam Computed Tomography (CBCT) images are sometimes described using speckle-noise assumptions borrowed from ultrasound and Synthetic Aperture Radar (SAR). However, visual similarity alone does not establish equivalence in the physical mechanisms of noise formation. This study tests the hypothesis that speckle-like degradation in CBCT does not originate from the coherent-interference mechanism responsible for classical speckle. A physics-based comparative analysis traced image-formation mechanisms in ultrasound, SAR, and CBCT, focusing on transmitted energy, reflection/transmission, wave interactions, detector configuration, and the sources of stochastic degradation. The analysis shows a fundamental distinction: classical speckle in ultrasound and SAR results from the coherent superposition of scattered waves, whereas CBCT is a transmission-based X-ray system in which the detected intensity is governed by photon attenuation. Stochastic degradation in CBCT arises from various processes, including photon-counting fluctuations (quantum mottle), scattered radiation such as Compton photons, and detector/electronic noise, which are later transformed during reconstruction. Structured degradations such as beam-hardening streaks, motion artifacts, and other reconstruction artifacts are distinguished from stochastic noise and are not considered evidence of speckle. The mechanistic analysis supports the hypothesis that CBCT's granular appearance should not be interpreted as classical speckle noise solely on visual grounds. Instead, CBCT stochastic degradation should be characterized according to modality-specific acquisition physics and reconstruction. These findings provide a physical basis for selecting appropriate degradation assumptions for CBCT noise modelling, synthetic noise generation, and physics-informed AI-based image restoration.

Financial assistance from NSF Sri Lanka (*Grant No: NSF/SCH/2025/26*) *is acknowledged.*

Keywords: Physics-informed AI, Biomedical image enhancement, Medical image denoising, Computational imaging, CBCT noise modeling

CAMS 30

Computer Science, Artificial Intelligence, Mathematics & Statistics

GRAPH DATA MODELLING FOR INTEGRATING CKDu EVIDENCE AND DISCOVERING PATIENT-EXPOSURE PATTERNS

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Chronic Kidney Disease of unknown etiology (CKDu) is a major public health issue in the dry zone of Sri Lanka. Its cause remains unresolved, with evidence scattered across clinical, environmental, occupational, biochemical, and demographic domains. This study demonstrates how a property-graph database can integrate multidimensional CKDu data into a clinically interpretable framework for retrieving connected patient information and tracking disease progress. Current studies remain disconnected, limiting the tracing of exposure pathways and shared disease patterns. The framework represents patients and related information as nodes, relationships, and properties, with root-node identification used to select clinically relevant anchors. Baseline and follow-up data from 293 CKDu patients in Wilgamuwa were pre-processed through cleaning, categorical encoding, and clinically defined categorisation of biochemical measures and BMI. Each patient was represented as a central node linked to disease stage, progression category, occupation, water source, agrochemical exposure, family structure, and categorised biochemical status, with exposure values stored as relationship properties. Graph exploration employed multi-criteria Cypher queries from selected root nodes. One query combining >20 years of farming, CKD stage 4, and rapid progression identified a single patient; removing the stage constraint identified 16 rapid progressors with long farming histories, most linked to fertiliser, herbicide, and pesticide categories, classified as CKD stages 3a or 3b. These findings show the feasibility of graph-based patient information integration and progress tracking, though not causal pathway analysis.

Keywords: Graph data modelling, Property-graph database, Root-node identification, Patient progress tracking

CAMS 31

Computer Science, Artificial Intelligence, Mathematics & Statistics

MATRIX-BASED VERTEX-SUM INVARIANT FOR RSA KEY CONSTRUCTION USING COLOURING OF COMPLETE BIPARTITE GRAPHS

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The present study proposes a graph-theoretic cryptographic framework that integrates Rainbow Vertex Antimagic Coloring (RVAC) of complete bipartite graphs with the Rivest-Shamir-Adleman (RSA) cryptosystem through matrix-based vertex-sum invariants. In the construction, a bijective edge labeling of a complete bipartite graph is represented as an n×n matrix. The induced row and column sums determine the vertex weights, which are organised into structured vertex-sum classes. Unlike existing graph-labeling cryptosystems that use labels for encoding, substitution, or direct key construction, this framework employs the matrix-derived vertex-sum invariant as input for nonlinear RSA private-key generation. The study examines how the vertex-sum spectrum can be minimised under bijective labelling constraints. Complementary pairing of edge labels yields balanced configurations in even-dimensional cases, compressing spectra, while odd-dimensional constructions contain a central unpaired label that introduces asymmetry and variation. These structural differences provide a mathematical basis for deterministic yet combinatorially rich key-generation schemes. The framework retains standard RSA encryption and decryption via modular exponentiation, while deriving the private key through a nonlinear function of vertex-sum classes. This adds a structured combinatorial layer to RSA key generation without altering its mechanism. Experimental implementation confirms correct encryption and decryption using graph-based keys. Complexity analysis shows the preprocessing stage requires linear matrix computation, while cryptographic execution remains comparable to classical RSA. The significance lies in introducing vertex-sum invariants as new structured cryptographic parameters and a distinct principle for graph-based RSA key generation. Although further security analysis with large parameters is needed, the framework opens a promising direction for hybrid cryptographic design by connecting graph labeling theory, matrix structures, and public-key encryption.

Financial assistance from PGIS, UOP (Grant No: PGIS/2024/07) is acknowledged.

Keywords: Complete bipartite graphs, Matrix-based cryptography, Rainbow vertex antimagic coloring, RSA cryptosystem, Vertex-sum invariants

CAMS 32

Computer Science, Artificial Intelligence, Mathematics & Statistics

RECOGNITION OF HANDWRITTEN TAMIL VILLAGE NAMES USING HYBRID FEATURE FUSION FOR POSTAL AUTOMATION

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Handwritten Tamil village name recognition is challenging due to the script's complexity and handwriting variability, particularly in postal automation. This paper proposes a hybrid fusion method based on deep and handcrafted features for handwritten Tamil village name recognition. It demonstrates that handcrafted Histogram of Oriented Gradients (HOG) features provide complementary discriminative information that is not fully captured by deep CNN representations, making feature fusion beneficial for handwritten Tamil word recognition. In the proposed fusion scheme, deep convolutional features are first extracted from handwritten word images using an EfficientNetB0-based CNN, selected for its effective feature extraction, lightweight architecture, and squeeze-and-excitation (SE) optimization, which uses attention mechanisms to focus on important feature channels while suppressing less relevant information. Meanwhile, HOG descriptors are computed to extract handcrafted features that describe local patterns in strokes and their orientation. The two sets of complementary features are combined at the feature level and further processed using a deep MLP classifier to perform multi-class village-name recognition. The proposed solution was tested on a novel handwritten Tamil village-name dataset curated by the authors, containing 100 unique Tamil village names handwritten by 90 different people, totaling 9,000 handwritten word images. All experiments were conducted under identical conditions with consistent hyperparameter settings. The performance of the suggested fusion model was evaluated against a custom CNN baseline, VGG16, and ResNet50, selected to represent a baseline model and well-established pretrained architectures with different depths and feature-learning strategies. The experimental results demonstrate that the proposed fusion model outperforms both the baseline CNN and pretrained architectures, achieving 91% recognition accuracy. Thus, the effectiveness of fusing deep and handcrafted features for recognizing complex handwritten characters is demonstrated. Moreover, promising generalization properties and high robustness make the proposed solution suitable for real-life applications in postal automation.

Keywords: Convolutional neural network (CNN), Deep learning, Feature extraction, Handwritten Tamil village names

CAMS 33

Computer Science, Artificial Intelligence, Mathematics & Statistics

DISTANCE MAGIC LABELING OF $K_{2m,2m}$ AND A SUBFAMILY OF ITS UNBALANCED EXTENSIONS

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Graph labeling studies the assignment of integers to the vertices or edges of a graph according to specific rules. Among these labelings, distance magic labeling has attracted considerable attention due to its combinatorial structure and applications in network design and communication systems. For the complete bipartite graphs considered in this work, we provide explicit arithmetic constructions of distance-magic labelings and develop a vertex-swapping technique to extend these constructions to a subfamily of unbalanced complete bipartite graphs. A distance magic labeling of a graph is a bijection from the vertex set to the set $\{1,2,\dots,n\}$, such that the sum of the labels of the neighbors of each vertex is equal to a constant called the magic constant k. This research is significant as it extends the known collection of distance magic graphs and provides constructive methods that may be applicable to complete multipartite graphs. The primary objectives were to construct an explicit distance magic labeling for the complete bipartite graphs of the form $K_{2m,2m}$, to derive their respective magic constants and to extend these constructions to the complete bipartite graph $K_{p,q}$ through combinatorial techniques. A constructive approach was employed, using block-based label assignments under symmetric label distributions, complemented by a vertex-swapping technique in which groups of consecutive vertices in one partition are exchanged with a single vertex in the opposite partition whenever their label sums coincide. It was established that $K_{2m,2m}$ admits a distance magic labeling with $k = m(4m+1)$ for all integers $m \geq 1$. Using a vertex-swapping technique, we extend the labeling construction of $K_{2m,2m}$ to obtain distance-magic labelings for broader families of complete bipartite graphs. The construction permits block swaps under specific congruence conditions, thereby preserving the original magic constant. These findings demonstrate that the existence of distance magic labelings in complete bipartite graphs depends not only on regularity but also on the underlying arithmetic structure of their partition sizes and suggest that systematic constructive methods can be used to extend distance magic labeling to complete multipartite graphs.

Keywords: Complete bipartite graphs, Distance magic labeling, Graph labeling, Magic constant, Vertex labeling

CAMS 34

Computer Science, Artificial Intelligence, Mathematics & Statistics

A GENERALISED VERSION OF CLIQUE COMPLEXES FOR ANALYZING HOMOLOGY OF GRAPHS

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Clique complexes serve as a foundational mathematical tool for mapping higher-order relationships and capturing the underlying topological features of graphs. Clique Complexes restrict simplicial faces exclusively to complete subgraphs, and this research work proposes a related, more flexible framework designated as a generalised clique complex, or the k-plex complex. By permitting a controlled number of missing edges within localised vertex subsets, this formulation constructs a broader class of downward-closed simplicial complexes. A k-plex in n vertices is a simple graph whose vertices have degree at least $n-k$. Formally for a graph G, the k-plex complex $X_k(G)$ is a simplicial complex constructed by making each k-plex that spans n vertices into an $(n-1)$-simplex. We establish that $X_1(G)$ coincides with the clique complex of G, and that the (k)-plex complexes form a filtration $X_1(G) \subseteq X_2(G) \subseteq \cdots \subseteq X_{|V|}(G) = \Delta^{|V|-1}$. The hereditary property of k-plexes ensure that $X_k(G)$ is a simplicial complex for every k. Based on the structural relationship between $X_k(G)$ and the clique complex $X_1(G)$, we establish that $\beta_0\big(X_k(G)\big) \leq \beta_0(X_1(G))$ for all $k \geq 1$. Moreover, for every graph with at least two vertices, $X_k(G)$ is connected for all $k \geq 2$, since every pair of vertices forms a 2-plex. More precisely, the 1-skeleton of $X_k(G)$ for a graph with n vertices is the complete graph K_n of n-vertices, for $k \geq 2$. The resulting filtration $j_k: X_k(G) \hookrightarrow X_{k+1}(G)$ induces homomorphisms between the corresponding homology groups, providing a framework for investigating the creation, persistence, and destruction of topological features as the plex parameter increases. Future work will focus on introducing a pipeline starting from raw graphs to compute the homology of graphs corresponding to $X_k(G)$.

Keywords: Clique complexes, Homology, k-plexes, Simplicial complexes, Topological data analysis

CAMS 35

Computer Science, Artificial Intelligence, Mathematics & Statistics

MULTI-AGENT RETRIEVAL-AUGMENTED GENERATION FOR BILINGUAL (ENGLISH–TAMIL) LEGAL QUESTION ANSWERING IN SELECTED SRI LANKAN LEGAL DOMAINS: A COMPARATIVE STUDY

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Reliable access to legal information requires question-answering systems that do not hallucinate, since fabricated answers could constitute incorrect legal advice. This study evaluates four distinct Retrieval-Augmented Generation (RAG) approaches for bilingual legal question answering over Sri Lankan law: Vector RAG, Graph RAG, Keyword Search, and a novel multi-agent Agentic RAG system comprising five specialized agents for routing, retrieval, reasoning, synthesis, and verification. The objectives of this study are to design and systematically optimize the multi-agent system, to compare the four approaches, and to analyze cross-language performance. A corpus of 45 Sri Lankan legal documents (27 English, 18 Tamil) covering value-added tax law, company law, case law, and civil procedure is indexed in vector, graph, and keyword stores, and 145 test queries (115 English, 30 Tamil) were evaluated using an LLM-as-Judge framework across four legally relevant metrics: correctness, completeness, faithfulness, and citation quality (scored on a 0-to-5 scale, then averaged). Systematic debugging identified and corrected five implementation defects, improving the overall English score of Agentic RAG from 2.48/5.00 to 3.33/5.00 (a 34% improvement) and raising it from fourth to second place behind Vector RAG (3.57/5.00). The optimized system achieved the highest faithfulness (4.18/5.00) and citation quality (4.23/5.00) with zero detected hallucinations. Counter-intuitively, invoking the synthesis agent across all queries outperformed selective invocation in both quality and speed, as single-pass generation failed to synthesize multiple retrieved documents effectively. In Tamil, Agentic RAG again ranked second (1.59/5.00), while Graph RAG performed best (2.74/5.00), showing superior cross-language consistency (a 7% English–Tamil gap) compared with embedding-based systems (gaps of 52% to 75%). These findings demonstrate that multi-agent architectures can achieve competitive performance while offering distinctive value in faithfulness and source attribution for legal applications, and that language-independent retrieval is essential for equitable performance in minority languages. Given the limited availability of Tamil evaluation data, these results remain preliminary.

Keywords: Hallucination mitigation, Legal question answering, Multi-agent systems, Multilingual retrieval, Retrieval-Augmented Generation (RAG)

CAMS 36

Computer Science, Artificial Intelligence, Mathematics & Statistics

A CONTINUED FRACTION-BASED MULTI-PRIME RSA-ECC HYBRID CRYPTOSYSTEM

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Public-key cryptography relies on mathematically hard problems to ensure secure communication over insecure channels. Among the most widely deployed public-key systems are the Rivest–Shamir–Adleman (RSA) cryptosystem and Elliptic Curve Cryptography (ECC), whose security is based on the Integer Factorisation Problem and the Elliptic Curve Discrete Logarithm Problem, respectively. The present study introduces a hybrid cryptosystem that combines ECC with a continued-fraction-based multi-prime RSA framework to leverage their complementary security foundations and improve computational efficiency. Plaintext messages are mapped to elliptic-curve points using the Koblitz encoding method and encrypted through ECC, while the ephemeral scalar used in the elliptic-curve encryption process is encapsulated using a modified multi-prime RSA mechanism. The RSA component incorporates multiple prime-power factors together with an exponent generation strategy based on the convergent of a continued fraction expansion. Furthermore, the Chinese Remainder Theorem is utilised to accelerate decryption through efficient modular reconstruction. The resulting framework combines two independent cryptographic hardness assumptions within a unified architecture; however, increased mathematical complexity alone is not taken as evidence of improved security, and formal security analysis is required to establish its resistance to relevant attacks. Simultaneously, the multi-prime RSA construction improves decryption performance relative to conventional RSA implementations, while ECC provides strong security with comparatively smaller key sizes. The principal finding is that the construction is algebraically correct and can reduce private-key computational cost under its stated parameter choices, but any claim of stronger security than established RSA or elliptic-curve schemes requires a formal reduction and implementation-level evaluation. The study therefore offers a structured basis for subsequent security proofs, benchmarking, and practical validation.

Keywords: Chinese remainder theorem, Continued fractions, Elliptic curve cryptography, Hybrid cryptosystem, Multi-prime RSA

CAMS 37

Computer Science, Artificial Intelligence, Mathematics & Statistics

FOCUS ON COMMERCIAL DATA SCIENCE CRYPTOGRAPHIC PROTECTION OF PROPRIETARY ANALYTICAL LOGIC IN COMMERCIAL R PACKAGE DEPLOYMENTS: A HYBRID AES-256 AND RCPP FRAMEWORK

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The commercialization of data science has introduced a critical intellectual property (IP) vulnerability: proprietary analytical models delivered as custom R packages remain fully inspectable via standard R introspection mechanisms. This exposes model-building organizations to significant financial and competitive risk, as clients can extract, replicate, or redistribute logic that represents substantial investment in domain expertise, statistical methodology, and engineering effort. This paper presents a hybrid encryption framework that enables the secure distribution and execution of proprietary R functions without exposing their implementation to end users. The proposed approach combines AES-256-CBC symmetric encryption with a compiled C++ decryption layer implemented in Rcpp, creating a protection mechanism that operates entirely in memory at runtime. Sensitive R source code is encrypted into a binary artifact during the build phase and embedded within the R package's installation directory. At execution time, the C++ layer - compiled into a native shared library and therefore opaque to standard R inspection - decrypts the function code in memory, evaluates it within an isolated temporary environment, and invokes it with user-supplied arguments, returning results through the standard R interface. Security is achieved through AES-256-CBC encryption combined with runtime key retrieval from an authenticated license server, ensuring the decryption key is never accessible within the client's environment. The framework preserves the complete user experience of a conventional R package: clients invoke exported functions with standard arguments and receive expected outputs, while the internal computation logic remains entirely inaccessible. The architecture is demonstrated through a financial portfolio processing use case, validated against real-world database integration and multi-parameter function signatures. This work contributes a reproducible, production-deployable template for IP-protected R package distribution, with direct applicability to industries such as finance, healthcare analytics, and consulting, where proprietary model logic constitutes a primary commercial asset.

Keywords: AES-256 encryption, Data science commercialization, Intellectual property protection, R package security, Rcpp

CAMS 38

Computer Science, Artificial Intelligence, Mathematics & Statistics

A UNIFIED MULTILINGUAL SEMANTIC SIMILARITY MODEL FOR LOW-RESOURCE LANGUAGES AND AN AUTOMATED STRUCTURED ANSWER GRADING SYSTEM FOR SINHALA

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Automated assessment and semantic similarity estimation remain underdeveloped for many low-resource languages, leaving millions of learners without modern natural language processing tools. This study addresses the gap through two complementary transformer-based models sharing a Siamese-network methodology. The first is among the earliest Automated Answer Grading Systems (AAGS) for Sinhala, evaluating short student responses against examiner-referenced answers on a 0–5 scale. A Sinhala question–answer dataset of 5,172 samples was built by translating an Indonesian benchmark, with 80% manually verified by language experts; as a translated corpus, it serves as a baseline pending validation on authentic classroom data. An enhanced Siamese network on the AshenBERTo transformer uses multi-head attention pooling and similarity features: element-wise product, absolute difference, cosine similarity, and Euclidean distance, with dual-head outputs for grade and confidence and focal loss for class imbalance. The system achieved a validation accuracy of 75.71% (test: 57.29%), a weighted F1-score of 0.73, and a Cohen's kappa of 0.69, indicating substantial human-grader agreement, though the validation-test gap suggests further validation is needed. The second component is a Unified Multilingual Siamese Similarity Network (UMSSN) estimating sentence-level similarity across six low-resource languages: Sinhala, Tamil, Hindi, Marathi, Nepali, and Armenian. Using a shared multilingual encoder (XLM-R or LaBSE), six datasets normalized to a 0–5 scale, a hybrid regression–ranking loss, and per-language isotonic calibration, the model achieved calibrated Pearson correlations between 0.82–0.92 for five languages and 0.73 for Tamil, with mean absolute errors within one score unit. Although trained independently, both models are presented together as they address a shared problem using a common architecture. Together, they demonstrate the feasibility of semantic similarity modeling and automated grading in low-resource settings, providing baseline architectures and evaluation frameworks for future multilingual education.

Keywords: Automated answer grading, Low-resource languages, Semantic similarity, Siamese network, Sinhala NLP

CAMS 39

Computer Science, Artificial Intelligence, Mathematics & Statistics

THE ORBITAL PATH OF THE EARTH IN THE EXPANDING UNIVERSE

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The expansion of the Universe is a core concept in modern cosmology, yet its influence on smaller, gravitationally bound systems remains poorly understood from a theoretical standpoint. This study develops an analytical framework to investigate the orbital motion of the Earth in an expanding Universe, adopting the Friedmann–Lemaître–Robertson–Walker (FLRW) cosmological model and Einstein's general theory of relativity. The Einstein field equations, modified to include the cosmological constant, were applied to the FLRW metric to derive the Friedmann equations that describe cosmic evolution. The geometric properties of the FLRW spacetime, including the Christoffel symbols, Ricci tensor, and Ricci scalar, were derived methodically. A mathematical model for the cosmic scale factor, $R(t) = b\sqrt{1-(\omega t)}$ was proposed and verified against observational boundary conditions, including the current redshift range and the cosmological density ratio, and the key cosmological parameters, specifically the angular frequency and the amplitude, were determined. The radial geodesic equation was derived from the FLRW metric and linearised under the assumption of small comoving coordinates, generating an equation of motion that accounts for both cosmic expansion and orbital angular momentum. The physical radius of the Earth's orbit was expressed as $a(t) = R(t)u$, where $u = \frac{r}{r_0}$.In the FLRW metric, and its time-dependent change was modeled using MATLAB. Consistent with the established view that cosmic expansion has a negligible effect on tightly bound local systems, the results confirm that this effect on the orbit is negligible, while the oscillatory behavior of the physical radius suggests a non-circular, elliptical orbit, consistent with established planetary dynamics. The principal contribution of the study is the analytical framework and linearisation technique developed to derive this result, providing an integrated mathematical proof, within relativistic spacetime, of the negligible coupling between cosmic expansion and local orbital mechanics.

Keywords: Cosmic scale factor, Cosmology, Expanding universe, FLRW metric, Geodesic equation.

CAMS 40

Computer Science, Artificial Intelligence, Mathematics & Statistics

STATISTICAL PERSISTENCE LANDSCAPES FOR WEIGHTED DIRECTED GRAPHS VIA DOWKER FILTRATIONS

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Topological data analysis provides powerful tools for extracting shape-level features from data, but its most common pipeline is fundamentally restricted to symmetric settings using point clouds and undirected weighted graphs. Financial transaction networks, neural connectivity maps, and migration networks are often directed, and most existing network analysis methods assume that edge weights are symmetric. Two complementary lines of work address parts of this problem but have never been combined. Chowdhury and Memoli [2018] introduced the Dowker filtration, which constructs persistence diagrams directly from an asymmetric weighted relation without requiring symmetry, and proved the stability of persistence diagrams. Independently, Bubenik [2015] developed the persistence landscape, a functional summary of a barcode that lives in the Banach space. In this project, we define the Dowker persistence landscape for a directed weighted graph by applying a tent function to the barcode obtained from the Dowker filtration, and we propose a theorem that characterises the behaviour of the persistence landscape for directed networks. The Stability Theorem establishes that for two directed weighted graphs G and G′ on the same vertex set and the same edge structure, differing only in edge weights, if the edge weights satisfy $||w-w'||_{\infty} \leq \varepsilon$, then their Dowker persistence landscapes $\Lambda(G)$ and $\Lambda(G')$ satisfy $\|\Lambda(G) - \Lambda(G')\|_{\infty} \leq \varepsilon$, where the Λ is the persistence landscape function. This means that a perturbation of at most ε in the edge weights results in a perturbation of at most ε in the persistence landscape, ensuring that small measurement errors in the input data produce equally small errors in the topological summary. This makes the method reliable on real network data. Further, we plan to implement this in Python and test it on real data.

Keywords: Directed weighted graphs, Dowker filtration, Persistence landscapes, Topological data analysis

CAMS 41

Computer Science, Artificial Intelligence, Mathematics & Statistics

AN INVESTIGATION OF THE ATMOSPHERIC SCAVENGING PROCESS IN THE KANDY BASIN AND THE QUANTIFICATION OF WASH-OUT EFFECT EFFICIENCY

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Kandy city is a topographically enclosed sink where complex terrain and stagnant conditions trap particulate matter (PM), threatening public health. This study quantifies precipitation wash-out efficiency for $PM_{2.5}$ (≤ 2.5 μm) and PM_{10} (≤ 10 μm) from 2019–2025. Hourly data from the Central Environmental Authority covered six monitoring stations and included meteorological variables (temperature, humidity, pressure, solar radiation, rainfall, wind speed/direction) and air-quality variables (O_3, CO, NO, NO_2, NO_x, SO_2, $PM_{2.5}$, PM_{10}). Missing values were handled using Kalman smoothing and linear interpolation. An empirical cumulative distribution function was used to compare wet-versus-dry concentration profiles, while Gradient Boosting Machines ranked meteorological predictors. Pre-whitened cross-correlation functions identified response latencies, and a Generalised Additive Model (GAM) estimated efficiency thresholds and parameterised a three-way thermodynamic tensor-product interaction (solar radiation, temperature, humidity) to isolate mechanical washout from inversion dynamics. A Prophet–XGBoost hybrid separated emission-driven baseline trends from residual meteorological interactions and used the SHAP framework to attribute marginal features. Statistical modelling revealed strong temporal persistence ($F > 1000$). PM_{10} scavenged within 1 hour (13.2% hr^{-1}), whereas $PM_{2.5}$ showed a 10-hour lag (7.72% hr^{-1}), shifting the $PM_{2.5}/PM_{10}$ ratio from 0.468 to 0.526. Scavenging efficiency saturated at 2.0 mm hr^{-1} for PM_{10} and 2.6 mm hr^{-1} for $PM_{2.5}$, with diminished clearing thereafter. The thermodynamic GAM explained 72.8% of variance, with vertical washout 3.26 times more effective than sheltered wind dispersion. Hybrid predictions achieved $R^2 = 0.751$ (PM_{10}) and 0.708 ($PM_{2.5}$). Residual autocorrelation and lag-1 SHAP confirmed persistence, treated as a predictive feature. SHAP showed process decoupling: precipitation scavenging drove PM_{10} removal (0.014), solar–thermal mixing governed $PM_{2.5}$ (0.019), and wind dispersion was negligible (0.002). Rainfall alone cannot clean the Kandy Basin effectively due to limited washout capacity and restricted airflow. Effective air quality management, therefore, requires controlling vehicle emissions during stagnant conditions and nighttime inversions.

Keywords: Atmospheric Scavenging, Hybrid Forecasting, Kandy Basin, Particulate Matter, Thermodynamic Lid

CAMS 42

Computer Science, Artificial Intelligence, Mathematics & Statistics

ADAPTING THE SEGMENT ANYTHING MODEL FOR PRECISE THYROID NODULE SEGMENTATION ON ULTRASOUND IMAGES

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Accurate diagnosis of thyroid diseases is essential for early intervention and effective treatment. Ultrasound imaging plays a key role in assessing thyroid nodules due to its non-invasive nature and cost-effectiveness. However, manual segmentation of thyroid nodules is labor-intensive, dependent on radiologists' expertise, and subject to observer variability. Ultrasound images are also affected by speckle noise, low contrast, and indistinct boundaries, making accurate nodule delineation challenging. To address these challenges, this study proposes an automated thyroid nodule segmentation framework based on the Segment Anything Model (SAM). A dataset of 212 thyroid ultrasound images collected from the National Hospital of Sri Lanka was used for evaluation. Manual segmentation was used to generate ground-truth annotations, while automated segmentation was performed with SAM. The proposed method leverages SAM's prompt-based segmentation capability, in which bounding-box prompts guide the localization of thyroid nodules. A transfer learning strategy is adopted by fine-tuning the mask decoder while keeping the pretrained vision and prompt encoders frozen, enabling effective adaptation to the ultrasound domain with limited annotated data. There is limited existing work on applying SAM to thyroid nodule segmentation using ultrasound data from Sri Lankan patients, which highlights the uniqueness of this study. The proposed framework is evaluated using standard segmentation metrics, including the Dice coefficient, Intersection over Union (IoU), accuracy, sensitivity, and specificity. Experimental results show that the proposed model achieves an average IoU of 84.45%, indicating strong agreement between the predicted masks and the ground-truth annotations, and that it is effective for thyroid nodule segmentation, as demonstrated by a comparison with U-Net. Qualitative analysis further confirms accurate boundary delineation and robustness across different nodule sizes and challenging imaging conditions. Overall, the results demonstrate the potential of foundation models such as SAM for thyroid ultrasound image segmentation, with promising applicability as a clinical decision-support tool for improving diagnostic accuracy and efficiency.

Keywords: Computer-aided diagnosis, Deep Learning (DL), Segment anything model, Thyroid nodules, Ultrasound image segmentation

CAMS 43

Computer Science, Artificial Intelligence, Mathematics & Statistics

MAPPING TIME-FREQUENCY CO-MOVEMENTS BETWEEN PUBLIC EXPENDITURE AND ECONOMIC GROWTH IN SRI LANKA: A WAVELET APPROACH

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Public expenditure plays a crucial role in macroeconomic policy, yet its impact on growth remains debated across countries. This study examines the dynamic, time-frequency relationship between economic growth and public expenditure in Sri Lanka from 1965–2024. Using wavelet coherence and lead-lag phase-difference analysis, with significance tested against a red-noise null model at the 5% level, the study decomposes co-movements between growth and expenditure categories-defence, education, and health—across short-run (0–8 quarters), medium-run (8–32), and long-run (32–64). Results show total government expenditure and growth moved together in the short run, with a positive phase from 1965–1973 consistent with Keynesian demand-led expansion, before shifting into a negative relationship during 1973–1982 and 2007–2016, linked to Sri Lanka's transition to an open economy and post-conflict debt pressures. Disaggregated results reveal defence spending showed a positive phase during peaceful years (1965–1973) but showed a strongly negative phase during the civil war (2007–2010), when military outlays crowded out broader performance. Education spending showed a medium-term inverse relationship (1965–1982) but a strong positive long-run link from 2007–2024, consistent with Wagner's Law. Health spending displayed a lagged inverse short-run relationship before turning positive after 2016. Overall, the macroeconomic association between expenditure and growth depends heavily on horizon and category. Non-developmental surges, such as wartime defence, crowd out growth, while sustained investment in human capital yields slower but durable positive co-movements. Policymakers may benefit from horizon-specific budgeting strategies that moderate defence allocations and strengthen education and health infrastructure.

Keywords: Economic growth, Keynesian hypothesis, Lead-Lag relationship, Public expenditure, Wagner's Law, Wavelet coherence

CAMS 44

Computer Science, Artificial Intelligence, Mathematics & Statistics

BREAST CANCER CLASSIFICATION USING MACHINE LEARNING METHODS BASED ON CLINICAL DATA IN SRI LANKA

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Breast cancer remains a major health concern in Sri Lanka, highlighting the need for reliable and interpretable classification approaches using local clinical data. This study addresses this need by using a newly collected hospital-based clinical dataset from Apeksha Hospital, Maharagama, which has not been used for breast cancer classification before, and evaluating selected machine learning models on it. A retrospective case-control study was conducted using 500 female patient records collected from Bed Head Tickets during 2022-2025, comprising 321 breast cancer cases and 179 colorectal cancer controls. Apeksha Hospital was selected as a national cancer referral centre, receiving patients from across Sri Lanka and providing a broad clinical representation of those receiving cancer care. Missing values were handled using Multiple Imputation by Chained Equations (MICE), selected to account for relationships among incomplete clinical variables of mixed types. Multicollinearity was assessed, and an Age_Meno_Group composite variable was created to reduce redundancy arising from the strong association between age and menopausal status. Seven machine learning models were compared based on training and testing performance. Support Vector Machine (SVM) was selected for further interpretation based on its classification performance, achieving a test accuracy of 0.78 and an F1-Score of 0.85. Shapley Additive Explanations (SHAP) analysis identified tumour stage (particularly T2 and T3), Ki-67 index, and N2 stage as the most important features contributing to SVM classification and distinguishing breast cancer cases from colorectal cancer controls. The findings demonstrate the potential of interpretable machine learning with newly collected Sri Lankan hospital-based clinical data and highlight the need for further validation with larger, multicentre datasets that include healthy individuals as controls.

Keywords: Breast cancer, Classification, Clinical data, Machine learning, Sri Lanka

CAMS 45

Computer Science, Artificial Intelligence, Mathematics & Statistics

A NOVEL TENSOR PRODUCT OPERATION FOR HYPERMATRICES

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Matrices have a complete algebraic framework that directly reflects the algebraic operations on linear transformations. However, hypermatrices, which represent multilinear maps modulo choice of ordered bases, lack a multiplication rule because multilinear maps do not compose in the usual sense. Similarly, unlike for matrices, there is no standard tensor product operation for hypermatrices. This study partially fills this gap by deriving two fundamental operations directly from the universal property of tensor products. First, utilising this property, we develop a specific flattening procedure for hypermatrices. This yields the factorisation $H_f = M_{\tilde{f}} H_\tau$, providing a constructive method to merge all input dimensions of a hypermatrix into a single dimension, effectively converting an arbitrary-order hypermatrix into an ordinary matrix. Second, we generalise the classical Kronecker product to hypermatrices. For bilinear maps f and g with hypermatrix slices F^a and G^b, the hypermatrix of $f \otimes g$ is obtained entrywise as $C^{(a,b)}_{i,j,k,l} = F^a_{i,j} G^b_{k,l}$. Consequently, the hypermatrix of $f \otimes g$ has order equal to the sum of the orders of the input hypermatrices, and each of its (a, b)-th slice is precisely the Kronecker product $F^a \otimes G^b$ of a slice from H_f with a slice from H_g, generalising the classical Kronecker product to hypermatrices of arbitrary orders. This study provides both explicit computational procedures and theoretical proofs. Beyond partially extending matrix algebra to a multilinear setting, the flattening operation and the generalised Kronecker product presented here offer new perspectives on the relationship between hypermatrices and multilinear maps. Moreover, these operations have the potential to serve as the foundation of an algebraic theory of hypermatrices, analogous to classical matrix algebra.

Keywords: Flattening, Hypermatrices, Kronecker product, Multilinear maps, Tensor products

CAMS 46

Computer Science, Artificial Intelligence, Mathematics & Statistics

ON THE METHOD OF DIRECTLY DEFINING INVERSE MAPPING FOR A NONLINEAR AGE-STRUCTURED POPULATION MODEL

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Nonlinear age-structured population models are important for describing population dynamics in which growth, mortality, fertility, and competition vary with age and depend on the current population size. In this study, the Method of Directly Defining inverse Mapping (MDDiM), a new approach of the Homotopy Analysis Method (HAM), is extended and applied to obtain semi-analytical approximate series solutions for a nonlinear age-structured population model. This work is academically significant as it introduces MDDiM to age-structured population models for the first time. Many nonlinear age-structured population models are inherently nonlocal integro-differential equations with nonlocal boundary conditions. Unfortunately, many existing analytical methods either fail to address such problems effectively or exhibit certain limitations. This study confirms that the MDDiM provides a flexible and efficient approach to solving these types of problems. In the MDDiM, the inverse operator is defined directly, thus avoiding the need to compute it. Moreover, this inverse mapping need not even be expressed explicitly in differential form. In addition, the MDDiM provides us with great freedom to choose the initial guesses, convergence control parameters, and to define the inverse mapping. The results show that accurate approximations can even be obtained with only a few iterations. Due to the direct definition of the inverse operator, the series solutions were obtained with less CPU time, lower errors, and simpler terms. The proposed method produced lower errors and a faster convergence rate than the HAM while requiring less computational time. Therefore, it can be concluded that the MDDiM is not only easy to use but also accurate. All computational results were achieved using Maple.

Keywords: Directly defining the inverse mapping, Homotopy analysis method, Nonlinear age-structured population models, Series solution, Squared residual error

CAMS 47

Computer Science, Artificial Intelligence, Mathematics & Statistics

GRAPH THEORETICAL ANALYSIS OF PETROLEUM NETWORK: A CASE STUDY FROM GAMPAHA DISTRICT, SRI LANKA

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Petroleum is the backbone of Sri Lanka's transport and energy sectors, yet distribution networks remain vulnerable to disruption. While Dijkstra's algorithm, genetic algorithms, clustering, and fuzzy logic have each been applied to optimise distribution networks individually, this study integrates centrality analysis, sensitivity analysis, and Monte Carlo simulation within a single framework. The petroleum distribution network of Ceylon Petroleum Corporation (CEYPETCO) in Gampaha District was modeled as a weighted undirected graph with a main terminal and 65 fuel stations (66 nodes), using Google Maps shortest-path road distances as edge weights. Four centrality measures, degree, closeness, betweenness, and eigenvector, were used to identify priority nodes, each capturing a complementary structural role: degree identifies local hubs, closeness identifies stations with fastest network-wide access, betweenness identifies bridging or critical stations, and eigenvector identifies stations connected to other influential stations. Spectral clustering, using eigengaps of the normalized Laplacian matrix, grouped the network into four clusters of 9, 15, 19, and 22 stations, with a priority node identified in each cluster to support the placement of a new secondary depot. Sensitivity analysis assessed the stability of node rankings for all four centrality measures under ±20% edge-weight perturbations and 5% random edge removal. Degree and eigenvector centrality yielded the most stable rankings (correlations ≈of 0.98 to 1.00), whereas closeness centrality showed moderate stability. Betweenness centrality was the most sensitive, with correlations falling as low as 0.86. Monte Carlo simulation of 1,000 runs modeling random route failures found demand-satisfaction probabilities ranging from 0.00 to 0.46 across clusters, efficiency reductions of 14% to 21%, and identified specific routes with failure probabilities of up to 0.124, marking priority targets for reinforcement. Unlike previous Sri Lankan studies, the present study identifies both critical nodes and vulnerable routes, providing a practical basis for improving the efficiency and resilience of the petroleum distribution.

Keywords: Centrality analysis, Graph theory, Monte Carlo simulation, Petroleum distribution, Spectral clustering

CAMS 48

Computer Science, Artificial Intelligence, Mathematics & Statistics

MATHEMATICAL MODELLING OF REACTIVE DYE ADSORPTION ONTO COCONUT SHELL ACTIVATED CARBON IN BATCH AND FIXED-BED SYSTEMS USING COMPUTATIONAL FLUID DYNAMICS

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Synthetic reactive dyes in textile wastewater pose a serious environmental problem due to their high toxicity, chemical stability, and poor biodegradability. This highlights the need for effective and scalable treatment strategies. This work has developed a mathematical model of the adsorption of Reactive Black WNN dye onto coconut shell activated carbon (CSAC) in batch and fixed-bed systems to improve the design of the adsorption column and predict system performance under continuous-flow conditions. The work combines experimental adsorption studies with computational modelling to provide a framework linking laboratory-scale behaviour to possible industrial applications. Initial batch experiments were performed to determine the equilibrium adsorption characteristics, and a laboratory-scale fixed-bed column was subsequently developed to study breakthrough behavior under dynamic conditions. The dye concentration was determined by UV-Visible spectrophotometry at 595 nm and the calibration curve showed excellent linearity (R^2 = 0.9997), confirming the applicability of the Beer-Lambert law for precise analysis. The equilibrium data were analyzed using both Langmuir and Freundlich isotherm models. The Freundlich model showed a better fit (R^2 = 0.914) than the Langmuir model (R^2 = 0.552), indicating adsorption on a heterogeneous surface by a multilayer mechanism. A computational fluid dynamics (CFD) model was then developed in SimFlow by coupling the Navier-Stokes equations with a convection-diffusion equation including an adsorption sink term to represent dye uptake within the packed bed. The model parameters, such as the adsorption and mass-transfer coefficients, were determined from experimental adsorption data. The experimental and CFD breakthrough curves showed the same overall progression toward bed exhaustion ($C/C_0 \approx 1$); however, the CFD model predicted an earlier breakthrough than the experimental results. Therefore, the current results demonstrate qualitative agreement between the CFD prediction and experimental breakthrough behaviour rather than complete quantitative validation. In conclusion, the developed model reproduces the principal adsorption and breakthrough trends of the fixed-bed system and provides a useful framework for further model refinement. Further quantitative error analysis, model calibration, and mesh-independence testing are required before the model can be considered a fully validated tool for industrial-scale adsorption system design and optimization.

Keywords: Adsorption, Adsorption mathematical modeling, Coconut shell activated carbon, Computational fluid dynamics, Reactive dye removal

CAMS 49

Computer Science, Artificial Intelligence, Mathematics & Statistics

GROUP-LIKE CONNECTED COMPONENTS OF CLASSICAL CAYLEY GRAPHS OF INVERSE SEMIGROUPS

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Cayley graphs play an important role in understanding the structures studied in Abstract Algebra from a graph-theoretic perspective. While Cayley graphs of groups are strongly connected and vertex-transitive, Cayley graphs of inverse semigroups are generally more complex and may not possess these properties. Shoufeng Wang studied the problem of determining the conditions under which the Cayley graph of a semigroup is isomorphic to that of a group, showing that every finite vertex-transitive Cayley graph of an inverse semigroup is isomorphic to a Cayley graph of a group. However, Wang's work employs a definition of Cayley graphs based on a connection set. In contrast, the classical definition of Cayley graphs uses a generating set. Because of this difference in definitions, Wang's results do not directly apply to the setting considered in this study. Therefore, instead of studying the whole Cayley graph, we focus on its strongly connected components. The aim of this research is to determine when a strongly connected component of the Cayley graph of an inverse semigroup is isomorphic to the Cayley graph of a group. Using Green's relations on the underlying inverse semigroup, the study investigates the algebraic properties of these components. A characterisation of strongly connected components having the structure of a Cayley graph of a group is obtained, and these components are shown to correspond precisely to maximal subgroups associated with a unique idempotent of the inverse semigroup. These findings provide a clear description of the relationship between strongly connected components and maximal subgroups, contributing to a deeper understanding of the interplay between inverse semigroup theory and graph theory.

Keywords: Cayley graphs, Green's relations, Inverse semigroups

CAMS 50

Computer Science, Artificial Intelligence, Mathematics & Statistics

CONSISTENCY OF DEFOCUS ESTIMATION UNDER PUPIL-SIZE EXTRAPOLATION OF ZERNIKE WAVEFRONT COEFFICIENTS

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Precise quantification of refractive defocus is essential to vision science and in the design of optical correction strategies based on wavefront sensing. Zernike polynomials are widely used to represent ocular aberrations, and extrapolation of Zernike coefficients across different pupil sizes is often carried out without adequate assessment of their physical validity, since the corrections are made over the largest pupil size. Unlike prior works, we therefore analytically evaluated the stability of defocus estimation under pupil-size extrapolation. To this end, the refractive defocus values were varied to correspond to refractive errors ranging from 0 to -5 D at a reference pupil radius of 1.5 mm. The resulting wavefronts were extrapolated to larger pupils with radii ranging from 1.75 to 3. 00 mm. The defocus-equivalent (DE) values were then evaluated using the standard Zernike-based conversion. The distribution of DE values shows a linear trend at each pupil radius, with slopes that gradually flatten as pupil size increases. Numerically, the normalized slope decreased from 1.00 at 1.5 mm to 0.54, 0.32, 0.20, 0.13, 0.08, and 0.06 at 1.75, 2.00, 2.25, 2.50, 2.75, and 3.00 mm, respectively. For the first 0.25 mm increase in pupil radius, the results show a reduction of DE of almost 50%. Therefore, for larger pupils, defocus extrapolation across pupil sizes is mathematically ill-conditioned, potentially leading to biased or non-physical estimates. These findings highlighted a critical limitation of Zernike-based methods and emphasized the need for physically consistent, pupil-independent frameworks for precise measurement and correction of refractive error.

Keywords: Defocus equivalent, Extrapolation, Pupil size, Refractive errors, Zernike coefficients



Science Education

SE 01 ***Science Education***

THE EFFECTS OF PARENTAL INVOLVEMENT ON THE ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY STUDENTS: A CASE STUDY FROM THE KALMUNAI EDUCATION ZONE, SRI LANKA

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Parental involvement is widely recognized as a key determinant of student achievement. However, evidence from peripheral, socio-economically disadvantaged regions of Sri Lanka remains limited. This study investigates the effects of parental involvement on the academic achievement of senior secondary (Grades 10–11) students in the Kalmunai Education Zone, Ampara District, Eastern Province, Sri Lanka. Adopting a mixed-methods design, data were collected from 60 teachers, 120 students, and 120 parents using questionnaires, and from 47 educational stakeholders, including principals, deputy and assistant principals, zonal education officers, and school development society members, through semi-structured interviews, direct observation, and document reviews across twelve schools. Quantitative data were analyzed descriptively, while qualitative data were analyzed thematically and triangulated with quantitative findings. The findings show that parents' educational level, economic status, time allocation, and direct educational support are associated with student achievement. The majority of teachers regarded parental involvement as highly important (42 of 60, 70%), while a substantial proportion of parents allocated only limited time to their children's studies (61 of 118, 52%) and reported average or low economic status (82 of 120, 68%). The principal challenges constraining involvement were parents' time constraints, low educational qualifications, and economic hardship. Thematic analysis of interviews and survey data revealed that active parental support, academic interest, and constructive parent–teacher collaboration were key facilitators of improved achievement, whereas educational, economic, and time-related limitations were consistently cited as negative influences. The study recommends that strengthening parent-teacher partnerships, together with targeted parental education, economic support, and awareness programs, is essential for improving student achievement in disadvantaged zones. As the first focused investigation of parental involvement in the Kalmunai Education Zone, it offers context-specific guidelines for educational planners, school administrators, and policymakers.

Keywords: Academic achievement, Kalmunai education zone, Parent-teacher collaboration, Parental involvement, Secondary education

SE 02 ***Science Education***

CHALLENGES IN IMPLEMENTING ENVIRONMENTAL SUSTAINABILITY EDUCATION IN JUNIOR SECONDARY SCIENCE EDUCATION IN WESTERN PROVINCE, SRI LANKA

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Environmental Sustainability (ES) has become an important focus of education in response to growing global environmental concerns and the need to foster environmentally responsible behaviors among students. Science education provides an important context for integrating ES into school learning. Although sustainability themes are included in the Sri Lankan school science curriculum, limited attention has been given to the challenges teachers face in implementing ES-based teaching and learning. Therefore, this study examined teachers' perceptions of the availability of institutional and professional support, and the barriers to effectively integrating ES into science pedagogy in the junior secondary classrooms. A quantitative descriptive survey design was used to collect and analyze data from 328 junior secondary science teachers in government schools in the Western Province. The findings identified several key barriers to integrating ES into science teaching. Only 13% (42) of participating teachers reported receiving training to promote ES through science pedagogy. Among the reported sources of training, 8 teachers identified national-level training, while 14, 17, and 9 teachers reported school-level, provincial-level, and private sector training, respectively. Moreover, 96% of teachers perceived parental involvement in promoting students' ES competencies as poor. These findings highlight the need to expand access to ES-related teacher training, strengthen the quality and availability of professional development opportunities and institutional support, and enhance parental involvement in developing students' ES competencies.

Keywords: Environmental sustainability, Science education, Teacher development

SE 03 ***Science Education***

A STUDY OF THE IMPACT OF GEOGEBRA SOFTWARE ON TEACHING CIRCULAR GEOMETRIC THEOREMS IN G.C.E. ORDINARY LEVEL CLASSES IN TYPE 2 SCHOOLS IN THE POLGAHAWELA DIVISION, SRI LANKA

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Geometry accounts for approximately one-quarter of the G.C.E. Ordinary Level (O/L) Mathematics examination in Sri Lanka, yet circular geometry remains challenging, with consistently poor performance in questions on circular theorems. This underachievement has been attributed to weak spatial-visualization skills, limited geometric reasoning, and traditional teacher-centered methods that emphasize memorization over conceptual understanding. GeoGebra, a free dynamic mathematics software, enables interactive exploration and visualization of geometric concepts, potentially enhancing conceptual learning. However, empirical evidence in the Sri Lankan context remains limited. This study investigated the impact of GeoGebra on teaching and learning circular geometric theorems among G.C.E. O/L students in Type 2 schools in the Polgahawela Division using a quasi-experimental mixed-methods design. A total of 62 students from two schools completed a pre-test (control $M = 26.06$, $SD = 13.76$; experimental $M = 25.26$, $SD = 14.13$) and were alternately assigned to the experimental and control groups based on pre-test rankings. Both groups improved, but the experimental group showed a greater mean gain (+16.71) than the control group (+6.55), with a higher post-test mean ($M = 41.97$, $SD = 13.41$) compared with the control group ($M = 32.61$, $SD = 19.06$). An independent-samples t-test confirmed a significant difference in post-test achievement ($p = 0.029$), with Cohen's $d \approx 0.57$ indicating a moderate effect. Post-intervention Likert-scale responses also showed higher engagement, confidence, perceived conceptual understanding, ability to identify angle relationships, and teacher–student connection among students taught using GeoGebra. These findings suggest that GeoGebra-based instruction was associated with greater achievement gains and more positive learning experiences. The study supports piloting GeoGebra through teacher training

Keywords: Circular geometry, GeoGebra, Mathematics education

SE 04 ***Science Education***

IMPACT OF REALISTIC MATHEMATICS EDUCATION (RME) APPROACH ON TEACHING FRACTIONS TO GRADE 10 STUDENTS IN SRI LANKA

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This study examines how the Realistic Mathematics Education (RME) approach affects the teaching of fractions to Grade 10 students in Sri Lanka. Fractions fall under the "Number" theme, which accounts for roughly 22% of the national Ordinary Level mathematics syllabus, but student performance in this area remains consistently poor. Nearly 29% of candidates who sat for the year 2019 G.C.E. Ordinary Level mathematics paper failed the subject, and fraction-related questions recorded some of the lowest scores across the examination. While RME has proven successful in countries such as the Netherlands, Indonesia, and Vietnam, its viability in Sri Lankan classrooms has remained unexplored. Preliminary survey data from 100 practicing mathematics teachers, selected from seven districts with the highest pass percentage in Mathematics for the Ordinary level examination through mutual contacts, confirmed that traditional lecture-based teaching still dominates local classrooms, though 75% of teachers expressed a strong interest in adopting RME. To address this gap, the researcher conducted a mixed-methods quasi-experimental study with 40 Grade 10 students from a government school in Colombo over four 40-minute lessons. No control group was maintained in this research due to ethical constraints. Instead of abstract formulas, fractions were taught through everyday situations such as sharing pizza, dividing plots of land, and tracking water levels in household tanks. A pretest was administered before the intervention, and a post-test was administered immediately afterward. The Wilcoxon Signed-Rank Test showed that the improvement in scores was statistically significant ($W = 703, p < 0.001$), with the class average rising from 13.82 to 17.05 out of 20. 37 students improved their marks, 3 maintained their perfect scores, and not a single student performed worse than before. The effect size was large ($r = 1.00$). A post-survey of the subject group showed that 72.5% of student participants preferred learning through real-life contexts to conventional teaching. Despite limitations such as a small sample size and the absence of a control group, these findings offer encouraging early evidence that RME has positive effects as a practical, context-sensitive strategy for improving mathematics education in similar classroom contexts.

Keywords: Context-based learning, Fractions, Quasi-experimental design, Realistic Mathematics Education (RME), Secondary education

SE 05 ***Science Education***

EFFECTIVENESS OF SKILLS-ORIENTED INSTRUCTION IN ENHANCING GENERIC SKILLS IN GRADE 8 SCIENCE EDUCATION (CHEMISTRY COMPONENTS) IN SRI LANKA

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Conventional science teaching practices in secondary classrooms often offer limited opportunities for students to develop the essential generic skills required in modern learning environments. This study investigated the influence of skills-oriented instructional and assessment practices on the development of generic skills among Grade 8 students studying chemistry concepts in the Central Province of Sri Lanka. A quasi-experimental mixed-methods approach was adopted, involving 156 Grade 8 students and 6 science teachers across three government schools with parallel classes. Two chemistry-focused instructional units were implemented using both conventional teaching methods and skills-oriented learning strategies. Data were collected through post-tests, skill-based assessments, rubric-guided evaluations, classroom observations, interviews, and focus group discussions. Quantitative data were analyzed using SPSS, while qualitative data were analyzed using thematic analysis. Pre-intervention analyses confirmed baseline equivalence in academic performance between the experimental and control groups ($p > 0.05$). Post-intervention findings demonstrated statistically significant performance advantages for students exposed to skills-oriented instruction across all assessment categories ($p < 0.001$). Specifically, in the Unit 1 rubric-based assessment, the experimental group achieved a mean score of 60.97 (SD = 11.29), whereas the control group scored 34.24 (SD = 5.36). Similarly, the Unit 2 skill-based assessment yielded a mean score of 59.00 (SD = 5.15) for the experimental group compared to 35.81 (SD = 4.69) for the control group. Qualitative findings confirmed these results, showing increased participation, enhanced communication, stronger peer collaboration, and improved problem-solving abilities among experimental participants. The study concludes that skills-oriented instructional strategies are significantly more effective than conventional methods in fostering generic skills and academic performance in Grade 8 chemistry education, supporting the systemic integration of competency-focused pedagogy in Sri Lankan secondary science classrooms.

Keywords: Competency-based learning, Generic skills, Science education, Skills-oriented instruction

SE 06 ***Science Education***

EFFECTIVENESS OF POWERPOINT-BASED INSTRUCTION IN TEACHING SCIENCE FOR GRADE 10 STUDENTS: A CASE STUDY FROM WATTEGAMA EDUCATIONAL ZONE, SRI LANKA

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PowerPoint is widely used in teaching and learning worldwide. However, limited research has examined its impact on teaching and learning in the Sri Lankan context. This quantitative study aimed to determine whether PowerPoint-based instruction significantly improves Science achievement compared with conventional teaching among Grade 10 students at a Tamil-medium National School in the Wattegama Zone of Education, Kandy District, Sri Lanka. A convenience sample of 84 Grade 10 students was divided into two comparable groups of 42 (Groups A and B) based on their Grade 9 third-term Science examination marks. The groups were taught two chemistry topics (catalyst and rate of reaction) and two biology topics (protein and food chain) from the Grade 10 Science textbook by the same teacher, using both PowerPoint-based and conventional methods. Across the four topics, both groups alternated between the two teaching methods. Group A received PowerPoint instruction on the catalyst and protein, and conventional instruction on the rate of reaction and the food chain, while Group B received the opposite sequence. A post-test, validated through expert judgment, was administered after each topic. Normality was assessed using the Shapiro-Wilk test, followed by the Mann-Whitney U test to compare post-test scores between the two teaching methods. Students receiving PowerPoint-based instruction performed significantly better in all four post-tests than those taught conventionally (catalyst: $p<0.05$, $r=0.45$; rate of reaction: $p<0.05$, $r=0.25$; protein: $p<0.05$, $r=0.25$; food chain: $p<0.05$, $r=0.6$). The findings indicate that PowerPoint-based instruction was associated with improved post-test performance in this sample. Science teachers may therefore consider using PowerPoint presentations more frequently in classrooms. Further studies with larger samples and students from different instructional media and age groups could provide a more generalizable understanding of its effectiveness in improving science performance.

Keywords: Conventional teaching, PowerPoint-based instruction, Science performance

SE 07 ***Science Education***

A STUDY ON THE IMPORTANCE GIVEN TO PHYSICS EXPERIMENTS IN SRI LANKAN SCHOOLS: A CASE STUDY IN MATALE EDUCATIONAL ZONE

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Practical experimentation plays a vital role in physics education by helping students connect theoretical concepts with real-world phenomena and develop essential scientific skills. This study investigated the importance given to physics experiments in schools within the Matale Educational Zone, Sri Lanka, focusing on the adequacy of laboratory facilities, the methods used to conduct practical activities, and the interest of students and teachers in physics experiments. A mixed-methods explanatory sequential design was employed. The quantitative phase involved 332 Advanced Level physics students and 12 teachers, while the qualitative phase consisted of five focus group discussions with students and five semi-structured interviews with teachers. Quantitative data were analyzed using descriptive statistics, whereas qualitative data were analyzed through thematic analysis. The findings revealed that most schools had separate physics laboratories and adequate facilities for certain curriculum areas, including Measurements (91.67%) and Mechanics (75.00%). However, significant inadequacies were identified in Thermal Physics (8.33%), Electronics (25.00%), and Properties of Matter (25.00%). Most students reported using real apparatus for experiments (73.49%) and expressed highly positive attitudes toward practical work (88.02%). Three major themes emerged from the qualitative data: experiments are a more enjoyable aspect of learning physics than memorizing theories, most experiments included in the practical syllabus are not conducted, and real apparatus is frequently used when experiments are carried out. However, many prescribed practical activities are not conducted regularly due to challenges such as low student attendance and limited resources. The study concludes that practical work is highly valued by both students and teachers. However, improvements in laboratory facilities and the consistent implementation of practical activities are necessary to enhance the effectiveness of physics teaching and learning.

Keywords: Advanced level, Experiments, Laboratory, Physics, Student interest.

SE 08 ***Science Education***

EFFECTS OF TRANSPORTATION DIFFICULTIES DURING THE 2026 FUEL CRISIS ON ACADEMIC ENGAGEMENT AND WELL-BEING AMONG SCIENCE UNDERGRADUATES, UNIVERSITY OF PERADENIYA

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The Middle Eastern geopolitical conflict disrupted global oil supply chains and energy transportation routes, contributing to a widespread fuel crisis in many countries, including Sri Lanka, from March to April 2026. Fuel shortages, rising transportation costs, and instability in public transport services posed significant challenges for individuals, including undergraduates who rely on daily commutes. This study investigated the impact of transportation difficulties during the fuel crisis on undergraduates in the Faculty of Science at the University of Peradeniya. A cross-sectional online survey conducted in April 2026 collected data on transportation difficulty, stress levels, sleep disturbance, and lecture attendance decisions using a 5-point Likert scale. A total of 91 responses were collected at a 95% confidence level. Bus transportation was the predominant travel mode, used by 81.3% of respondents, and bus users reported the highest average transportation difficulty score (3.11), compared with students who walked (2.00) or used private vehicles (2.90). Spearman correlation analysis showed moderate positive relationships between transportation difficulty and stress level ($r_s = 0.547$) and between transportation difficulty and sleep disturbance ($r_s = 0.475$). A strong positive relationship was observed between stress level and sleep disturbance ($r_s = 0.706$). Regression analysis further showed that transportation difficulty significantly predicted student stress level ($R^2 = 0.327$, $p < 0.001$). Among respondents, 16.5% reported not attending lectures due to transportation difficulties, while 31.9% were uncertain, indicating that 48.4% were hesitant to attend during the fuel crisis. Students considering non-attendance reported higher average transportation difficulty (3.13), stress levels (3.20), and sleep disturbance (3.00) than those attending lectures without hesitation (2.47, 2.38, and 2.11, respectively). The findings highlight the significant effects of transportation disruptions on academic participation and student well-being, emphasizing the need for flexible learning systems and effective institutional support during future crises.

Keywords: Fuel crisis 2026, Transportation difficulty, Academic engagement, Stress, sleep disturbance, Lecture attendance hesitation, Undergraduate students

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PGIS RESCON
RESEARCH CONGRESS 2026

Nature, Science, and Sustainability: Research for a Resilient Planet

ISSN 3051-4622