THE COLOMBO CONFERENCE

The 03rd International Conference on University-Industry Collaborations for Sustainable Development (ICSD 2026)

BOOK OF ABSTRACTS

Editors
Prof. Ranjith Dissanayake | Dr. Pradeep Gajanayake

The 3rd International Conference on University-Industry Collaborations for Sustainable Development (ICSD 2026)

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Vision

To create a global platform that inspires and empowers University-Industry collaborations, driving sustainable solutions, innovative technologies, and entrepreneurial strategies for sustainable development

Mission

To facilitate dialogue, knowledge exchange, and partnerships among academia, industry, and policymakers. By integrating cutting-edge research, practical insights, and visionary thinking, the conference seeks to enhance university curricula, strengthen business links, and catalyze the development of innovative sustainable solutions that promote environmental and socio-economic growth

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PREFACE

Welcome to the Third International Conference on University–Industry Collaborations for Sustainable Development (ICSD 2026), also known as the Colombo Conference. This distinguished gathering serves as a catalyst for the exchange of cutting-edge ideas, innovative technologies, and entrepreneurial strategies within the realm of agro-industries. With a strong commitment to sustainability, the conference aims to advance university curricula into new dimensions, strengthen industry partnerships, and cultivate a dynamic environment for invention, innovation, and entrepreneurship. Contained within this abstract book are research contributions spanning a wide range of sub-specialties, reflecting the diversity and impact of work carried out by scholars and practitioners alike. These abstracts are scheduled for presentation at parallel sessions on March 26th and 27th, 2026, at gapHQ, Colombo 07, Sri Lanka. We extend our deepest appreciation to our esteemed keynote speakers, whose valuable insights have significantly contributed to shaping the discourse on University–Industry Collaborations for Sustainable Development. The richness of this compilation is largely due to the dedication and high caliber of the contributing authors, who have presented research of exceptional quality. Each abstract featured in this book has undergone rigorous review by a panel of academic and professional experts distinguished in their respective fields. We express our sincere gratitude to these reviewers for their tireless efforts in upholding and enhancing the scholarly standards of this publication. We also acknowledge with appreciation the unwavering support and guidance provided by both local and international advisory committees, as well as the committed members of the co-chairs committee. Their contributions have been instrumental in ensuring the success of this important event. We extend our heartfelt thanks to all volunteers who have generously contributed their time and expertise toward the seamless execution of the conference. Furthermore, we gratefully acknowledge the FOUNTAIN Project, co-funded by the European Union, for its valuable financial contribution and continued support. As editors, it is our earnest hope that this abstract book will serve as a valuable resource for the global research community engaged in University–Industry Collaborations for Sustainable Development. May the insights shared within these pages inspire and guide future endeavors toward a more sustainable and collaborative future.

Editors
Prof. Ranjith Dissanayake
Dr. Pradeep Gajanayake

The Third International Conference on University-Industry Collaborations for Sustainable Development (ICSD 2026) 25th to 27th March 2026, gapHQ, Colombo 07, Sri Lanka

Message from the Conference Co-Chairs

It is with great pleasure that we extend a warm welcome to all participants of the Colombo Conference – the Third International Conference on University–Industry Collaborations for Sustainable Development (ICSD 2026), held in the vibrant city of Colombo, Sri Lanka. The chosen theme, "University–Industry Collaborations for Sustainable Development," resonates strongly with the global imperative to foster innovative and sustainable research that shapes a brighter future. In organizing this conference, our vision is to create a dynamic convergence point for talent, knowledge, and commitment. We believe this platform will serve as a catalyst for generating groundbreaking ideas and facilitating the exchange of expertise among participants dedicated to sustainable global development. This year's conference explores diverse sub-themes within the broad spectrum of sustainable development, with particular emphasis on the vital interplay between academia and industry. We anticipate insightful discussions across a wide range of disciplines, each contributing to the overarching goal of advancing sustainable research and innovation for the benefit of future generations. Selected high-quality full papers presented at the Colombo Conference (ICSD 2026) will be considered for publication by Springer Nature under the book series Proceedings in Technology Transfer. All other accepted papers will be published in a special volume of conference proceedings with an International Standard Serial Number (ISSN). The choice of Colombo as our host city remains significant, as it is a destination rich in heritage, distinctive architecture, cultural diversity, and natural beauty. We hope that alongside the intellectually engaging sessions, you will find time to experience the unique charm and warmth of Colombo. Our heartfelt gratitude is extended to our distinguished guests, keynote speakers, contributing authors, members of the international advisory committee, and the dedicated editorial team. We also sincerely appreciate the generous support of our sponsors and the invaluable efforts of all volunteers who have contributed to making this event a success. As conference co-chairs, we are honored to be part of this collaborative journey toward sustainable development. We look forward to a vibrant exchange of ideas and the creation of lasting partnerships during this memorable event.

Prof. Ranjith Dissanayke
Prof. G. Yugantha Jayasinghe
Mr. Ravi Nissanka
Dr. Ravi Liyanage
Prof. Sujeeva Setunga
Prof. Dilanthi Amaratunga
Prof. Lasith Gunawardena
Prof. Irene Lill
Prof. Artūras Kaklauskas
Mr. Sujith Gunawardena
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The Third International Conference on University-Industry Collaborations for Sustainable Development (ICSD 2026) 25th to 27th March 2026, gapHQ, Colombo 07, Sri Lanka

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BIOTECHNOLOGY, BIOMEDICAL SCIENCE & NATURAL PRODUCTS - I

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COMPREHENSIVE BIOLOGICAL PROFILING OF *Croton caudatus Geiseler*.; A SUSTAINABLE APPROACH TO COLORECTAL CANCER THERAPY

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Abstract: Colorectal cancer is the third most prevalent cancer globally and the second leading cause of cancer-related deaths. Current therapeutic strategies are often associated with limited efficacy and adverse side effects. This highlights the urgent need for alternative, effective, and safer therapeutic options. *Croton caudatus* Geiseler. (CCG) is a plant prevalent in Asia and has traditionally been utilised to treat gastrointestinal disorders, fever, and inflammation. While some studies suggest its pharmaceutical relevance in cancer treatment, the scientific evaluation of its potential against colorectal cancer remains underexplored. This study aimed to conduct a comprehensive biological profiling of leaf and bark extracts of CCG using the DLD-1 human colorectal adenocarcinoma cell line. Extracts were prepared by cold percolation using methanol as the solvent and rotary evaporated under optimal conditions. Gas Chromatography-Mass Spectrometry (GC-MS) analysis confirmed the presence of a variety of bioactive compounds in leaf and bark extract with potential anticancer effects, including Hexadecenoic acid-methyl ester, Octadecenoic acid-methyl ester, and other saturated fatty acids. In addition to these compounds, the bark extract contained phenolic compounds including phenol, 2-methoxy-3-(2-propenyl)-. Cytotoxicity evaluation using the Methylthiazol Tetrazolium (MTT) assay demonstrated a clear dose-dependent reduction in DLD-1 cell viability after 24 hours. The half-maximal inhibitory concentrations (IC_{50}) of the leaf and bark extract were 93.22 µg/mL and 282.65 µg/mL, respectively. DLD-1 cells treated with 2 × IC_{50} and 4× IC_{50} concentrations of leaf and bark extracts showed an inhibition of cell migration after 24 hours. The toxicity assay on the Vero cell line revealed no cytotoxic effects, confirming the selective activity and biocompatibility of the extracts. Collectively, these findings provide robust evidence for the antitumorigenic potential of *Croton caudatus* Geiseler. against colorectal cancer and highlight its significance as a sustainable, renewable natural resource for anticancer drug discovery with less reliance on synthetic compounds.

Keywords: Cell Migration; Colorectal Cancer; GC-MS; Herbal Medicine; Phytochemicals

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ROLE OF PLANT TISSUE CULTURE IN DEVELOPING CLIMATE – RESILIENT CROP VARIETIES: EMERGING TRENDS AND FUTURE AGRI – TECH OPPORTUNITES

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Abstract: Climate change creates exceptional challenges to global agriculture, threatening crop productivity, food security, and the sustainability of farming systems. Developing climate-resilient crop varieties has therefore become a critical priority and plant tissue culture plays a considerable role in this process. This review highlights the key advancements, emerging challenges and future opportunities in using plant tissue culture for producing climate resilience crops. Plant tissue culture techniques such as micropropagation, somaclonal variation, *in vitro* mutagenesis, embryo rescue and somatic embryogenesis have strongly supported the development of genetically stable and stress-tolerant plants. These methods enable rapid multiplication of elite genotypes, preservation of valuable germplasm and production of disease-free planting materials, thereby supporting climate-smart agricultural systems. Advanced tissue culture techniques have been directly involved in making the surface of modern agri-tech innovations against climate change. However, challenges such as genotype-specific responses, high production costs, somaclonal variations, and the lack of skilled technical experts hinder the stability and scalability of improved traits. In many developing regions, the potential of plant tissue culture remains underutilized due to inadequate resources, a shortage of skilled experts and low awareness among growers. To maximize its benefits, there is a need for innovative, cost and resource efficient protocols, improved culture media and scalable technologies that can be easily applied. Emerging opportunities involve linking plant tissue culture with advanced tools such as AI-based trait prediction, digital phenotyping, precision agriculture and climate-adaptive breeding approaches. Utilizing these integrations can accelerate the production of climate-resilient crops capable of withstanding drought, salinity, heat, and pest pressures. This review points out the evolving role of plant tissue culture in enhancing crop resilience, novel trends in agri-tech applications, limitations and highlights key areas for further research.

Keywords: Agri – Tech Innovations; Biotechnology; Climate Resilience; Molecular Approach; Plant Tissue Culture

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SYNERGISTIC EFFECTS OF CHITOSAN AND NANO-SILICA SEED PRIMINGON EARLY DROUGHT TOLERANCE AND RADICLE GROWTH IN MAIZE

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Abstract: The initial establishment of maize (*Zea mays* L.) seedlings is negatively affected by drought stress. Seed priming is an effective technique that promotes stress tolerance during early growth. We evaluated the effects of chitosan and nano-silica (NSi) seed priming on germination, radicle development, starch mobilization, and antioxidant activity in maize under polyethylene glycol (PEG) induced drought stress. The priming treatments included chitosan (100 ppm) + NSi (200 ppm), chitosan (100 ppm) + NSi (250 ppm), chitosan (100 ppm), NSi (200 ppm), NSi (250 ppm), and distilled water (control). Maize seeds were primed in each treatment for five hours. Following priming, seeds were germinated in Petri dishes under drought stress at -0.5 MPa induced by polyethylene glycol (PEG). On the 7th day, the germination percentage, primary root length, and starch content of the seedlings were measured, and the antioxidant activity was evaluated on the 3rd day. No significant differences were observed in the germination percentage across all priming treatments. However, the physiological responses during pot germination differed significantly. The residual starch concentration in the combined chitosan-NSi priming treatments was considerably lower than that in the control, indicating enhanced starch mobilization during stress. Enhanced antioxidant activity was identified in the combined chitosan-NSi treatments, suggesting a considerable reduction in oxidative damage during early seed imbibition. Consequently, these treatments produced the longest radicles. However, shoot emergence was not detected under any of the priming treatments, possibly due to severe osmotic stress inhibiting plumule growth while prioritizing the root growth. These findings indicate that chitosan and NSi synergistically enhanced early drought tolerance in maize by improving antioxidant defences, promoting reserve mobilization, and radicle growth. The practical applicability of these priming treatments in drought-prone areas should be further tested and confirmed using field and greenhouse trials.

Keywords: Chitosan; Drought Stress; Maize (*Zea mays* L.); Nano-Silica; Seed Priming

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DEVELOPMENT OF A SINGLE-ACTIVE-HERBAL-COMPONENT TOOTHPASTE USING *Mimusops elengi* L. WITH ANTIMICROBIAL AND PHYSICOCHEMICAL ANALYSIS

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Abstract: Oral diseases, primarily dental caries, affect approximately 3.5 billion people globally, resulting in a substantial socio-economic burden. Growing concerns regarding antimicrobial resistance and potential adverse effects of conventional toothpastes highlight the need for safer and sustainable oral care alternatives. The current study aimed to develop a standardized, industry-applicable herbal toothpaste using *Mimusops elengi* L. stem bark as the single active herbal component. Crude aqueous and ethanolic bark extracts were prepared and evaluated for antimicrobial activity against *Candida albicans* and *Streptococcus mutans* using agar well diffusion bioassay on Mueller Hinton Agar. The toothpaste was formulated using finely powdered *M. elengi* bark, and antimicrobial and physicochemical properties were evaluated. It was tested against *C. albicans*, *S. mutans*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. Formulation and evaluation followed the Industrial Technology Institute (ITI), Sri Lanka guidelines. The ethanolic extract exhibited significant antimicrobial activity against 31 *C. albicans* clinical isolates (mean zone of inhibition (23.33 ± 0.29) mm), which was significantly greater than the negative control ($p < 0.001$) and against *S. mutans* ((19.67 ± 0.29) mm; $p < 0.001$). The aqueous extract showed no activity. Formulated toothpaste showed significant antimicrobial activity against *C. albicans*, *S. mutans* and *S. aureus* with mean zones of inhibition significantly higher than the toothpaste base ($p < 0.0001$). No inhibition was observed against Gram-negative bacteria; *E. coli* and *P. aeruginosa* at the concentration tested. The product demonstrated high buffering capacity (1.25 ± 0.08 cm^3 of 0.1 M HCl/g), significantly exceeding artificial saliva alone ($p < 0.0001$), ensuring effective acid neutralization. It maintained acceptable pH (6.88 - 7.99), rheological properties, short-term stability and microbiological safety (absence of *E. coli* and *Salmonella* spp.). The results support the successful development of an effective toothpaste by utilizing a single active herbal component with clear potential for practical and industrial applications.

Keywords: Antimicrobial Activity; Buffering Capacity; Herbal Toothpaste; Natural Products; Oral Care; Physicochemical Analysis

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SRI LANKAN MARINE ALGAE AS A SUSTAINABLE SOURCE OF NOVEL ANTIMICROBIAL AGENTS: CURRENT FINDINGS AND FUTURE PROSPECTS

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Abstract: Antimicrobial resistance (AMR) is a major global public health concern, necessitating the imperative identification of novel therapeutic agents to combat multidrug-resistant pathogens. This review synthesizes findings from approximately 50 studies to evaluate the antimicrobial potential of marine algae inhabiting the coastal waters of Sri Lanka, a biodiversity hotspot characterized by unique tropical environmental conditions. The analysis focuses on prominent algal taxa found in the region, including species of *Sargassum*, *Gracilaria*, *Ulva*, and *Caulerpa*, which serve as rich reservoirs of bioactive secondary metabolites. The review categorizes key chemical functional groups, such as phlorotannins, fatty acids, sulfated polysaccharides, peptides, terpenes, and chrysophaentins, and elucidates their mechanisms of action. These mechanisms range from the inhibition of oxidative phosphorylation and bacterial cell lysis to the disruption of quorum sensing via halogenated furanones. Furthermore, the study highlights the broad-spectrum efficacy of these metabolites against bacteria (e.g., *Staphylococcus aureus*, *Vibrio cholerae*), fungi (*Candida albicans*), and viruses, with specific attention to the potential of algal sulfolipids and phlorotannins in blocking SARS-CoV-2 entry. Finally, the review critically assesses various screening methodologies, including agar disk diffusion, E-test, and high-performance liquid chromatography (HPLC). It concludes that while Sri Lankan marine algae offer a sustainable source of alternative antimicrobials, future progress requires standardized harvesting practices, advanced metabolomic profiling, and rigorous clinical trials to translate these natural compounds into effective pharmaceutical applications.

Keywords: Antibiotic Resistance; Antimicrobial Activity; Bioactive Metabolites; Screening Methods; Sri Lankan Marine Algae

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CYTOTOXICITY AND NO INHIBITORY PROPERTIES OF AGAR RICH FRACTION EXTRACTED FROM *Gracilaria japonica*

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Abstract: Seaweeds are one of the marine resources rich in numerous phytochemicals, with significant potential for utilization in various industries as a safe and cost-effective natural agent. Red seaweed is an abundant marine resource along the coastal regions of Sri Lanka, which still remains largely underutilized despite the significant potential for commercial applications, crucially in the food industry. The present study was conducted to determine the cytotoxicity, cell viability, and anti-inflammatory properties of the agar-rich fraction (ARF) from an underutilized red seaweed, *Gracilaria japonica.* Cytotoxicity and cell viability analysis were assessed via MTT assay against lipopolysaccharide (LPS) induced RAW 264.7 macrophages. The RAW 264.7 macrophages were cultured at 1×10^5 cells/ml in the 96 - well plate and incubated for 24 h and then stimulated with LPS. Then, the cells were treated with the different concentrations (25, 50, 100, 200, and 400 µg/ml) of ARF. While nitric oxide (NO) production was quantified by Griess reaction and IL-1β secretion levels were determined by ELISA in LPS-activated RAW 264.7 macrophages with 50 µM of Dexamethasone as a reference standard. Accordingly, the treatments of ARF from *G. japonica* showed no cytotoxicity under the tested conditions, up to 200 µg/mL. Furthermore, treatment with ARF significantly reduced NO production in LPS-activated RAW 264.7 macrophages while restoring the cell viability that had been reduced by LPS stimulation. In addition, ARF dose-dependently inhibited LPS-induced IL-1β production in RAW 264.7 macrophages across the tested concentrations. The current findings of this study strongly indicate the potential of *G. Japonica* to develop value-added seaweed-based food products that are safe for consumers.

Keywords: Anti-Inflammatory; Cell Viability; Cytotoxicity; *Gracilaria Japonica*; Red Seaweed

CLIMATE-SMART AGRICULTURE AND AGRI-TECH INNOVATIONS - I

ICSD26_152

IDENTIFICATION OF SELECTED SRI LANKAN TRADITIONAL AND NEW IMPROVED RICE VARIETIES AT GRAIN LEVEL USING COMPUTER VISION AND MACHINE LEARNING

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Abstract: Rice is the staple food for more than half of the world's population, and Sri Lanka is home for wide range of traditional and new improved rice varieties. The high diversity among these varieties makes grain-level identification particularly challenging, even though it is essential for quality control, breeding programs, and market authentication. At present, there is a notable lack of national and international studies focusing on precise grain-level identification. This study presents a non-invasive, image-based supervised machine learning approach to classify Sri Lankan rice varieties at the grain level. Ten varieties namely Bg 358,Bg 94-1, Bw 272-6b, At 362, At 307, Ld 368, Madathawalu, Goda Heenati, Dikwee and Masuran covering both red and white rice across paddy, whole-grain, and milled forms were used in this study. High-resolution images were captured using a digital camera under controlled lighting conditions, from which 14 morphological, 10 colour, and 10 texture features were extracted and normalized. Supervised models, including Linear Discriminant Analysis, Support Vector Machines, k-Nearest Neighbour, Naive Bayes, and Ensemble Discriminant classifiers, were trained and evaluated. Linear Discriminant Analysis gave the best results, reaching up to 99.7% accuracy and an AUC of 1.00. Ensemble Discriminant models also performed extremely well. Support Vector Machines with polynomial kernels worked strongly, especially for whole-grain and milled-grain samples. K-Nearest Neighbors and Naive Bayes had lower accuracies compared to the others, but they still achieved more than 85% in many cases. Overall, ssupervised machine learning models showed very high accuracy for classifying all rice grain datasets. Using a combination of morphological, colour, and textural features helped the models classify the varieties reliably across all grain types. The study concludes that image-based machine learning might be a promising tool for varietal identification of rice in Sri Lanka.

Keywords: Computer Vision; Grain Level Identification; Machine Learning; New Improved Rice; Sri Lankan Rice; Traditional rice

ICSD26_180

WEEDIQ: SMART WEED MANAGEMENT, AN AI-DRIVEN MULTI-STAGE SYSTEM FOR CROP–WEED DETECTION, DENSITY MAPPING, AND HERBICIDE DOSAGE OPTIMIZATION

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Abstract: Weed infestation remains a major challenge in modern agriculture, leading to significant crop yield losses, increased production costs, and adverse environmental impacts due to the excessive and uniform application of herbicides. This study aims to design and evaluate an AI-driven, multi-stage weed management system, termed WeedIQ, that enables precise weed detection, spatial density estimation, and optimized herbicide application to support sustainable and data-driven farming practices. The proposed system adopts an integrated framework that combines crop-weed semantic segmentation, weed density mapping, and herbicide dosage optimization within a unified pipeline. A U-Net-based deep learning model is employed for pixel-level semantic segmentation to accurately distinguish crops and weeds using publicly available agricultural image datasets. The segmentation outputs are subsequently processed to generate spatial weed density maps, allowing the identification of weed distribution patterns across agricultural fields. Based on the derived weed density information, a rule-based herbicide dosage optimization module is developed to recommend location specific herbicide application rates, with the objective of reducing chemical usage while maintaining effective weed control. Experimental evaluation demonstrates that the proposed approach can reliably identify weed-infested regions and support informed decision making for site specific herbicide application. The findings highlight the potential of WeedIQ to improve operational efficiency, reduce unnecessary herbicide usage, and promote environmentally sustainable farming practices. Overall, this study demonstrates the effectiveness of integrating deep learning and computer vision techniques in advancing climate-smart and resource efficient agricultural systems.

Keywords: Computer Vision; Deep Learning; Herbicide Optimization; Precision Agriculture; Semantic Segmentation; Sustainable Farming; Weed Detection

ICSD26_257

MICROALGAE INTEGRATION IN HYDROPONIC SYSTEMS FOR SUSTAINABILITY: A SYSTEMATIC LITERATURE REVIEW

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Abstract: Hydroponic agriculture needs to be more sustainable due to its expanding role in global food production. Microalgae integration into hydroponics is a potential solution to the problem in terms of co-cultivation, effluent recycling, and aquaponic systems. A systematic literature search was conducted using ScienceDirect, ResearchGate, and Google Scholar databases for articles published between 2020 - 2025, following PRISMA guidelines. Search terms such as "Biostimulants", "Circular bioeconomy", "Hydroponic systems", "Microalgae–plant interactions" and "Nutrient recycling" were used, combined with Boolean operators (AND/OR). Twenty-five peer-reviewed English articles on microalgae-hydroponic crop interactions were selected. Findings indicate that microalgae co-culture can boost crop production, where yield increases have been reported to range between 9 - 43.7% in crops such as tomato, lettuce and cucumber. Microalgae can provide sustainability to the system in several ways such as direct release of bioavailable organic compounds (proteins, amino acids, carbohydrates) to plant roots, constant maintenance of dissolved oxygen levels through photosynthesis, recycling of nutrients with accumulation efficiencies of 86-88% of nitrogen and potassium, respectively; and the production of biostimulant compounds such as phytohormones and polysaccharides that increase stress tolerance. Recycling of effluents converts hydroponic wastewater into a nutrient-rich growth medium and produce useful microalgal biomass as biofertilizers. However, there are several obstacles that limit commercial scalability in this integrated system. The competition between autotrophic partners to maintain optimal microalgae concentrations (0.5 - 0.8 mg/mL) along with complexity of controlling environmental parameters (light intensity, pH, temperature) are such constrains and those should be optimized carefully. There are still critical research gaps in terms of long-term performance, compatibility of different crops, economic feasibility, and standardized protocols in various conditions to enable microalgae integration as an alternative towards the principles of a circular bioeconomy in controlled environment. Nevertheless, effective implementation requires species-based optimization, high-quality contamination management, and life-cycle evaluation. The next-generation studies should prioritize intelligent monitoring systems, investigation of molecular mechanisms underlying synergistic interactions, and techno-economic analyses to facilitate commercial adoption of microalgae-enriched hydroponic systems.

Keywords: Biostimulants; Circular Bioeconomy; Hydroponic Systems; Microalgae–Plant Interactions; Nutrient Recycling

ICSD26_350

THE CHALLENGES OF SWAT-BASED ASSESSEMENT OF RUNOFF AND SOIL EROSION MODELLING IN TROPICAL WATERSHEDS: A SYSTEMATIC REVIEW

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Abstract: The research assesses how the Soil and Water Assessment Tool (SWAT) operates for predicting runoff and surface erosion in tropical river drainage areas. The reviewed research examines SWAT as it demonstrates what it does best while showing its restrictions and demonstrating its strength in tropical hydrological modeling systems. The research study identified literature within the time period from 2010 to 2024 according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework using Boolean search methods on Google Scholar. The researchers analyzed relevant studies which satisfied the inclusion criteria among 89 English-language publications. The review establishes that SWAT performance in tropical river basins depends mainly upon three factors, namely climate variability and land-use changes and input data quality and model calibration and validation difficulties along with human-induced watershed modifications. The review evidence shows SWAT demonstrates strong capabilities in hydrological process and soil erosion simulation although it demands high-quality inputs together with accurate calibrations. The study demonstrates that modifications in both climate patterns and land patterns have a substantial effect on runoff behavior together with soil erosion rates. Improved access to quality data and enhanced calibration methods combined with SWAT integration of additional models will increase modeling accuracy. The research findings provide essential information for researchers and stakeholders and water resource managers who strive to create enduring watershed management programs in tropical settings. Future studies need to maximize SWAT's calibration processes while implementing advanced modeling systems for managing the current climate change and land-use issues

Keywords: Climate Variability; Hydrological Modeling; Runoff Estimation; Soil Erosion Modeling; SWAT Model; Tropical Hydrology

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RELATIONSHIP BETWEEN SALINITY STRESS CONDITION OF PLANT GROWTH, YIELD AND TASTE COMPONENTS IN TOMATO (*Solanum lycopersicum*)

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Abstract: Salinity stress is a widespread problem that has a significant impact on both productivity and quality in Sri Lankan tomato farming. In this research, we undertake a thorough investigation of the various effects of salinity stress on tomato growth, yield, and fruit characteristics. To better understand the complex relationship between salinity stress and tomato cultivation, our study explores three different treatments: the control, additional salinity stress, and excess salinity stress. There are numerous observable consequences of high salinity stress on tomato plants. Interestingly, it has a discernible effect on plant height and leaf growth, resulting in appreciable decreases in both metrics. The difficulties and limitations that salinity stress places on tomato plants' vegetative features are reflected in these effects. Nevertheless, this hardship is counterbalanced by an interesting finding: when excessive salinity stress is applied, the fruits' quality improves. Fruit quality demonstrates resilience in the face of challenging growth conditions, highlighting the complexity of the relationship between stressors and plant responses. However, the impact of salinity stress on yield is another crucial issue that this study brings to light. In this case, our results show a noticeable impact, with a reduction in yield due to excessive salinity stress. This finding highlights the precarious equilibrium that exists in agricultural systems, where maximizing fruit quality may result in a lower total yield. They offer valuable information about the intricate connection between salinity stress and tomato cultivation, information that is essential for directing sustainable farming practices in the face of escalating environmental challenges. This study essentially adds to the larger discussion about sustainable agriculture and the necessity of adaptable approaches to deal with the challenges presented by a changing global environment.

Keywords: Fruit Characteristics; Plant Height; Salinity Stress; Tomato; Yield

ICSD26_366

A SYSTEMATIC REVIEW OF DIGITAL TWIN APPROACHES FOR ENHANCING PRODUCTIVITY IN TROPICAL CONTROLLED ENVIRONMENT AGRICULTURE: ARCHITECTURES, OPTIMIZATION, AND IMPLEMENTATION GAPS

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Abstract: Intensified pressure is on global food security especially in tropics, due to rapid population increase and intensifying demand for food. However, Controlled Environment Agriculture (CEA) presents a strategic solution for this, yet its productivity is constrained by unique biophysical and economic challenges. Digital Twin (DT) technology can be identified as a transformative tool for optimizing agricultural systems, but DT applications in tropical CEA remains fragmented and insufficiently adaptable to local conditions. This systematic literature review, synthesizes 53 relevant studies and identifies and analyzes this issue through seven critical thematic areas: (1) the distinctive challenges of the tropical CEA environment, (2) a multi-dimensional analysis of productivity, (3) architectural foundations for DTs, (4) DT-driven optimization mechanisms, (5) the critical interaction between microclimate and crop models, (6) the integration of Artificial Intelligence (AI), and (7) persistent implementation challenges and technological gaps. The central finding of this study explains the applications of DT for tropical CEA to resolve the fundamental trade-off between maximizing yield and minimizing prohibitive cooling energy costs, which is a challenge less pronounced in temperate systems. In response, this paper also propose a novel conceptual framework centered on a Tropical Optimization Loop, a closed-loop, adaptive engine that leverages AI to continuously simulate, predict, and analyze scenarios, thereby making real-time decisions that optimize net economic return. The review concludes that advancing DT efficacy in the tropics requires prioritized development of tropical-calibrated models, improved data infrastructure, cost-effective modular designs, and enhanced grower capacity. This work provides a consolidated roadmap for researchers and practitioners aiming to harness DT technology for sustainable and productive tropical CEA.

Keywords: Controlled Environment Agriculture; Digital Twin; Optimization; Productivity Enhancement; Tropical Agriculture

ICSD26_367

SPECIES-SPECIFIC GROWTH RESPONSES OF MUNG AND RADISH MICROGREENS TO LED SPECTRAL COMPOSITION UNDER CONTROLLED-ENVIRONMENT CONDITIONS

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Abstract: The spectral structure of light is one of the critical productivity determinants in the field of Controlled-Environment Agriculture (CEA); however, the responses of individual species to microgreens are not fully outlined. This study evaluated the interactive effects of seven light regimes, including monochromatic red, blue, and white LEDs, two red–blue combinations, purple light, and natural sunlight, on the growth performance of mung (*Vigna radiata*) and radish (*Raphanus sativus*) microgreens cultivated under controlled conditions. The experimental design used was factorial, and phenotypic measures of plant height, fresh, and dry weights were taken at the harvest point. The statistical analysis was conducted with the help of the two-way analysis of variance (ANOVA), evaluating both the main effects and the interaction effects of light spectrum and crop species. An important effect of light quality and crop identity was recorded on the height of plants and fresh biomass ($p < 0.001$), and an interesting light x crop interaction was also found in both parameters. Spectral composition ($\eta 2$ $p = 0.54$) had a significant influence on fresh weight, but plant height was generally controlled by species variation ($\eta 2$ $p = 0.73$). The use of spectra with high red wavelengths encouraged elongation of mung microgreens, and the use of red and blue together gave the best fresh biomass compared to monochromatic blue light. In comparison, the effect of spectral treatments on dry weight was not shown to be statistically significant ($p > 0.05$), implying that the effect of illumination on tissue expansion is stronger than on structural carbon accrual. These findings demonstrate distinct species-specific spectral responses and the need to adopt crop-specific LED lighting systems to maximize productivity and resource-use efficiency of microgreen production systems.

Keywords: Controlled-Environment Agriculture; LED Lighting; Light Spectra; Microgreens; Species-Specific Response

ICSD26_370

EFFECT OF WATER DEFICIT ON THE DEVELOPMENT OF TOMATO (*Solanum lycopersicum*) FRUIT AND FRUIT QUALITY IN THE DRY ZONE OF SRI LANKA

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Abstract: Tomato *(Solanum lycopersicum L.)* is a vegetable widely consumed globally. One of the main problems of tomato cultivation is drought stress, especially in regions like Sri Lanka's dry zone. This study focused on the effects of drought stress on various aspects of tomato cultivation, including plant growth, yield, and taste components. The experiment was carried out by using the "Bathma" variety and under controlled environmental conditions, in Jaffna, Sri Lanka. Three water-stress conditions were implemented to explore the impact of water availability on tomato plants: drought, control, and excess water. Parameters collected include wet weight, dry weight, plant height, number of branches, number of leaves, fruit diameter, Brix%, pH, fruit weight, the number of fruits, and yield per plant. Drought stress had a significant negative impact on tomato plants, particularly during the 8th week of the study. At this stage, drought stress inhibited the overall growth of the plants. Moreover, leaf growth was severely affected by the drought-stressed plants. Notably, drought stress led to a decrease in both plant weight and the number of fruits produced compared to the excess water stress treatment. However, it's worth highlighting that drought stress had a limited effect on fruit quality attributes. The Brix% and pH values of the fruits in the drought stress treatment were similar to those in the control treatment, indicating that these essential fruit quality characteristics were relatively unaffected.

Keywords: Brix%; Crop Management; Drought Stress; Quality; Taste Component; Tomato

ICSD26_375

ADDRESSING DETECTION GAPS IN FUSARIUM WILT: A COMPARATIVE STUDY OF PCR AND VISUAL INSPECTION METHODS

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Abstract: Fusarium wilt, caused by *Fusarium oxysporum f. sp. cubense (Foc)*, represents a critical threat to global banana production, particularly with the emergence of Tropical Race 4 (TR4). Traditional visual inspection-based disease management misses approximately 20 - 60% of infections in field conditions. This study quantitatively evaluated the detection gap between conventional visual inspection and polymerase chain reaction (PCR)-based molecular diagnostics for Fusarium wilt in Sri Lankan banana plantations. A total of 60 banana plants were sampled from 12 smallholder farms in Anuradhapura and Monaragala districts using stratified random sampling. DNA extraction and PCR amplification targeting the *Fusarium oxysporum f. sp. cubense* translation elongation factor 1-alpha (TEF1α) gene were performed using TR4-specific primers. Visual assessments were conducted independently by two experienced evaluators without knowledge of PCR results. PCR analysis revealed that 35 samples (58.3%) tested positive for Foc infection, while 25 samples (41.7%) were negative. Among PCR-confirmed infected plants, visual inspection identified 28 plants (80.0%) showing characteristic symptoms but completely failed to detect 7 asymptomatic plants (20.0%) that tested positive through molecular diagnostics. PCR-based diagnostics achieved 100% sensitivity (95% CI: 97.1% - 100%) and 100% specificity (95% CI: 95.4% - 100%), compared to 80% sensitivity and 100% specificity for visual inspection. These asymptomatic carriers continued spreading the pathogen for 3-8 weeks before symptom development. A tiered surveillance approach combining visual inspection with systematic PCR testing at 4-6 week intervals achieves disease stabilization through early detection of presymptomatic infections and prevents 50 - 80% yield losses. Implementation of PCR-based surveillance programs with decentralized laboratory facilities and rapid molecular techniques (LAMP) is critical for resource-limited banana-producing regions. This study demonstrates that PCR-validated diagnostics provide essential early detection tools for protecting global food security and smallholder farmers' livelihoods.

Keywords: Banana (*Musa spp*.); Fusarium Wilt; Panama Disease; Polymerase Chain Reaction (PCR); Visual inspection

SUSTAINABLE MATERIALS, AGRICULTURE, AND EMERGING TECHNOLOGIES

ICSD26_013

INFLUENCE OF CELLULOSE SOURCE ON THE PROPERTIES OF CELLULOSE HYDROGELS DERIVED FROM WASTE BIOMASS: A REVIEW

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Abstract: Cellulose-based biomass hydrogels have gained significant interest due to their ability to absorb and retain massive quantities of water while maintaining their structural integrity. Studies on hydrogels illustrate that the extent of their applications depends significantly on their properties. The current study aims to identify the influence of cellulose fibre characteristics on the properties of the Cellulose-based hydrogels (CBH) derived from waste biomass sources. The impact of the cellulose source on mechanical properties; tensile strength and elongation%, water retention capacity (equilibrium water content-EWC), and viscoelastic (VE) properties of the resultant CBH from selected waste biomasses; sugarcane bagasse, agave bagasse, pineapple waste, and bamboo waste were investigated. Studies employing similar cellulose extraction methods (chemical pretreatment followed by dissolution in Lithium Chloride (LiCl)/ N, N-dimethyl acetamide (DMAc)) and physically cross-linked hydrogel formations were selected to analyse the effect of cellulose fibre characteristics minimizing methodological variations. This review reveals that bamboo and agave bagasse-based hydrogels exhibit higher tensile strength compared to those from sugarcane bagasse and pineapple waste which can be correlated to the higher fibre aspect ratios and the lower microfibril angles (MFA) of bamboo and agave bagasse cellulose fibres. The percentage elongation showed only modest variation among the four CBHs yet can be related to the fibre aspect ratio and crystallinity, inversely. Further, CBHs from sugarcane bagasse exhibit better VE properties than CBH from agave bagasse which is due to the lower crystallinity of sugarcane bagasse cellulose. The findings demonstrated that, intrinsic fibre characteristics including fibre crystallinity, aspect ratio and microfibril angle significantly influence the hydrogel properties.

Keywords: Biomass Valorisation; Cellulose Hydrogels; Mechanical Properties; Sustainable Materials; Waste Biomass; Water Retention

ICSD26_024

SUSTAINABLE UTILIZATION OF TEXTILE WASTE FLUFF FOR PRODUCTION OF BIODEGRADABLE PACKAGING MATERIAL: SYNTHESIS, CHARACTERIZATION, AND PERFORMANCE EVALUATION

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Abstract: Biodegradable packaging materials offer a sustainable solution to plastic waste pollution. This study evaluated polycaprolactone, natural rubber, gelatin, and polyvinyl alcohol (PVA) as binding agents to determine a sustainable and commercially viable composite. Each formulation was prepared by Mixing textile waste fluff with the respective binder, casting the mixtures into molds, and drying under controlled conditions to ensure uniform consistency. This process was conducted using a completely randomized experimental design with five Replicates. The biodegradability analysis showed minimal degradation in PCL composites at 1.7%, moderate in Natural Rubber at 15%, rapid in Gelatine at 76.7%, and balanced in PVA at 31.3%, indicating favorable environmental compatibility. Water absorption testing revealed minimal moisture uptake in PCL at 1.6% and in Natural Rubber at 0.9%, whereas Gelatine absorbed 121.9% of its weight, and PVA absorbed 74.9%, indicating their hydrophilic nature. Chemical solubility was evaluated using concentrated sulfuric acid, ethyl alcohol, acetone, and glacial acetic acid. The results showed that PCL and Natural Rubber were partially soluble, Gelatine was highly soluble in all solvents, while PVA exhibited moderate solubility, confirming acceptable chemical stability. Mechanical analysis using the Universal Testing Machine (UTM) demonstrated that PCL composites possessed the highest tensile strength of 9.02 MPa with limited elongation of 5.9%. Natural Rubber showed a lower tensile strength of 3.14 MPa but exhibited superior flexibility with 78.8% elongation. Gelatine composites were weakest with 2.28 MPa and 22.7% elongation, while PVA composites achieved 8.56 MPa and 16.8% elongation, providing the best overall mechanical balance among all materials. FTIR analysis confirmed O–H, C–H, C=O, and C=C functional groups, while SEM revealed uniform surface morphology and structural degradation patterns in the composites. Overall, the PVA–fluff composite achieved optimal performance, proving to be the most promising formulation for cost-effective, biodegradable, and sustainable packaging applications aligned with the circular economy.

Keywords: Biodegradable Packaging Materials; Circular Economy; Textile Fluff; Waste Upcycling

ICSD26_025

CROSS BREEDING AND CULTURING OF FIVE DIFFERENT COLOUR OF *"Neocaridina davidi"* SHRIMP, TO GET COMMERCIAL PROFIT AND TO DEVELOP NEW COLOURS

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Abstract: *Neocaridina davidi*, commonly known as aquarium shrimp, is widely favoured in the ornamental aquaculture industry due to its diverse body coloration and ease of breeding. This species typically reaches a maximum length of 3 – 4 cm, with females generally larger than males as a result of egg carrying and protection until hatching. In the aquarium trade, egg-bearing females are commonly referred to as "berried." Successful breeding of *N. davidi* is strongly dependent on maintaining optimal water quality and tank conditions. The market value of *N. davidi* varies according to body coloration. Red cherry shrimp are sold at relatively low prices, whereas blue, yellow, orange, and black colour morphs command higher commercial value. Consequently, cross-breeding strategies are frequently employed to enhance offspring coloration and increase economic returns. The present study was conducted between August and November 2023 to evaluate the commercial viability of selective breeding in *N. davidi* shrimp culture. Shrimp were cultured in nine experimental tanks, including one control tank. The control tank contained two pairs of red cherry shrimp, while the remaining tanks consisted of cross-breeding combinations between red cherry shrimp and high-value colour morphs (male or female). Water quality parameters were monitored throughout the experimental period, with the exception of temperature and dissolved oxygen (DO). A gradual decline in DO levels was observed and was primarily attributed to elevated tank temperatures. Crosses between red cherry shrimp and orange- and yellow-coloured shrimp resulted in offspring displaying stable orange and yellow coloration, indicating strong commercial potential. In contrast, crosses involving blue velvet and black rose shrimp produced a wide range of colour variations, including wild-type forms, reducing their economic suitability. Overall, the results indicate that targeted selective breeding of *N. davidi*, supported by proper environmental management, can reliably improve colour quality and commercial profitability in ornamental shrimp aquaculture.

Keywords: Aquarium shrimp; *Neocaridina davidi*; Red Cherry Shrimp; Water Quality.

ICSD26_101

ENHANCED DIABETIC RETINOPATHY DETECTION USING SWIN TRANSFORMER WITH CLAHE AND SMOTE: IMPROVING ACCURACY AND CLINICAL INTERPRETABILITY

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Abstract: Diabetic retinopathy (DR) continues to contribute substantially to vision impairment worldwide, particularly within the diabetic population, underscoring the critical need for precise and timely diagnosis to prevent vision loss. This study proposes integrating the Swin Transformer, a recent vision-transformer architecture that organizes attention through a multi-scale, shifted-window mechanism, into the DR detection pipeline. The model integrates the Swin Transformer's ability to model fine-grained and broad spatial patterns with preprocessing steps like CLAHE for contrast enhancement and SMOTE for balancing underrepresented classes for addressing class imbalance the model significantly enhances classification accuracy and robustness. Experimental evaluation on publicly available retinal fundus image datasets demonstrates that the Swin Transformer-based approach demonstrated superior performance compared with standard CNN architectures, reaching approximately 97% accuracy on the evaluated datasets, along with high sensitivity and specificity in identifying DR severity stages. The generated attention visualizations help clarify which retinal regions most influenced the model's predictions. This research evidences that employing Swin Transformer models in automated DR screening can facilitate earlier, more reliable diagnosis, thereby promoting improved patient outcomes and supporting clinical decision-making.

Keywords: Deep Learning; Diabetic Retinopathy; Fundus Images; Medical Image Classification; Swin Transformer

ICSD26_111

A SYSTEMATIC REVIEW OF CRISPR-CAS-MEDIATED GENOME EDITING FOR DEVELOPING CLIMATE-RESILIENT CROPS: A FOCUS ON YIELD STABILITY UNDER DROUGHT AND SALINITY STRESS

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Abstract: Climate change is one of the primary challenges in global food production, drought and salinity as the main abiotic stresses, reducing crop yield and threatening world food security. The rapid progress in CRISPR-Cas-based genome editing provides a valuable and robust technique for the generation of climate-resilient crops with an emphasis on making changes to crucial genes responsible for adaptation to stress. The mechanism of CRISPR-based genetic tolerance to increase yield stability under on-farm agricultural conditions has not been fully understood. In this review, discuss the recent progress in applying CRISPR-Cas technology toward improving crop yield and stress tolerance. Studies that were published between 2019 and 2025 were searched from Scopus, Web of Science, and PubMed with inclusion criteria. The results of this study suggested that the drought resistance and salt tolerance of plants could be effectively improved by CRISPR-based editing system through targeting OS, ABA signaling-related genes, antioxidant-regulated genes, and ion homeostasis-regulated genes, which led to increased plant water-use efficiency and maintained productivity under unfavorable environmental conditions. Among these, cereal plants such as rice and wheat have exhibited notable advancements in photosynthetic stability, root system establishment, and alleviation of oxidative damage under stress. However, the majority of studies are conducted in controlled environments and greenhouse conditions and require further validation to be applicable for field conditions. The heavy reliance on single gene knockouts limits the applications of CRISPR systems to their maximum. Advanced editing approaches, including multiplex editing and base editing have largely been ignored. In conclusion, although there is great promise in applying CRISPR-Cas to crop genome editing for producing climate-resilient plants, a huge gap between laboratory-based results and field applications needs to be narrowed. Its validation in the field, integration with other traits, and sustainable delivery systems are priorities for future research to ensure operability under stress climate.

Keywords: Climate-Resilient Plants; CRISPR-Cas; Food production; Genome editing

ICSD26_232

EXTRACTION AND CHARACTERIZATION OF CELLULOSE FROM PINEAPPLE LEAVES, CORN COBS, AND BAMBOO STEMS FOR SUSTAINABLE MATERIAL APPLICATIONS

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Abstract: Lignocellulosic biomass is a highly renewable, low-cost and high-cellulose source; however, Lignocellulosic biomass has complex interactions between hemicellulose and lignin, which require rigorous extraction and purification procedures. and purification measures. A consistent sequence of protocols for isolating and characterizing cellulose involving hot water treatment (HWT), alkali treatment (AT), bleaching (BT), and acid hydrolysis (ACT) was developed in the current study on the isolation and characterization of cellulose in three agro-industrial residues, including bamboo stems, corn cobs, and pineapple leaves. Analysis of chemical composition indicated that the structural attributes of each of the raw materials were unique. In particular, the content of cellulose in the pineapple leaves was maximum, the hemicellulose ratio in the corn cobs was the largest, and the content of lignin in bamboo was also the highest. A significant interaction effect between treatment modality and the type of plant material was also found, as the yield of cellulose recovery had a variation in relation to its source of biomass. Yield evaluations proved that the sequence of treatment and provenance of biomass had a great impact on cellulose recovery. As the non-cellulosic fractions, hemicellulose and lignin, were removed in a progressive manner, Fourier-transform infrared spectroscopy confirmed that the ACT samples did not have any non-cellulosic absorbance signature but had strong cellulose-specific bands. The results of X-ray diffraction showed that crystallinity increased after acid hydrolysis, thus confirming the effective extraction of crystalline cellulose sub-structures. Subsequent stereomicroscopic assessment after treatment also indicated the reduction of surface defects and improvement in the consistency of the fibers. This research, in total effects, highlights the viability of the previously underutilised biomass materials in usage in biocomposites, nanocellulose materials and sustainable packaging and demonstrates the effectiveness of combining both chemical and mechanical pretreatments to produce high-purity cellulose.

Keywords: Acid Hydrolysis; Agro-industrial Residues; Cellulose Extraction; Crystalline Cellulose; Lignocellulosic Biomass

ICSD26_235

BROAD-SPECTRUM BIO-INOCULUM FOR ENHANCED SOIL HEALTH AND FERTILITY

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Abstract: The dependence on chemical fertilisers in Sri Lanka has resulted in high cost of production and the degradation of soil health across agro-ecosystems. Sustainable alternatives that restore soil functionality while maintaining crop productivity are urgently needed. This study aimed to develop and evaluate a broad-spectrum bio-inoculum for sustainable agricultural applications. Therefore, soil microbiomes from organically managed agricultural fields were comprehensively profiled, and functionally beneficial microbial taxa were identified for formulation into a biofertiliser suitable for use across diverse agro-ecological systems. Soil bacterial community composition was characterised using metabarcoding sequencing, revealing a diverse community comprising 636 bacterial genera, with *Bacillus*, *Staphylococcus*, *Bradyrhizobium*, *Streptomyces*, and *Burkholderia* accounting for 62% of total sequences. Network-based interaction analysis was employed to identify bacterial species exhibiting high abundance (>1000), broad spatial distribution, and complementary plant growth-promoting traits. Based on functional attributes and co-occurrence patterns, a compatible consortium consisting of *Bacillus megaterium*, *Bacillus aryabhattai*, and *Bacillus flexus* was selected and immobilised in a rice-husk biochar matrix to enhance microbial survival and delivery. Functional assays confirmed the consortium's capacity for atmospheric nitrogen fixation, inorganic phosphate solubilisation, and mutual compatibility. Greenhouse experiments using *Lactuca sativa* demonstrated that biofertiliser application, particularly when combined with reduced chemical fertiliser inputs (30% DOA recommendation), significantly improved plant biomass (39.98 ±3.83x10-3 kg), leaf number (12 ± 1), and nutrient uptake compared with chemical fertilizer (100% DOA recommendation) only treatments with lower biomass (19.13 ± 6.12 x 10-3) and less leaves (8 ± 1 leaf count). Biofertiliser treated soils exhibited enhanced total organic carbon, improved nitrogen retention, and greater phosphorus utilisation, reflecting improved soil nutrient dynamics and microbial activity. Overall, the results demonstrate that the functionally designed, bioencapsulated microbial consortium can enhance soil health, nutrient-use efficiency, and crop performance while reducing reliance on synthetic fertilisers. The developed broad-spectrum bio-inoculum represents a scalable and ecologically sustainable solution for improving soil fertility and agricultural resilience in Sri Lanka and similar tropical agro-ecosystems.

Keywords: Agro-ecosystems; Bio-inoculum; Fertiliser; Microbial Community

ICSD26_279

IDENTIFICATION OF SEASONAL WEATHER AND SOIL CHEMICAL PARAMETERS INFLUENCING RICE PRODUCTIVITY IN DRY ZONE SRI LANKA

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Abstract: Rice cultivation of Dry Zone Sri Lanka, plays an important role in national food security. But the rice productivity remains highly vulnerable to seasonal climate variability and changes in soil chemical conditions. Therefore, identification of weather fluctuations that interact with soil chemical properties across cropping seasons is essential for sustaining rice production in this climate-sensitive region. This study focused to (I) identify the key seasonal weather parameters affecting the productivity (II) analyse soil chemical properties controlling rice productivity including soil available nitrogen, phosphorus, potassium, soil pH, and electrical conductivity during the Yala and Maha cultivation seasons. Long-term weather and rice productivity data (1995 – 2025) were analysed together with one year (2024 – 2025) analysed soil data and four years (2020 - 2024) literature soil data using correlation analysis and analysis of variance. The included meteorological variables were rainfall, number of rainy days, temperature, sunshine hours, and relative humidity. According to the analysed productivity trends the Maha season rice yield was approximately 10 – 15% higher than the recorded yield during the Yala season, with typical productivity ranging between 3.5 – 6.2 MT/ha across major rice-producing Dry Zone areas. Strong negative correlations were observed between rice productivity and average temperature (r = -0.91 to - 0.92) and number of rainy days (r = -0.82 to -0.85) in both seasons, indicating significant sensitivity to thermal stress and excessive moisture conditions. In contrast, relative humidity showed a moderate positive association with productivity (r = 0.51 - 0.52), while sunshine hours exerted a negligible influence. Soil chemical analyses revealed that Dry Zone paddy soils generally exhibited pH values ranging from 6.3 to 8.0 and electrical conductivity levels typically below 1.5 dS/m, with episodic increases associated with irrigation-induced salinity stress. Seasonal nutrient dynamics were characterised by low to moderate availability of nitrogen (NH_4^+/N: 0.4 - 0.7 mg kg^{-1}), phosphorus (PO_4^{3-}/P: 0 - 4.0 mg kg^{-1}), and potassium (K^+: 70 – 100 mg kg^{-1}), reflecting strong sensitivity to rainfall intensity, flooding conditions, and temperature-controlled redox processes. According to the analysis of variance, there is a statistically significant influence on rice productivity by seasonal weather parameters ($p < 0.001$). The rice productivity of Dry Zone is influenced by the close interaction between climate and soil chemical conditions, indicating the importance of climate-responsive and soil-informed seasonal management for sustaining the productivity.

Keywords: Rice Productivity; Seasonal Climate Variability; Soil Chemical Properties; Soil Nutrient Dynamics

ICSD26_297

DEVELOPMENT OF A LATEX-STABILIZED COCO PEAT–COMPOST CARRIER MEDIUM FOR *Trichoderma harzianum* BIOFUNGICIDE PRODUCTION

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Abstract: The widespread use of chemical fungicides to control soil-borne plant pathogens presents economic, environmental, and health challenges, highlighting the need for sustainable biological alternatives. *Trichoderma harzianum* is a well-organized biocontrol agent and its efficacy as a biofungicide depends on identifying suitable carrier media that support fungal growth, viability, and ease of application. This study evaluated a low-cost, eco-friendly carrier medium composed of coco peat, natural rubber latex, and compost to promote the growth and survival of T. *harzianum*. Coco peat blocks were manually prepared with varying proportions of natural rubber latex (16–24 g rubber equivalent per 100 g coco peat) and compost (0, 3, and 15 g), eliminating high-pressure mechanical compression. Nine treatment combinations were assessed under laboratory conditions. Substrate blocks were inoculated with a spore suspension of T. *harzianum* (3×10^8 spores mL^{-1}), and fungal viability was monitored over a 30-day incubation period using colony-forming unit (CFU) counts. Results showed that rubber latex functioned as an effective natural binding agent, producing structurally stable blocks suitable for handling. The addition of compost significantly enhanced fungal establishment, sporulation, and population density compared to coco peat–rubber substrates without compost. The highest fungal viability (73,333 CFU g^{-1} at day 30) was achieved in the treatment containing coco peat:compost:rubber at a ratio of 85:15:16 (T7). Excessive rubber content negatively affected block texture without improving fungal growth. These findings demonstrate that latex-stabilized coco peat–compost blocks represent a promising, economical, and environmentally friendly carrier for T. *harzianum*. The medium supports biofungicide production, offers cost-effectiveness, and provides environmental benefits. This approach is particularly suitable for small-scale and resource-limited agricultural systems. Further research is recommended to evaluate long-term shelf life and field-level biofungicidal efficacy.

Keywords: Biological Control; Fungal Antagonists; Low-cost Formulation; Mycelial Growth; Sustainable Agriculture

CIRCULAR ECONOMY AND WASTE-TO-VALUE INNOVATIONS FOR INDUSTRY - II

ICSD26_014

ADVANCING BIO-BASED WASTEWATER TREATMENT SYSTEMS FOR SUSTAINABLE RESOURCE RECOVERY: A SYSTEMATIC REVIEW

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Abstract: The growing interest in bio-based wastewater treatment technology has been occasioned by the increasing concern of sustainable water management as alternatives to the chemical and mechanical technologies that are considered to be environmentally safe. Traditional wastewater treatment consumes 3% - 4% of the global energy and produces about 300 million tons of CO_2 equivalents annually, which explains the fact that more and more attention is paid to finding solutions that are environmentally friendly. The purpose of this review is to identify the performance and effectiveness of bio-based wastewater treatment systems in terms of sustainability. 20 peer-reviewed articles (2008 - 2023) were shortlist on the PRISMA basis through the databases such as Google Scholar and ResearchGate. Keywords included bio-based wastewater treatment, constructed wetlands, microbial fuel cell, algal bio reactors, and biochar filtration. Studies were excluded when they were not relevant to bio-based wastewater treatment, contained no original data, or did not mention pollutant removal, sustainability, or resource recovery. Bio-based and hybrid systems are highly effective in removing organic contaminants, nutrients, and metals, while also recovering energy, biofertilizers, and biofuels. Microbial Nitrogen cycling involves the microbial-mediated process, which is augmented by bioaugmentation, synthetic consortia, and genetic engineering contributes significantly to nutrient removals. Advanced technologies, including AI, metagenomics, nanotechnology, and bio-electrochemical systems, contribute to an increase in the efficiency of the treatment process, stability, and cyclic recovery of resources. Bio-based approaches have an opportunity to reuse up to 50 billion m^3 of water each year and save about 20 TWh of energy because of comparing it with conventional methods. Constructed wetlands are nature-based decentralized systems, which provide cost-effective and environmentally-friendly solutions but encounter issues of process instability and energy efficiency. The focus of future studies should be on hybrid, digitally enabled bio-based wastewater treatment systems, advanced microbial consortia engineering, life-cycle assessment, supportive policies, and enhanced academia-industry partnership around the world, sustainably. In conclusion, bio-based wastewater treatment is a sustainable process of management with low carbon and cyclical perspectives of water management and high chances of great mass usage.

Keywords: Bio-based Wastewater Treatment; Constructed Wetlands; Microbial Fuel Cells; Nanotechnology; Resource Recovery; Sustainability

ICSD26_039

SYNTHETIC BIOLOGY DRIVEN BIODEGRADATION FOR WASTE MANAGEMENT AND ENVIRONMENTAL SUSTAINABILITY: A COMPREHENSIVE REVIEW

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Abstract: Plastic pollution has become one of the most dominant environmental crises of the 21st century, posing serious impact to ecosystems, marine biodiversity, and human health. Like many other developing countries, Sri Lanka faces growing challenges in non-effective waste segregation systems and limited plastic recycling infrastructure have intensified microplastic contamination in terrestrial and aquatic environments. Accordingly, based on the PRISMA 2020 guidelines, reports were identified following pre-determined search data from Google Scholar, ResearchGate, and PubMed from 2010 to 2025. Ultimately, 210 studies were selected for qualitative analysis. This review discusses effective and scalable solutions for plastic waste degradation using direct biotechnology and environmental biotechnological approaches. Key synthetic biology approaches, including the engineering of biocatalytic enzymes such as PETase, MHETase, and laccases, optimization of microbial consortia, and metabolic pathway engineering for the conversion of plastic-derived monomers into value-added products. Engineered microorganism such as *Ideonella sakaiensis*, *Pseudomonas putida*, and *Bacillus subtilis* have optimized the conversion of PET monomers into valuable substances such as bioplastics (PHA), vanillin, and adipic acid more efficiently. Furthermore, advances in biocatalytic enzyme stabilization and nano-biocatalyst systems have enabled PET degradation up to 95% under controlled bioreactor conditions, which highlighting strong industrial applicability. This review further summarizes recent progress in completing CRISPR-based microbial pathways, biosecurity tools, and policy codification for the responsible deployment of engineered microorganisms. Through an integrated perspective, this paper identifies how synthetic biology can be aligned with the United Nations Sustainable Development Goals (SDGs) 12, 13, and 15, promoting responsible production and consumption, climate action, and the protection of terrestrial ecosystems in a way that can influence environmental management in Sri Lanka and globally.

Keywords: Biodegradation; Environmental Biotechnology; PETase; Sustainable Development Goals; Synthetic Biology; Waste Management

ICSD26_070

EFFECT OF ANIMAL FAT ON ANAEROBIC CO-DIGESTION AND PROCESS OPTIMIZATION

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Abstract: One of emergent challenges in meat processing industries is producing biogas with animal waste incorporated high-fat characterized wastewater. This study has been focused on studying the effect of animal fat (poultry) on anaerobic co-digestion and process optimization by means of food waste as the co-substrate and cow dung (CD) as the inoculum by considering the trend of biomethane production. A series of batch fermentations were carried out in a lab-scale batch reactor (> 500 mL) based on the VDI 4630 protocol. One control batch experiment was conducted with inoculum alone and five other different co-digestion experiments were implemented in triplicates with the proportions of rendered poultry fat emulsion : food waste at 0:100, 25:75, 50:50, 75:25, 100:0 (w/w) in the presence of inoculum. The proportion of substrates to inoculum was 100:300 (w/w) in all experiments. Each co-digestion was implemented for four (4) days continuously under the mesophilic (35 °C) condition and at 200 rpm of mixing speed by ensuring the continuous mixing within the batch reactor. The highest total biogas potential was achievable with co-digestion experiments incorporated with high quantity of food waste (0:100, 25:75) with a sudden process failure of post acidification and with minimal organic material conversion rate (mL/ $gCOD_{removal}$) even though experiments utilized relatively high quantity of fat emulsion were represented relatively low total biogas production without any sudden failure of the process with high organic material conversion rate. Highest pH reduction with high TCOD and volatile solid removal efficiencies were represented by high quantity food waste incorporated batch experiments. The most viable feedstock proportion was 50:50, w/w among the batch experiments incorporated with food waste pertained to the limited pH drop of the feedstock mixture. The other satisfactory fermentation was the co-digestion of animal fat associated with inoculum without using any food waste (100:0) which produced continuous biomethane production with a fairly high rate of organic material conversion.

Keywords: Anaerobic Digestion; Animal Fat Inhibition; Biochemical Methane Potential; Co-digestion; Process Optimization

ICSD26_081

HEALTHCARE WASTE MANAGEMENT PRACTICES: A SYSTEMATIC REVIEW OF TRENDS AND CHALLENGES IN SAFE AND SUSTAINABLE MEDICAL WASTE HANDLING

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Abstract: Healthcare waste management (HCWM) is crucial for environmental sustainability and public health due to the increasing generation of infectious, chemical, and pharmaceutical wastes from healthcare facilities. According to the WHO, about 85% of healthcare waste is non-hazardous, while the remaining 15% is hazardous, containing infectious, toxic, or radioactive materials. Improper segregation, collection, and disposal can lead to severe environmental contamination and disease transmission. Safe and sustainable HCWM practices are therefore essential to minimize health and ecological risks associated with medical waste. The purpose of this systematic review is to investigate the trends and challenges in the safe and sustainable handling of medical waste. Using the PRISMA protocol, (a) identify global trends and existing practices in healthcare waste management, (b) analyze the challenges faced in implementing safe and sustainable HCWM systems, and (c) highlight emerging strategies and technologies for improving medical waste treatment. The review was based on 45 peer-reviewed articles published between 2010 and 2025 that were selected from databases including PubMed, ScienceDirect, Scopus, and the WHO library, with keywords such as "healthcare waste management," "medical waste segregation," "safe disposal," "sustainable treatment technologies," and "environmental impact." The review evaluates waste segregation practices, treatment and disposal technologies, and challenges such as regulatory compliance, staff training, and infrastructure limitations. Results show that while advances in alternative treatment technologies (such as autoclaving, microwave, and chemical treatments) offer potential sustainable possibilities, poor segregation and inappropriate disposal contribute significantly to environmental pollution and occupational health concerns. The review also identifies obstacles that prevent the implementation of best practices in low- and middle-income nations, such as lack of awareness and resource limitations. Standardized procedures, improved training initiatives, green technology investments, and legislative changes are some of the suggested tactics to increase HCWM sustainability. The critical need for integrative strategies to improve healthcare waste management, lessen health risks, and lessen environmental impact is highlighted by this review.

Keywords: Environmental Sustainability; Healthcare Waste Management; Infection Control; Medical Waste; Waste Treatment Technologies

ICSD26_128

UPCYCLING BREWER'S SPENT YEAST FOR FLAVOR ENHANCEMENT: A CIRCULAR ECONOMY APPROACH

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Abstract: Brewer's spent yeast (BSY), a by-product of the brewing industry, is a rich source of glutamic acid, nucleotides and peptides. Yet in Sri Lanka BSY is discarded, due to its high moisture content and perishability. Owing to the inherent biochemical composition, converting BSY into a natural flavor enhancer drives a sustainable strategy to reduce waste and to enhance resource efficiency in the food industry. The study explored the production of concentrated brewer's spent yeast extract (CBSYE) derived from *Saccharomyces pastorianus* and evaluated its flavor enhancing potential relative to monosodium glutamate (MSG). Debittering of yeast was optimized using a full factorial design across pH levels 7 - 12, and time 30 – 120 min. At 24 ^{0}C, pH 10 with a treatment time of 30min was found to remove bitterness effectively, protecting the natural flavor profile. Autolysis was performed at 50 ^{0}C for 60 hrs at pH 5.5 with 0.03%(w/v) salt concentration to release intracellular flavor compounds, followed by concentration. Vegetable broths were the carrier systems throughout the sensory evaluation. Samples prepared with the addition of CBSYE and MSG were assessed for umami intensity, saltiness, mouthfeel and overall intensity using a 9 - point hedonic scale. CBSYE exhibited superior umami intensity & mouthfeel compared to MSG, and a preference ranking test revealed that no significant difference in overall preference for CBSYE and MSG as flavor enhancers (Wilcoxon signed-rank test, $p = 0.141$). The FT-IR spectroscopy confirmed the presence of glutamate related functional groups in CBSYE, with matching peaks to that of MSG at 3100 - 3400 cm^{-1} (N-H, O-H stretching) and 2956 cm^{-1} (C-H stretching). CBSYE also exhibited peaks at 1403 - 1327, 1242, and 1072 cm^{-1} which indicates nucleotide phosphates and peptides contributing to mouthfeel. Lastly yield analysis showed that BSY can be efficiently repurposed into a stable, concentrated extract with favorable sensory outcomes, and it outlined a circular economic approach, valorizing brewery waste into a high-value ingredient.

Keywords: Brewer's Spent Yeast Extract: Circular Economy; Flavor Enhancer: Glutamate: Umami; Upcycling

ICSD26_192

BIO-BASED RECYCLING SYSTEMS FOR PLASTIC WASTE REDUCTION: A REVIEW

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Abstract: Worldwide plastic production increased from 311 to 368 million tonnes between 2014 and 2019. Projections estimate that 12 billion tonnes of waste will be accumulated by 2050. This review evaluates emerging bio-based recycling technologies and their potential contribution to circular economy frameworks. A systematic literature review of peer-reviewed articles, patents, and industrial reports from 2014 to 2025 is presented, which categorized the technologies into the microbial degradation processes, enzymatic depolymerization, and bio-integrated chemical recycling. Technologies were ranked according to published life-cycle assessment data, which included greenhouse gas emissions, energy use, and material recovery rates. A promising approach is enzymatic recycling, which can depolymerize PET at 30 – 70 °C with an efficiency of up to 97.5%, whereas thermal methods need 200 °C + . The first commercial plant (50 000 tonnes/year) is under construction in France for 2026. Microbes work better on newer bioplastics like poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), which reaches 80% degradation in a year at 30 °C in seawater, while conventional Polyethylene terephthalate (PET) barely budges with low-crystallinity types achieving only 17% after six weeks. Biochemical systems recover 85 - 95% of monomers from polylactic acid (PLA), polyhydroxyalkanoates (PHA), and polybutylene succinate (PBS). There are substantial environmental benefits, such as 30 - 45% less greenhouse gases, 60% of raw material savings, and a reduction in energy consumption of 15 - 25%, compared to producing virgin polymers. Hybrid bio-chemical systems also provide an extra 20 – 35% lowering in energy requirement. Issues, including slow degradation kinetics (2 - 12 months), the instability of the enzyme imposed above 40% polymer crystallinity, need to implement separate waste management for infrastructure, and high capital costs ($15 - 30 million). Despite these difficulties, technology functions on an industrial scale. This assessment shows that bio-based recycling is industrially viable, which, in combination with upgraded separation systems as well as decarbonized energy and supportive policy frameworks, can significantly contribute to circular economy objectives while complementing reduced production of virgin plastic.

Keywords: Bio-Based Recycling; Chemical Recycling; Circular Economy; Enzymatic Depolymerization; Life Cycle Assessment; Microbial Plastic Degradation

ICSD26_292

APPS TO ACTION: HOW ENVIRONMENTAL AND DIGITAL LITERACY DRIVE CIRCULAR ECONOMIC BEHAVIOR

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Abstract: Digital green applications are increasingly recognized as important digital tools for advancing circular economy practices and promoting resource-efficient, low-waste systems. Despite their growing availability, individuals' adoption and sustained engagement with such applications remain uneven, limiting their contribution to circular economic behavior. Addressing this challenge, the present study develops and empirically tests a parsimonious behavioral model explaining circular economic behavior through environmental literacy, digital literacy, and green application engagement. Building on the Technology Acceptance Model and the Theory of Planned Behavior, the study proposes that environmental literacy enhances the perceived usefulness of green digital applications. Technology-related perceptions are expected to influence attitudes toward green app use, which together with social norms drive intention to use green applications. Intention is subsequently converted into actual circular economic behavior through sustained green application engagement. The study adopted a quantitative, descriptive cross-sectional design, drawing on survey data from respondents exposed to green digital applications. The proposed conceptual model was empirically tested using structural equation modeling to examine both direct and mediating relationships among the constructs. The results demonstrate that environmental and digital literacy significantly influence technology acceptance beliefs, which in turn shape attitudes and intentions toward green app use. Furthermore, green application engagement emerges as a key behavioral mechanism through which usage intention is translated into observable circular economic behavior. The study contributes to the circular economy and sustainability literature by empirically integrating literacy-based antecedents into technology acceptance processes and by highlighting engagement as a critical link between intention and behavior. From a practical perspective, the findings underscore the importance of strengthening environmental and digital literacy and designing user-centered green applications to support effective university–industry initiatives aimed at accelerating the transition toward a circular economy.

Keywords: Circular Economic Behavior; Digital Green Applications; Digital Literacy; Environmental Literacy; Technology Acceptance Model (TAM)

CLIMATE-SMART AGRICULTURE AND AGRI-TECH INNOVATIONS - II

ICSD26_020

AI-DRIVEN SMART INFRARED DRYING SYSTEM FOR CLIMATE-RESILIENT SPICE PROCESSING

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Abstract: Climate change has significantly impacted the drying process of spices such as cardamom, cloves, and pepper, reducing their quality and market value. This project introduces an AI-driven infrared drying system to overcome these challenges by integrating far infrared (FIR) heaters (500 W – 2000W), centrifugal fans for enhanced hot air circulation, and reflective walls to maximize heat absorption. The system utilizes moisture sensors (DHT22, AS7263 NIR) and an infrared thermal camera (FLIR Lepton 3.5), connected to a microcontroller (ESP32/Raspberry Pi) for real-time moisture detection. A Random Forest regression model dynamically adjusts heater power and fan speed to optimize drying efficiency while preventing over-drying and under-drying. The system is also equipped with a cloud-based dashboard for remote monitoring and control, ensuring ease of operation and scalability. Performance tests confirm that the system significantly reduces drying time, enhances spice quality, and minimizes energy consumption compared to traditional drying methods. By improving process reliability and reducing manual intervention, this cost-effective and sustainable drying solution enables farmers and industrial producers to consistently achieve high-quality dried spices, increasing their profitability and resilience against climate-related drying challenges.

Keywords: AI-driven Drying System; Climate Resilience; Energy-Efficient Drying; Infrared Heating; Moisture Monitoring; Spice Processing

ICSD26_032

ACOUSTIC FREQUENCY-BASED DETECTION OF RED COCONUT BEETLES INSIDE COCONUT TREES

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Abstract: The red palm weevil (*Rhynchophorus ferrugineus*) is a destructive pest that severely threatens coconut trees by tunnelling into their trunks, often leading to irreversible damage and crop loss. Early detection is crucial for effective pest management, as infestations are difficult to identify through visual inspection. This study presents an acoustic frequency-based detection system that captures and analysis the characteristic sound signatures of red palm weevils inside coconut trees. Using sensors and wireless communication, the system distinguishes pest activity from environmental noise and transmits real-time alerts to a central device. A web application provides farmers with an accessible monitoring platform, enabling timely intervention and large-scale plantation management. The scalable sensor network allows simultaneous monitoring of multiple trees, offering a proactive solution to reduce economic losses while supporting sustainable agricultural practices.

Keywords: Acoustic Detection; IoT-Based Monitoring; Pest Management; Red Palm Weevil; Smart Agriculture; Wireless Sensor Networks

ICSD26_202

AWARENESS, BEHAVIOUR, AND BARRIERS TO SUSTAINABLE WASTE DISPOSAL AMONG UNIVERSITY STUDENTS IN SRI LANKA

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Abstract: Global waste generation has increased rapidly in recent decades, creating significant environmental and public health challenges. In such a case university students play a crucial role in promoting sustainable waste management, as their behaviors and attitudes can significantly influence campus-wide environmental practices. This study investigates awareness, behavioral patterns, and barriers related to the use of recycling bins among university students. A quantitative descriptive survey was conducted among 190 undergraduate students from multiple faculties and universities through an online questionnaire comprising demographic and thematic sections that examined students' awareness, behaviors, and barriers related to recycling bin usage. Findings revealed high awareness (87%) of recycling bin purposes, yet inconsistent participation, with 58% of respondents recycling only "sometimes." Bins were concentrated near canteens and hostels, while academic areas were underserved. The most cited barrier was unclear labelling, followed by inconvenient bin placement and inadequate maintenance. Although students demonstrated strong pro-environmental attitudes, systemic and infrastructural issues limited regular recycling. Preferred engagement strategies included social media campaigns, workshops, and reward-based initiatives. The study highlights a pronounced intention–behavior gap driven by structural deficiencies rather than lack of awareness. Improving bin visibility, labelling, and distribution, coupled with educational programs and motivational incentives, could significantly enhance recycling consistency. Universities should integrate environmental education with improved infrastructure and participatory initiatives to foster a culture of sustainable waste management.

Keywords: Behavioral Barriers; Environmental Awareness; Recycling Behavior; Sustainable Consumption; University Students; Waste Management

ICSD26_204

A DEEP LEARNING-BASED EARLY DETECTION OF POTATO DISEASE

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Abstract: Agriculture is a primary source of revenue and employment in Sri Lanka. In Sri Lanka, a considerable amount of potato is grown to meet the local demand. However, the crop's maximum harvest reduces due to diseases such as early blight and late blight. Currently, farmers identify these diseases when they have become more widespread and the yield loss caused by it is at around 21.8%. In order to overcome this, a potato disease prediction system was developed as a mobile responsive web application. The system uses a deep learning approach, specifically a Convolutional Neural Network (CNN) model, to classify potato leaves as healthy, early blight or late blight. The proposed model was trained and evaluated on a dataset taken from 'Kaggle' comprising 2156 potato leaf images labelled as healthy, early blight and late blight. CNN architecture outperformed conventional machine learning baselines, with a test accuracy of 99%. This system serves as a precautionary step to identify plant healthiness early and suggest appropriate remedies. The developed system accurately classifies diseases with high accuracy. This solution offers a user-friendly platform for early disease detection, reducing crop spoilage and financial loss for farmers by suggesting remedies.

Keywords: CNN; Early Blight; Late Blight; Potato Disease

ICSD26_209

FARMER ADSORPTION OF CLIMATE SMART AGRICULTURAL PRACTICES IN PUSSELLAWA, SRI LANKA

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Abstract: Smallholder farming systems in mid-elevation areas of Sri Lanka are increasingly vulnerable to climate variation, mainly irregular precipitation and varying seasonal patterns. In Pussellawa, a farming land near Doluwa in the Kandy District, these variations have created challenges for crop production, water managing, and farm sustainability. This study expected to evaluate the level of adoption of selected climate-smart agricultural (CSA) practices among smallholder farmers and to find the important factors influencing their adoption. The study employed a field-based survey method. Key data were collected from 40 farmers using a structured survey, while direct field explanations were carried out to prove the implementation of reported practices. The CSA performs observed included mulching, mixed cropping, drip irrigation, and the use of drought-tolerant seed variations. Descriptive statistical study was used to summarize adoption levels and perceived barriers. The results show that adoption levels vary considerably among practices. Mulching was the most commonly adopted practice, with 60% of farmers using it often in vegetable schemes and home gardens. Mixed cropping was practiced by 48% of farmers, mostly to progress soil moisture retention and decrease pest incidence. In contrast, adoption of drip irrigation was low (15%), mainly due to high installation costs. Only 25% of farmers reported using drought-tolerant seed variations in at least one cropping season. Main constraints to CSA adoption included unpredictable precipitation (70%), imperfect access to agricultural extension services (55%), and the high cost of new inputs (40%). The study concludes that farmers in Pussellawa show a favorite for low-cost, familiar, and simply manageable climate-smart practices, while adoption of investment- and knowledge-intensive technologies remains limited. Strengthening extension facilities, improving access to inexpensive irrigation technologies, and promoting appropriate drought-tolerant crop variations could enhance the wider adoption of climate-smart agriculture, thereby improving farm resilience and sustainability in mid-elevation areas of Sri Lanka.

Keywords: Climate Smart Agriculture; Farmer Adoption; Pussellawa; Smallholder Farming

ICSD26_287

HARDNESS REDUCTION IN WATER THROUGH RICE HUSK ASH ADSORPTION AND ELECTRODIALYSIS USING LOCALLY AVAILABLE MATERIALS

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Abstract: Minerals such as calcium and magnesium are the most common causes of water hardness. They adversely affect both industrial processes and drinking water quality. Reverse osmosis involves virtually removing all dissolved substances, hence one may lose vital minerals that are usually found in water. The ion exchange method exchanges all ions, requiring regeneration even for unnecessary removals. Conventional chemical precipitation involves the use of chemicals and generates wastes that are harmful to the environment. Hence, this study aimed to investigate the potential of two effective treatment mechanisms, namely electrodialysis and adsorption, for hardness removal in water using low-cost or waste-derived materials. Electrodialysis selectively removes dissolved ions, mainly Ca^{2+} and Mg^{2+} without stripping all minerals. Cation- and anion-selective membranes were produced using eggshell powder, rice husk ash, kaolin clay, glass powder, and cation/anion exchange chemicals. During the adsorption mechanism, rice husk ash was evaluated as an adsorbent for hardness removal through batch sorption experiments and a laboratory-scale column experiment. Four experimental runs were conducted using the electrodialysis apparatus. The highest hardness removal achieved was approximately 30% at a 12 V electrical supply using two waste-derived membranes, each with an area of about 16 cm². The efficiency of these membranes can be significantly improved by increasing the membrane area, exploring alternative electrode materials, investigating causes of membrane fouling. The laboratory-scale column bed (≈0.2 cm^3) was loosely packed with rice husk ash. It exhibited a breakpoint of 270 minutes to achieve 50 mg/L as $CaCO_3$ in the treated water. It achieved 100% removal up to 210 minutes for an initial hardness of 214 mg/L as $CaCO_3$. Individually Rice husk ash also proved to be an efficient adsorbent for hardness removal. Conducting additional experiments with scaled-up columns could further enhance the performance of this treatment system.

Keywords: Batch Sorption; Column Experiment; Electrodialysis; Rice Husk Ash (RHA); Semi-Permeable Membrane

ICSD26_361

DEVELOPMENT AND COMPARATIVE EVALUATION OF SOLID BIOFERTILIZERS FORMULATED FROM RICE BYPRODUCTS (RICE HUSK CHARCOAL AND RICE BRAN) FOR PLANT GROWTH ENHANCEMENT USING *Rhizobium spp.*

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Abstract: The overuse of chemical fertilizers has caused environmental degradation and decline in soil fertility, highlighting the need for sustainable nutrient management strategies. Plant Growth Promoting Rhizobacteria (PGPR) biofertilizers offer an ecofriendly approach to enhance soil fertility and agricultural productivity. The present study aimed to formulate and evaluate solid biofertilizers based on rice byproduct as carrier materials and to determine influence the effects of the developed biofertilizers on soil properties, microbial population, growth parameters and yield attributes of chili (*Capsicum annuum L*.). The biofertilizer formulations were prepared with *Rhizobium spp*. using rice bran and rice husk charcoal as carrier materials. A pot experiment was carried under controlled conditions using a completely randomized design with nine treatments, including T1 – recommended chemical fertilizer (control), T2 – rice bran biofertilizer, T3 – T5 – the integration of rice-bran biofertilizer with chemical fertilizer at application rates of 25%, 50% and 75%, respectively, and T6 – rice husk charcoal biofertilizer, In addition three treatments (T7,T8 and T9) consisted of rice husk charcoal biofertilizer integrated with chemical fertilizer at rates of 25%, 50% and 75% respectively. The experiments results showed that the positive effects of combined inorganic–organic applications on plant growth and yield were similar to those of inorganic fertilizer treatment alone. The rice husk charcoal biofertilizer combined with 50% chemical fertilizer (T8) gave the highest values of plant height (94.75), pod weight (118.75 g) and pod length (12 cm) indicating best overall performance. The highest microbial population (0.407×10^6 CFU g^{-1}) was recorded in soil treated with the rice bran biofertilizer (T2) demonstrating that the treatment effectively maintained microbial populations. Although biofertilizers cannot completely substitute for chemical fertilizers, their combined use with lower dose of chemical fertilizer may enhance chili productivity; improve soil fertility status and promote sustainable agriculture by reducing environment impacts and conserving beneficial soil microorganisms.

Keywords: Biofertilizer; Chili; Integrated Nutrient Management; *Rhizobium spp*.; Rice Bran; Rice Husk Charcoal

ICSD26_362

IN VITRO PHARMACOLOGICAL POTENTIAL OF *Leucas zeylanica*

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Abstract: The genus Leucas is a member of the Lamiaceae family. The *Leucas* species, especially the plant of *Leucas zeylanica*, is a commonly used medicinal plant in Ayurvedha, Siddha, and Unani for treating various body inflammations, diabetic patients, oxidative stress, parasitic infections, and various body infections. On such background, this review aims to highlight the pharmacological potential of *Leucas zeylanica.* The literature review was conducted using Google Scholar, PubMed, and Hinari. We explored the database using "Pharmacological potential of *Leucas Zeylanica* in vitro assays." The initial 361 articles were narrowed down to 48 after careful filtering based on the topic and abstract, following the PRISMA flowchart. The *Leucas zeylanica* methanol extracts have higher antioxidant activity, due to the presence of high phenolic and flavonoid content. Significant anti-inflammatory effects were seen through the inhibition of nitric oxide, TNF-α, IL-6, COX-2, and iNOS, with diterpenoids identified as a major component. The aqueous extracts of *Leucas zeylanica* demonstrated a significant reduction in blood glucose levels and inhibited α-amylase, α-glucosidase, and advanced glycation end-products. The *Leucas zeylanica* aqueous and methanol extracts showed dose-dependent anthelmintic activity comparable to albendazole-like medicines. The *Leucas zeylanica* toxicity assessments conducted using zebrafish embryo assays reported low cytotoxicity and good safety margins. Phytochemical analyses confirmed the support of a lot of bioactive compounds towards observed pharmacological effects. The *Leucas zeylanica* methanol extracts had stronger in vitro antioxidant, anti-inflammatory, antidiabetic, and anthelminthic qualities than aqueous extracts. The presence of various bioactive compounds in *Leucas zeylanica* supports traditional use and highlights its potential for the development of plant-based therapeutics.

Keywords: Anthelmintic; Antidiabetic; Anti-inflammatory; Antioxidant Activity; *Leucas zeylanica*

CIRCULAR ECONOMY AND WASTE-TO-VALUE INNOVATIONS FOR INDUSTRY - I

ICSD26_047

REMOVAL OF REACTIVE DYE FROM AQUEOUS SOLUTIONS USING BIOMASS-DERIVED BOTTOM ASH: A SUSTAINABLE APPROACH FOR TEXTILE WASTEWATER TREATMENT

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Abstract: The growing environmental challenges associated with textile wastewater highlight the necessity for effective and sustainable treatment methods. Adsorption is an effective treatment method that produces high-quality effluent. Additionally, cost-effective and sustainable adsorbents provide an alternative to costly wastewater treatment techniques. In the current study, biomass-derived bottom ash (BDBA), a waste product generated from the combustion of firewood (a mixture of *Gliricidia sepium* and *Hevea spp*.) in boiler operations, was investigated as a cost-effective and efficient adsorbent for the adsorption of the reactive dye from aqueous solutions. The BDBA was treated with distilled water and dried at 105 °C for 4 hr to enhance its adsorption capacity. The adsorption performance of the prepared BDBA was investigated using JAKOFIX RED ECON (JRE), a reactive dye commonly employed in the textile industry. The impact of critical process parameters, including dosage, shaking time, settling time, and initial pH of the dye solution, on the adsorption process was systematically studied at room temperature (25 °C). Batch adsorption experiments were performed using 100 mL of a 20 mg/L JRE solution, agitated at 150 rpm. The adsorption process exhibited optimal performance at an adsorbent dosage of 0.400 g under acidic conditions with a 2.5 optimum pH. Equilibrium was reached within 35 minutes of shaking time, and the settling time had no impact, indicating a rapid adsorption process. Therefore, in the current study, BDBA obtained from firewood combustion has been revealed as an effective, low-cost alternative for the removal of JAKOFIX RED ECON dye from aqueous solution.

Keywords: Adsorption; Bottom Ash; Efficient; Reactive Dye; Wastewater

ICSD26_106

A DATA DRIVEN APPROACH TO SUSTAINABLE FOOD WASTE MANAGEMENT: UTILIZING A LOCALLY TAILORED IOT SYSTEM FOR FOOD WASTE TRACKING IN LARGE SCALE HOTELS IN SRI LANKA

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Abstract: The substantial food waste generated from hotel industry presents a critical global sustainability issue. Effective food waste mitigation relies on precise, routine waste measurement and reporting, which is hindered by currently used imprecise and labor intensive traditional manual methods. While sophisticated, AI-driven waste monitoring systems exist internationally, their adoption in Sri Lankan hotels is impracticable due to excessive implementation costs and lack of customization for diverse local food items. This research introduces a novel, locally-developed, smart waste tracking system to use in large-scale hotel kitchens. The system's core innovation lies in its, Internet of Things (IoT) architecture, which uses a calibrated setup of load cells, an HX711 amplifier, and a Wi-Fi enabled microcontroller (ESP32) to accurately capture the weight of discarded food. Real-time weight data immediately transmitted to a firebase cloud database, for continuous data aggregation and simultaneous operations across connected devices. The system is operationalized via a flutter mobile application, which serves as the central user interface. Staff utilizes the app to classify waste by specific source and category, enabling the generation of comprehensive waste reports. Reports provide crucial and actionable insights, including waste amount by each source and category, edible vs. non-edible waste analysis, key waste indicators, and data-driven waste reduction recommendations, directly supporting optimized waste management strategies. The system's performance was rigorously evaluated in a hotel kitchen environment. A paired t-test comparing the system's weight readings against manually recorded measurements yielded ($p > 0.05$), confirming the statistical insignificance of the mean difference and thus validating accuracy of scale. Furthermore, a Wilcoxon Signed Rank test on user feedback demonstrated a significant improvement ($p < 0.05$) in the system's usability, usefulness, organization, clarity, and relevance over the manual method. This validated, data-driven system offers a highly practical, cost-effective, and sustainable framework for significantly reducing food waste within the hospitality sector.

Keywords: Database; Food Waste; Hotel Industry; Internet of Things (IoT); Mobile Application; Sustainability

ICSD26_201

AN ASSESSMENT OF AWARENESS, BEHAVIOURS, AND BARRIERS RELATED TO SUSTAINABLE WATER CONSUMPTION IN SRI LANKAN STATE UNIVERSITIES

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Abstract: Sustainable water consumption is critical to ensuring its long-term water security because Sri Lanka experiences climatic variability, population growth and increasing demand for limited freshwater resources. Universities consume considerable amounts of water and serve as places where they play a significant role in promoting sustainable practice of water use. The purpose of this study was to assess the level of awareness, water saving practices and identifying barriers and opportunities associated with sustainable water consumption of university students and staff in Sri Lanka. Data were collected through a quantitative and descriptive questionnaire from 106 participants, including undergraduates, postgraduates, academic staff, and non-academic staff across various Sri Lankan universities using convenience sampling method. The questionnaire covers five sections including demographic characteristics, awareness of limited water availability, water use behavioural data, barriers to conservation of water and opportunities to influence water saving practices. Data were analysed using descriptive statistics and Knowledge, Attitude and Practice (KAP) scoring techniques. The results indicated that participants normally exhibited moderate awareness (M = 3.36; 51.89%) about global and local water scarcity issues, with social platforms being the major source of information. Most of the respondents showed a positive behaviour towards activities such as closing fixtures while brushing teeth and reporting leaking pipes, however consistency of doing those was limited. Actions such as reusing of grey water, limited shower durations indicated a low tendency among responses. And a considerable gap was identified between the awareness and practical actions for sustainable water consumption. The limited access for water saving technologies, inadequate effort of individuals for water saving and lack of institutional support contributed to failure of water conservation. Strategies such as developing infrastructure in university premises, strengthen of university laws and regulations and proving financial incentives for university administrations could be identified as opportunities for sustainable consumption of water. Addressing limitations of infrastructures, reinforcing university commitment, conducting targeted awareness campaigns are essential for converting awareness into sustainable water conservation practices.

Keywords: Awareness and Behaviour; Sustainable Water Consumption; University Community; Water Conservation

ICSD26_222

SUSTAINABLE TEXTILE COLORATION USING FUNGI-DERIVED PIGMENTS: PROCESS DEVELOPMENT AND APPLICATION INSIGHTS

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Abstract: The textile industry contributes significantly to environmental pollution. This is largely due to the use of synthetic dyes, which are often non-biodegradable, toxic, and harmful to human health. In contrast, natural dyes are eco-friendly, biodegradable, and non-toxic. Therefore, natural dyes offer a much lower environmental impact. Among natural dyes, microbial pigments have emerged as a promising alternative because of their diverse colour palette, consistent quality, and suitability for large-scale fermentation. This study highlights the pioneering development of a fungal-derived microbial dye. During the study, pigments produced by fungal species of *Fusarium*, *Penicillium*, and *Aspergillus* were evaluated for their pigment production potential and textile dyeing performance. Low-cost mass culturing techniques were employed using a surface fermentation method, after which the pigments were extracted and subsequently characterised. Thereafter, the pigments were further optimised for textile dyeing applications. Single jersey cotton fabrics were pretreated and cationised using polyamines to enhance dye uptake. Dyeing was carried out using the microbial pigments, followed by fixation with a standard fixing agent suitable for direct dyes. The pigments effectively coloured the cotton fabrics, producing samples with excellent colour-fastness, including a wash-fastness rating of 4 and a light-fastness rating of 3.5 on the 1–5 scale, as evaluated according to international textile standards (AATCC). The dyed fabrics also demonstrated uniform coloration and strong pigment retention, indicating the effectiveness of the process. These findings highlight the potential of fungal-derived pigments as sustainable textile colorants, combining functional and aesthetic properties with reduced environmental pollution. The scalability of this microbial dyeing approach presents promising economic opportunities, reduces reliance on synthetic dyes, and contributes to a safer and more sustainable textile industry. More vibrant and diverse colour palette development will be targeted as future perspective on this project.

Keywords: Microbial Dye; Natural Dyes; Textile Colorant

ICSD26_300

A REVIEW ON BIOCHAR-BASED FILTER MEDIA DERIVED FROM INVASIVE AQUATIC PLANTS FOR SUSTAINABLE BATIK WASTEWATER TREATMENT IN SRI LANKA

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Abstract: Sri Lanka's batik industry, largely composed of small and medium-scale enterprises, contributes significantly to the country's cultural and economic identity. However, its decentralized structure and limited financial capacity often result in the direct discharge of untreated wastewater containing synthetic dyes, organic pollutants, and heavy metals into the environment. As conventional treatment technologies remain financially inaccessible for most producers, there is an urgent need for an affordable and sustainable alternative. This study evaluates the potential of low-cost biochar-based filter media produced from locally abundant invasive aquatic plants such as *Eichhornia crassipes* (water hyacinth) and *Salvinia molesta* for decentralized wastewater treatment. A structured literature-based methodology was employed, involving a systematic review of nearly 80 peer-reviewed articles, reports, and book chapters related to biochar production, physicochemical properties, adsorption mechanisms, and pollutant removal from dye-rich industrial effluents. Studies were selected based on biomass relevance, pollutant similarity to batik wastewater, and applicability to small-scale treatment contexts. Key findings were synthesized to assess the suitability of invasive-plant-derived biochar as a filtration medium, with emphasis on porosity, surface functional groups, cation exchange capacity, and activation processes that enhance adsorption performance. The literature indicates that biochar from invasive aquatic plants exhibits strong potential for reducing dye concentrations and heavy metal levels, making it a promising low-cost option for decentralized applications. The review also addresses the economic feasibility of invasive biomass utilization and the need for national regulatory guidelines for spent biochar disposal. The study further outlines a university-industry collaboration model in which academic institutions contribute expertise in biochar preparation, characterization, and conceptual filtration strategies, while batik producers provide practical insights for future pilot-scale implementation. This partnership promotes innovation, knowledge transfer, and circular resource use by transforming invasive biomass into a value-added treatment material. Overall, the findings suggest that biochar-based filtration, supported by collaborative engagement, offers a scalable and environmentally responsible pathway for improving wastewater management in Sri Lanka's artisanal batik sector.

Keywords: Biochar; Invasive Aquatic Plants; Batik Wastewater; Filter Medium; Wastewater Treatment

ICSD26_309

DESIGN AND DEVELOPMENT OF A DIGITAL PRODUCT PASSPORT TO COMMUNICATE PRODUCT SUSTAINABILITY AND CIRCULARITY OPTIONS

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Abstract: The growing emphasis on sustainability and circular economy practices has increased the demand for verifiable and accessible data across a product's entire life cycle. In response, the European Union has introduced the concept of the Digital Product Passport (DPP). This paper presents design and development a DPP, that links physical products with their digital sustainability information, facilitating the implementation of circular economy strategies throughout the product life cycle. The study uses the life-cycle thinking approach as the fundamental methodology to structure the framework and validates it through a case study of a household electric kettle to demonstrate its practical applicability. The prototype is designed as a web application with user-friendly digital interface that can be accessed via a QR code. By scanning the QR code, stakeholders can access all relevant information. Moving beyond a static database of product information, the DPP is structured to actively enable circular strategies, such as reselling, repairing, reusing, and recycling by connecting manufacturers, consumers, and downstream stakeholders. The results show that the proposed framework demonstrates the potential of DPPs as a practical tool for supporting circular economy practices and provides a foundation for extending to other product categories.

Keywords: 6R; Circular Economy; Digital Product Passport; Life Cycle Assessment; QR Code; Sustainability

ICSD26_359

DEVELOPMENT OF A SUPPLEMENTARY GELLING AGENT FROM BANANA (*Musa spp*.) CORM FOR THE ALOE VERA *IN-VITRO* ROOTING

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Abstract: Agar is the most used gelling agent in plant tissue culture. Due to several limitations like higher cost and limited availability, the development of alternative gelling agents has become significantly important. This study was conducted to address these limitations by applying banana (*Musa spp*.) corm starch as a substitute. Ash plantain (*Musa paradisiaca*) was used to extract the corm starch with accessibility, while *Aloe vera* (L.) *Burm.f.* suckers used for culturing. Through the preliminary tests, the optimum solidifying concentration of corm starch (100g/L) and the optimum solubility temperature (70 ^{o}C) were identified. Based on that, the experiment was designed into two groups as with (MS media + BAP + Sugar) and the other one without (MS + BAP + Sugar) along with changing the ratio of agar + corm starch concentration among six treatments per each group and 10 replicates per each treatment. Commercial AR grade agar was used as the control. The plant height and leaf number were observed over six weeks to evaluate media performance. Upon completion of the data collection, the statistical analysis reflected a positive result in both groups indicating that corm starch can be significantly used as an alternative to the agar while 3g/L agar + 70g/L corm starch (0.3% agar + 7% corm starch) showed comparatively higher result. Also, there was no significant difference within the treatments where MS media was added, which ensures agar can even be replaced by 100%corm starch. The cumulative findings demonstrate that banana corm starch can be used as a cost effective, alternative solidifying agent to the agar, leading to mitigate the environmental pollution of the corms which is an agricultural waste in large scale banana cultivation and can be used as a sustainable approach to address the limitations of the standard agar in the plant tissue culture industry.

Keywords: Aloe vera; Alternative gelling agent; Banana corm starch; Commercial AR grade agar; Plant tissue culture

URBAN RESILIENCE, CLIMATE RISK MODELING & DISASTER-RESILIENT PLANNING

ICSD26_016

DEVELOPMENT OF AN ENVIRONMENTAL RADIATION MONITORING, VISUALIZATION, AND PREDICTION SYSTEM USING GPS TRACKING AND GIS-BASED INTERPOLATION

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Abstract: Radiation monitoring is an essential element in assuring environmental safety and public health, particularly in sensitive and high-risk areas such as hospitals and public environments. This study introduces the design and implementation of a real-time portable radiation monitoring system integrated with Global Positioning System (GPS) and mobile app technology. The system addresses the critical need for accessible, continuous, and location-based radiation monitoring by providing a compact, battery-powered solution capable of real-time data transmission. Through its mobile interface, users can instantly visualize radiation and location data, supporting rapid decision-making in emergency scenarios. The system's accuracy under real-world conditions was demonstrated through field tests conducted at two main sites: a cancer treatment facility (name withheld due to legal constraints) and the Uswetakeiyawa coastline. Statistical analysis showed mean radiation levels of 171.47 ± 0.25 $nSvh^{-1}$ and 677.85 ± 0.25 $nSvh^{-1}$ at the two study sites, respectively, with the lowest and highest readings of 83.00 ± 0.35 $nSvh^{-1}$ and 972.00 ± 0.25 $nSvh^{-1}$ at the medical facility and 78.00 ± 0.35 $nSvh^{-1}$ and 4216.00 ± 0.20 $nSvh^{-1}$ at the coastline premises, indicating high spatial variability. The discovery of an iodine leakage from the iodine therapy unit at the medical facility was a noteworthy result that confirmed the system's usefulness and importance to society. Dynamic monitoring showed that, regardless of movement speed, the scintillator detector maintained a consistent reaction time of 3 ± 1 seconds. Six distinct speeds were used to estimate the calibration factors. At 0.1356 ± 0.0004 ms^{-1}, the calibration factor was 1.1875. Geographic information system (GIS) software employing Inverse Distance Weighting (IDW) interpolation predicted radiation levels in unmeasured areas. Overall, this system shows substantial promise for wide-scale radiation surveillance, emergency response, and risk assessment in both controlled and public environments.

Keywords: GIS; GPS Integration; IDW Interpolation; Radiation Monitoring

ICSD26_242

COMPARATIVE ANALYSIS OF SOIL-BASED AND CEMENT BASED MATERIALS ON THERMAL COMFORT AND COOLING ENERGY DEMAND IN LOW RISE BUILDING

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Abstract: In this study, the thermal comfort performance and cooling energy requirement of the soil-based construction materials are compared with ordinary cement-based materials in the low-rise construction in Sri Lanka. Compressed Stabilized Earth Blocks (CSEBs) were used to build two identical model chambers, and the roofs with soil-based roofing sheets and cement blocks with asbestos roofing were used. The thermal comfort parameters, relative humidity, and indoor temperature were measured, and the cooling load was calculated. and energy simulation by use of Revit was completed. The monitoring of both chambers under equivalent environmental conditions and the examination of their thermal conduct with regard to ASHRAE Standard 55 (PMV and Adaptive models) were used to answer the objective of the research. The differences in cooling energy requirements were calculated by using the Cooling Load Temperature Difference (CLTD) method to calculate the heat gain. These findings indicated that the soil-based chamber was able to keep indoor temperatures 30 C degrees cooler than the cement-based chamber and its humidity patterns were smoother by virtue of the moisture-buffering nature of soil materials. The overall heat gain of the soil chamber was determined to be 2232.65 W, which was nearly a quarter of its counterpart (cement chamber) 2820.02 W. Based on the PMV and Adaptive comfort assessment, the conditions in the soil-based chamber were more favorable in relation to the thermal comfort factors under tropical climatic conditions. Finally, it was shown that soil-based construction materials have better passive cooling functionality and lower cooling energy requirement than regular cement-based materials, meaning that they can be used to construct an energy-efficient, low-rise building in Sri Lanka.

Keywords: Heat Gain; Low Rise Building; Thermal Comfort Parameters; Tropical Climate Condition

ICSD26_249

ASSESSING THE ROLE OF BLUE CARBON ECOSYSTEMS IN PROTECTING COASTAL AGRICULTURAL LANDS FROM FLOODING AND SEA-LEVEL RISE: A SYSTEMATIC REVIEW

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Abstract: Climate change-induced sea-level rise and coastal flooding increasingly threaten agricultural lands in low-lying coastal regions, posing risks to food security and rural livelihoods. Nowadays, blue carbon ecosystems such as mangroves, salt marshes, and seagrass meadows are seen as potential solutions to the problem that can be used in nature and offer a dual benefit in terms of carbon sequestration and coastal protection. This systematic literature review evaluates the protective functions of blue carbon ecosystems against floods and sea-level rise, with specific emphasis on their effectiveness in preserving coastal agricultural lands. Following the PRISMA framework, twenty-eight peer-reviewed literature published between 2020 and 2025 was systematically reviewed using Scopus, Web of Science, Google Scholar, and ResearchGate. The synthesis indicates that mangroves provide substantial flood protection benefits, significantly reducing wave energy and coastal erosion, while salt marshes and seagrass meadows contribute to storm surge attenuation and high carbon sequestration rates. Dense mangrove stands can reduce coastal erosion by 97 - 99% in case of the estimated sea level rise. These ecosystem services play a critical role in safeguarding coastal agricultural lands by reducing inundation frequency, soil salinization, and erosion. The Hybrid engineering-ecosystems have a ratio of 2:1 to 7:1 in terms of benefits and costs. Among critical gaps, there are standardized assessment protocols, lack of long-term monitoring, geographic bias, and farmer-centric valuations. The review underscores that integrating blue carbon ecosystems with engineered coastal defences is essential to address accelerating sea-level rise while simultaneously supporting agricultural resilience, climate adaptation, and carbon mitigation goals.

Keywords: Agricultural Land Resilience; Blue Carbon Ecosystems; Coastal Flood Protection; Mangrove Ecosystem Services; Sea- Level Rise Adaptation

ICSD26_356

INTEGRATING CITIZEN SCIENCE AND AI FOR SURFACE WATER QUALITY MONITORING: A SYSTEMATIC REVIEW OF APPROACHES, TECHNOLOGIES, AND COLLABORATION MECHANISMS

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Abstract: Sustainable water resource management together with environmental conservation depends on surface water quality monitoring. Traditional monitoring techniques face two main limitations that include high expenses and restricted observation points in time and space. A promising solution has developed in modern times which combines citizen science with artificial intelligence (AI) to merge advanced computational tools and community participation. Current research about incorporating citizen science with AI persists insufficient due to inadequate research into collaboration models and integration strategies as well as ethical challenges and technical synergies. The study utilizes a systematic method to study surface water quality monitoring through the combination of citizen science and AI by examining approaches and technologies alongside interconnection methods. Following PRISMA guidelines, a comprehensive search of Scopus and Web of Science databases was conducted, yielding 34 peer reviewed articles published between 2014 and 2024. The research presents different citizen science models alongside AI possibilities and integration procedures which result in the proposed participatory AI framework to boost community involvement in surface water quality surveillance initiatives. The framework establishes four categories of citizen science methods including manual sampling, app-based reporting, participatory sensors and community-driven observations. It also evaluates their implementation with AI approaches such as predictive analytics together with data cleaning, explainable AI, gamification and blockchain-based data management. The effective transfer of information occurs through data pipelines, feedback loops, collaborative platforms and hybrid data systems. The research review reveals the powerful transformational value of AI-driven participatory frameworks that lead to better spatial–temporal data precision and lower costs together with enhanced community involvement. The paper tackles critical obstacles regarding data validation strategies along with privacy and fairness while proposing next-steps for standardizing AI-based validation techniques in addition to revealing transparent AI approaches and sustaining continuously involved citizens. By bridging knowledge gaps, this review creates a roadmap for interdisciplinary collaboration, advancing inclusive, AI-driven solutions for sustainable water resource management.

Keywords: Artificial Intelligence; Citizen Science; Collaborative Platforms; Predictive Analytics; Smart Water Management; Water Quality Monitoring

ICSD26_363

INTERACTIONS BETWEEN RAINFALL VARIABILITY, LAND-USE CHANGE, AND TERRAIN CHARACTERISTICS IN CONTROLLING LANDSLIDE OCCURRENCE IN TROPICAL MOUNTAINOUS REGIONS: A SYSTEMATIC REVIEW

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Abstract: Landslides represent one of the most devastating natural hazards in tropical mountainous regions, where slope instability results from complex intricate interactions between rainfall variability, terrain characteristics, and human-induced land use and land cover (LULC) changes In South and Southeast Asian tropical highlands, increasing climatic variability and rapid landscape transformation have significantly intensified landslide frequency and severity. A PRISMA-guided systematic literature review was conducted, synthesizing 42 peer-reviewed, open-access studies published between 2016 and 2025. The reviewed evidence was thematically analysed to examine spatial patterns of landslide occurrence, rainfall triggering mechanisms, LULC dynamics, terrain characteristics, and their interactive roles in slope failure processes. The synthesis reveals that landslides predominantly occur where steep slopes, highly weathered soils, and dynamic land-use changes coincide with cumulative and antecedent rainfall conditions. Multi-day rainfall accumulation and pre-existing soil moisture consistently emerge as stronger predictors of landslide initiation than single-day rainfall intensity alone. Anthropogenic disturbances including deforestation, agricultural expansion, infrastructure development, and unplanned urbanisation further amplify rainfall-driven instability by altering surface hydrology and reducing slope resistance. Integrated susceptibility models, particularly multivariate statistical and machine-learning approaches, consistently demonstrate superior predictive performance compared to single-factor models. Overall, the findings underscore the critical importance of interaction-based landslide susceptibility frameworks that explicitly integrate climatic, geomorphological, and land-use processes to enhance hazard assessment, early-warning systems, and risk-sensitive land-use planning in data-limited tropical mountainous regions facing escalating climate and development pressures.

Keywords Integrated Modelling; Landslide Susceptibility; Land-Use and Land-Cover Change (LULC); Machine-Learning Approaches; Rainfall Variability; Terrain Characteristics

ICSD26_364

SPATIO-TEMPORAL ANALYSIS OF $PM_{2.5}$ IN SRI LANKA USING SATELLITE REMOTE SENSING DATA

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Abstract: Fine particulate matter ($PM_{2.5}$) has become a major air pollutant and is the most extensively monitored ambient pollutant with the largest associated health burden. According to recent reports, air quality in Sri Lanka has increasingly deteriorated due to elevated $PM_{2.5}$ levels, while limited spatial coverage of ground-based monitoring stations restricts nationwide assessment. This study investigates the spatio-temporal dynamics of $PM_{2.5}$ from 2020 to 2024 using an integrated satellite-based remote sensing approach. Data from the advanced satellite sensor MODIS (Moderate Resolution Imaging Spectroradiometer) were processed using Google Earth Engine, a cloud-based geospatial processing system, to derive monthly and annual pollutant distributions, while ArcGIS Pro was used to develop district level spatial maps and identify the hotspots of $PM_{2.5}$ concentration across the country. The data validation of satellite data with the ground station data resulted R2 of 0.64 indicating good reliable relationship. According to the results, mean $PM_{2.5}$ concentrations consistently exceeded the World Health Organization Air Quality Guidelines (2021) with a marked decline observed in early 2020 during lockdown periods, followed by sharp surges in 2021 and 2022 as industrial and agricultural activities resumed. Time series analysis revealed pronounced peaks during dry seasons (January - April and July - September), and lower levels in monsoon-season with wet deposition. Over the study period, spatial analysis identified persistent hotspots in Colombo, Gampaha, Kandy, and Puttalam, and exhibited elevated annual means, reflecting the combined influence of dense traffic, industrial activities, and land-use changes. In addition, northern and coastal districts exhibited higher annual and monthly mean $PM_{2.5}$ levels, potentially due to transboundary transport, which is a situation reported repeatedly in recent years. These findings demonstrate the value of satellite-based monitoring for identifying high-risk areas and time periods, supporting targeted emission control strategies and further assisting in prioritizing health-risk assessments in the most affected districts.

Keywords: Air Pollution; Air Quality; Google Earth Engine; MODIS; Particulate Matter; Transboundary Pollution

ICSD26_365

MOBILE ADAPTIVE INTELLIGENT MULTIMODAL MICRO-CREDENTIAL COURSES FOR URBAN RESILIENCE

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Abstract: Collaborations between industry and universities are increasingly leveraging microlearning to skills gaps, providing flexible, rapid, focused, and highly customized educational opportunities. Just in time, task relevant general knowledge supports immediate application in dynamic work environments. Micro-credentials are structured to be applied directly in the workplace, addressing particular skill deficiencies. Micro-credentials are relevant forms of training that align with the speed of business. At present, microlearning is transitioning from the classroom to the workplace, enabling employees to engage in 10 - 20 minutes of learning during breaks or while working, thereby enhancing engagement and accommodating their hectic schedules. Mobile adaptive intelligent multimodal micro credentials courses for urban resilience (MAM) customize learning journals to personal requirements and offer adaptive experiences that align with particular employee positions, abilities, and objectives. MAM incorporates practical projects alongside academic concepts. The MAM includes (1) relational databases and a database management system; (2) a subsystem for equipment and sensors; (3) emotions and performance regression modelling; (4) a model for learners; (5) systems for affective video and text; (6) systems for computer learning; (7) opinion analysis for Google; (8) a subsystem for adaptive examinations; (9) real-time living virtual laboratories and 7D building information modelling (BIM); (10) access to electronic resources (simulators, case studies, calculators, databases, games, and software); (11) an graphical interface; (12) a model for emotion-based music therapy. The research problem includes creating (1) algorithms that adapt content, speed, and format in real-time according to a learner's immediate emotional, behavioural, and cognitive involvement; (2) productive real-time interactive feedback mechanisms; and (3) integrated multimodality (though courses might provide video, audio, and text, they frequently lack cohesive integration). The approach combines cutting-edge AI, emotional computing, mobile technology, multiple criteria analysis and various sensory inputs (text, audio, video) to develop tailored, captivating, and effective learning experiences. These systems assess learner behaviours and contexts in real time to adapt content, greatly enhancing engagement and retention compared with conventional, unchanging approaches. The key findings are: (1) improved learning outcomes and efficiency, through mass personalized learning paths that address varied needs and enhance knowledge retention; (2) notable increase in learner engagement; (3) important role of multimodal interaction by utilizing various modalities (visual, auditory, verbal, reading, writing) which proves highly effective, showing a strong positive link between multimodal use and improved learning outcomes; (4) AI-powered personalization and prediction enable proactive interventions and customized content delivery. The aforementioned courses greatly enhance education by markedly boosting learner engagement, knowledge retention, and overall learning effectiveness. These systems leverage AI to analyse diverse data types (text, audio, video, and learner interactions), offering customised learning experiences that address specific needs and improve learning by up to 25.4% compared to conventional approaches.

Keywords: Industry-University Collaboration; Mobile Adaptive Intelligent Multimodal Micro-Credentials Courses; Practical Projects Alongside Academic Concepts

ICSD26_368

A COMPREHENSIVE REVIEW OF THE MANGROVE ECOSYSTEMS IN CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION

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Abstract: Mangrove ecosystems play a critical role in protecting coastal regions, supporting climate change adaptation and disaster risk reduction in Sri Lanka. These ecosystems function as natural barriers against coastal hazards while enhancing biodiversity and sustaining local livelihoods. This comprehensive review employs the PRISMA methodology, examining 15 English articles published between 2017 and 2025, accessible through Research Gate and Google Scholar databases filtered with pre- selected keywords (Mangrove, Climate change adaptation, Disaster risk reduction, Sri Lanka). The review aims to identify key knowledge gaps and propose future research directions to strengthen mangrove conservation and coastal resilience under changing climatic conditions. Synthesized findings indicate that climate change has significantly affected mangrove ecosystems through sea-level rise, altered rainfall patterns, and increased frequency of extreme weather events. These stressors weaken ecosystem structure, reduce productivity, and diminish carbon sequestration capacity. The discussion emphasizes, despite these challenges, mangroves demonstrate natural adaptive mechanisms, including high carbon sequestration potential, ecosystem stabilization, and livelihood support for coastal communities. Case studies from coastal regions such as Negombo, Rekawa, and Bundala highlight the vulnerability of mangrove ecosystems and the benefits of conservation and restoration initiatives. However, the effectiveness of mangrove-based adaptation strategies is constrained by anthropogenic pressures, restoration failures, and gaps in policy implementation and management frameworks. The review further examines the Mangroves as nature-based solution for disaster risk management by reducing wave energy, storm surge impacts, coastal erosion, and flooding through their complex root and canopy structures. Strengthening policy integration, enhancing community participation, ensuring appropriate species selection, and implementing continuous ecological monitoring with site-specific restoration strategies are essential for long-term sustainability. Future research should prioritize quantitative disaster risk reduction assessments and long-term ecological monitoring to inform evidence-based management and policy decisions. In conclusion, mangroves offer a cost-effective and sustainable approach to enhancing coastal resilience in the face of climate change.

Keywords: Climate Change Adaption; Disaster Risk Reduction; Ecosystem Resilience; Mangrove Ecosystem; Sri Lanka

ICSD26_369

NUMERICAL INVESTIGATION OF REINFORCED CONCRETE SLABS STRENGTHENED WITH UHPFRC OVERLAYS CONSIDERING INTERFACE BOND BEHAVIOUR

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Abstract: Many existing reinforced concrete (RC) slabs require strengthening due to material deterioration, corrosion of reinforcement, and increased service load demands. Ultra-High-Performance Fibre-Reinforced Concrete (UHPFRC) has emerged as an effective strengthening material because of its high strength, excellent crack control, and superior durability. However, the structural performance of UHPFRC-strengthened RC slabs strongly depends on the bond behaviour at the interface between the existing concrete substrate and the UHPFRC overlay, which is often simplified or neglected in numerical studies.This study presents a detailed nonlinear finite element investigation of RC slabs strengthened with UHPFRC overlays, with particular emphasis on realistic modelling of interface bond behaviour. Finite element analyses were carried out using ABAQUS, where both normal concrete and UHPFRC were modelled using the Concrete Damaged Plasticity formulation. The interface between the RC slab and the UHPFRC overlay was explicitly represented using a cohesive zone model, allowing simulation of elastic stress transfer, damage initiation, and progressive debonding. The numerical framework was validated against experimental results reported in the literature. A comprehensive parametric study was then conducted to examine the influence of key interface parameters, including stiffness, strength, and fracture energy, on the global structural response.The results show that UHPFRC overlays significantly improve the stiffness, load-carrying capacity, and ductility of RC slabs when adequate composite action is achieved. Interface parameters were found to play a critical role in governing damage initiation, peak load, and post-peak behaviour. The findings highlight the importance of accurate interface modelling and provide valuable insight for the numerical assessment and design of UHPFRC-strengthened RC slabs.

Keywords: Cohesive Zone Model; Finite Element Analysis; Interface Bond Behaviour; Reinforced Concrete Slabs; Ultra-High-Performance Fibre-Reinforced Concrete (UHPFRC)

VETERINARY AND ANIMAL SCIENCES FOR ONE HEALTH AND SUSTAINABILITY

ICSD26_080

IMMUNOMODULATORY AND ANTI-CANCER PROPERTIES OF ALPINIA CALCARATA AND SOLANUM SURATTENSE IN RATS AND HUMAN LEUCOCYTES

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Abstract: Sri Lanka, recognized as a biodiversity hotspot, provides numerous valuable medicinal plants that support the Ayurvedic industry. Thus, the present study was undertaken to clarify the toxic effects, anti-oxidant capacity, immunomodulatory and anti-cancer properties of ethanolic extracts of *Alpinia calcarata* and *Solanum surattense.* The determination of these properties was carried out using Wistar albino rats and human cell lines. Toxicological evaluation was carried out by assessing the liver enzyme levels of ALT and GGT. The results indicated that lower doses of the plant extracts-maintained enzyme levels within the normal range, while a slight elevation was observed at higher doses. The antioxidant capacity of each extract was determined using the DPPH method, TAC assay, and Cayman assay. Both plant extracts exhibited significantly higher antioxidant activity compared to standard antioxidants ($p < 0.05$). Based on previous findings suggesting that *A. calcarata* possesses strong immunomodulatory effects, further investigations were conducted on its cytokine expression. *A. calcarata* extract was administered orally to Wistar rats at a dose of 200 mg/kg for 45 days, and human leukocyte cells were treated with varying doses in vitro. The results revealed a significant increase in the secretion of IL - 2, IL - 5, IL - 17, and IFN - γ, with IFN - γ secretion showing a clear dose-dependent response in human leukocytes. For anticancer evaluation, immunosuppression was induced in rats using oral administration of cyclophosphamide (50 mg/kg). The animals were then treated separately with extracts of *A. calcarata*, *S. surattense*, or water (control). After two weeks, the tumours were surgically removed, and their mass and volume were measured. The *A. calcarata*-treated group showed a significant reduction in tumour size compared to the other groups. These findings highlight *Alpinia calcarata* as a promising candidate with potent antioxidant, immunostimulatory, and anticancer properties, exhibiting minimal toxicity.

Keywords: *A.calcarata*; Anti-cancer; Anti-oxidant; Immunomodulation; *S.surattense*

ICSD26_089

THE FORAGING AND SOCIAL DYNAMICS OF CROWS IN CHILAW: AN INSIGHT FOR URBAN CROW MANAGEMENT

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Abstract: This study examined the foraging and social dynamics of two crow species, the House Crow (*Corvus splendens*) and the Large-billed Crow (*Corvus macrorhynchos*), focusing on their habitat preferences, factors affecting abundance, and community perceptions in Chilaw, Sri Lanka. Behavioral observations across 10 locations (5 urban and five suburban) revealed that crow abundance was generally higher in the evening (Urban: 203 ± 91 individuals/day, Suburban: 164 ± 46 individuals.day^{-1}) compared to the morning, although it is not statistically significant ($p > 0.05$), correlating positively with higher food availability and reduced human disturbance. Crow abundance varied significantly across urban ($F(4, 20) = 8.72$, $p < 0.01$) and suburban locations ($F(4, 20) = 3.41$, $p < 0.05$). The Chilaw Fishery Harbor (U-3) exhibited the highest habitat preference (HPI = 0.4483) and crow abundance (390 ± 154 individuals/day) due to abundant edible fish waste. Considering the crow diet, the highest proportion comprised processed food (67%), and the most abundant type of procured waste by crows was animal products (25%). U3 had the highest vigilance frequency (572 individuals.day^{-1}) among the locations, and a strong positive correlation ($r2 = 1$, $p < 0.05$) was found between vigilance and feeding behavior in these resource-rich urban locations, indicating that crows with alertness in competitive, high-risk environments balanced foraging. A positive correlation was exhibited between organic waste and crow abundance ($r = 0.160$), while high tree cover was negatively correlated ($r = -0.439$). A community survey revealed that crow-related disturbances were significantly correlated with garbage accumulation ($r = 0.526$) and poor waste-disposal practices ($r = 0.444$). The study advocates for integrated urban planning, improved waste management, and public awareness as essential, culturally appropriate steps to promote sustainable coexistence by addressing the root cause: unmanaged organic waste.

Keywords: Crow Abundance; Foraging Behavior; Habitat Preference; Urban Ecology; Waste Management

ICSD26_114

FORMULATION OF CATTLE PELLETS FOR SUSTAINABLE DAIRY FARMING USING LOCALLY AVAILABLE MATERIAL IN JAFFNA DISTRICT

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Abstract: Cattle feed production plays a crucial role in livestock productivity, and developing nutritionally balanced pellets has become increasingly important for sustainable dairy farming in the Jaffna district. This present study aimed to formulate nutritionally balanced, cost-effective cattle pellets from locally available raw materials, including cassava, Palm sprout (Odiyal), Black Soldier Fly Larvae (BSFL) meal, Azolla, Rice Bran, and coconut poonac from the Jaffna district. Mycotoxin Binder and Dicalcium Phosphate were added as feed additives. Raw materials were dried, ground, and mixed to produce pellet formulations F2 and F3, with F1 representing commercially available feed. Proximate analysis was performed to the individual ingredients and the formulated mixes (F2 and F3) to assess their nutritional composition and microbial stability over 21-days period. BSFL meal was exhibited highest crude protein 28.84 % (w/w) and ether extract 47% (w/w), while rice bran contained highest crude fibre 14.4% (w/w). Azolla contributed substantial crude protein and ash content. Significant differences ($p < 0.05$) were reflected in the percentage of dry matter, crude protein, ether extract, crude fibre. F3 showed the highest dry matter, crude protein, and ether extract contents, whereas F2 displayed comparatively lower values. Microbial analysis was performed to assess the stability and safety of the formulations over time. The formulations were designed to meet the daily energy and protein requirements of a 300 kg lactating cow, ensuring an optimal balance of energy and protein requirements per day. The results indicate that F3 represents a nutritionally superior, locally sourced alternative to commercial feed. This study highlights the feasibility of producing cost effective, nutritionally balanced cattle pellets using locally available agricultural resources. Further research is recommended to assess the long-term feeding performance and economic viability of these formulations under dairy farming conditions.

Keywords: Cattle Feed; Cost-Effective Formulation; Dairy Nutrition; Jaffna District Microbial Stability; Proximate Analysis

ICSD26_189

INFLUENCE OF PASSIVE INSULATION MATERIALS ON HIVE MICROCLIMATE AND COLONY DEVELOPMENT IN *Apis cerana* COLONIES

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Abstract: The Asian honeybee, *Apis cerana,* serves as an important pollinator in tropical ecosystems. It also supports small-scale farming systems. Still, colony performance remains quite sensitive to changes in the environment. Internal hive temperature and relative humidity have the most significant impact on it. The increasing internal moisture inside the hives disrupts brood development and also harms honey storage. Most commonly, increased humidity causes swarming in tropical regions which results loses in commercial-scale bee farming. Therefore, this study examined low-cost passive insulation materials sourced from local sources. The goal was to see if they could stabilize hive microclimate. They might also control moisture levels inside. Research carried out in Sri Lanka's low-country wet zone. They tested three setups. One used paper insulation, called T1. Another had gunny bag insulation, T2. The last was a control with no insulation, T0. Recorded readings of temperature and relative humidity by hand used a digital meter for this. Readings happened three times each day Morning, midday, and evening covered the schedule. Then, data went through statistical analysis. One-way ANOVA and test handled that. Findings revealed no significant differences in internal temperatures across treatments. The F value was 2, n-1 equal to 1.38 P came out at 0.296. But internal relative humidity showed clear differences. P equalled 0.035. Paper insulation kept the highest average RH at 80.22%. Its 95 percent confidence interval ran from 77.32 to 83.11%. Gunny bag insulation held moderate levels at 73.87%. That intervals 95 percent range was 70.97 to 76.76%. Visual checks pointed to better brood patterns in insulated hives. Honey storage improved there too, compared to the control. Overall, these results point to passive insulation as a useful option. Gunny bag material stands out in particular. It provides effective moisture control at low cost. This helps with colony stability in *Apis cerana* hives. In humid tropical settings, it could aid sustainable beekeeping practices in Sri Lanka.

Keywords: Apis Cerana; Hive Microclimate; Passive Insulation; Relative Humidity Control; Sustainable Beekeeping

ICSD26_357

THE DOMINANT ROLE OF HERD SIZE IN DETERMINING MILK YIELD ON DAIRY FARMS IN NORTHERN SRI LANKA

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Abstract: Nowadays, improving Dairy farming systems faces greater challenges and difficulties in tropical countries compare to temperate countries. In this present study investigate the determinants of milk yield on the dairy farming systems, with the objective of evaluating the relevance of conventional dairy development approaches under local production condition in the Kilinochchi District of the Northern Province, Sri Lanka. A cross-sectional survey was conducted among 66 dairy farms, which were comparatively assessed based on herd size, management system, housing conditions, seasonal management practices, reproductive technology adoption, and disease occurrence. The data set were analysed by using the multiple regression to identify the milk yield as an independent variable one-way ANOVA to compare production across management-related groups, and chi-square tests to examine associations between farm characteristics and disease prevalence. The analysis identified herd size as the highly significant with milk yield ($\beta = 0.42$, $p = 0.001$), accounting for 31.2% of the observed variation in production. In contrast, management system showed no significant effect on milk yield ($F = 2.532$, $p = 0.087$) or disease prevalence ($\chi^2 = 4.881$, $p = 0.087$). Disease prevalence was high, affecting 63.6% farms in Kilinochchi district. However, no significant associations were observed with housing type, seasonal variation, or stocking density. Adaptation for Artificial insemination in Kilinochchi district was relatively high (60.6%), these results indicating a gap between technology adoption and effective utilisation. This study findings give that, structural scale in Kilinochchi farms, represented by herd size, plays a more decisive role in dairy productivity than farm-level management practices. These findings highlight the need for future dairy development strategies to improve management, locally adapted feeding, upgrading practices suitable for the conditions of Northern in Sri Lanka that would be necessary to improve productivity of dairy farms.

Keywords: Dairy Production; Herd size; Kilinochchi; Management system; Milk yield

ICSD26_360

EVALUATING FECAL PELLET-GROUP COUNT METHODS FOR ESTIMATING SPOTTED DEER (*Axis axis*) DENSITY IN SUBURBAN LANDSCAPES: IMPLICATIONS FOR DISEASE MANAGEMENT

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Abstract: Estimation of population density is essential in the control of the disease risks associated with wildlife in the suburban areas, where human-wildlife contact can lead to the spread of zoonotic diseases. In Homagama and Kaduwela divisions of Colombo District, Sri Lanka, feral populations of spotted deer have become established out of their native range, which is drawing the attention of the public with a rabies outbreak in 2022, which claimed > 20 deer deaths. Although Fecal Standing Crop (FSC) and Fecal Accumulation Rate (FAR) techniques are well-tested to measure ungulate abundance in natural habitats, the techniques have not been tested in the heterogeneous suburban setting. This pilot study evaluated the accuracy of FSC and FAR across three suburban habitat types: scrubland, rubber plantations, and home gardens, during the dry season (February–March 2021) to minimise weather-induced pellet decay. Both methods were tested using two plot sizes (100 m^2 and $4m^2$). For FSC, all existing pellet groups were quantified on the first visit; for FAR, plots were cleared and revisited after 14 days to collect newly accumulated pellet groups. Simultaneous line transect surveys provided reference densities ranging from 46 to 197 deer/km^2 across habitats. Both indirect methods substantially overestimated density relative to transect-derived references: FAR by 13-fold and FSC by 30-fold on average. FAR with small plots yielded the lowest absolute errors. Rubber plantations produced the most accurate estimates, while home gardens exhibited the largest deviations. Major sources of error include the lack of population-specific defecation and decay rates, non-uniformly distributed pellets on fragmented landscapes, and removal of pellets through anthropogenic activities. Such results indicate that conventional techniques need substantial calibration, including population-specific biological parameters and habitat-specific correction factors, in order to be used reliably in suburban environments. Such methods are essential for accurate density estimation to inform effective disease surveillance and management.

Keywords: Indirect Population Survey; Pellet Group Counts; Spotted Deer Density Estimation; Suburban Wildlife Monitoring; Zoonotic Disease Management

FOOD PROCESSING, PRODUCT DEVELOPMENT, AND FOOD TECHNOLOGY INNOVATIONS - II

ICSD26_026

DEVELOPMENT OF NATURAL EDIBLE COATING FROM CEYLON OLIVE (*Elaeocarpus serratus*) LEAVES, ALOE VERA, TURMERIC AND CINNAMON LEAVES TO CONTROL SOFT ROT IN TOMATOES

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Abstract: Postharvest spoilage caused by soft rot results in serious damages to the quality and market value of fruits such as tomatoes. This study aimed to develop an eco-friendly natural edible coating incorporating extracts from Ceylon olive (*Elaeocarpus serratus*) leaves, Aloe vera (*Aloe barbadensis miller*), Turmeric (*Curcuma longa*), and Cinnamon (*Cinnamomum verum*) leaves for the prevention of microbial spoilage while extending the shelf life of tomatoes. Plant materials were collected, dried and subjected to ethanolic extraction and mixed with corn starch, carboxymethyl cellulose and glycerol to create four coating formulations (F1-F4), which were screened for their physicochemical, antioxidant, and antimicrobial properties. The pathogen *Erwinia carotovora* was isolated from naturally infected tomatoes and cultured and confirmed based on its morphological and biochemical characteristics, and then used to artificially inoculate healthy tomatoes during the study. The optimized formulation was verified using sensory evaluation and it showed strong antimicrobial activity against *Erwinia carotovora* with inhibition zone of 15.2 mm, comparable to positive control (70% ethanol, 12.5 mm). Coated tomatoes showed lower pH, slower total soluble solid increase and reduced weight loss compared to uncoated controls over the storage time, indicating the coating effectively minimized moisture loss, delayed ripening and maintained firmness during storage. In addition, tomatoes treated with selected formula had higher antioxidant potential with 67.30% DPPH radical scavenging activity. The presence of phenolics, flavonoids, and other active compounds in the extracts responsible for the high level of radical scavenging activity was confirmed using Fourier Transform Infrared Spectroscopy. The preservation activity of various extract combinations had synergetic effects on the improvement of the storage stability under both ambient and refrigerated storage. The developed coating is promising as a consumer-safe, natural alternative to artificial preservatives, which is in line with sustainable postharvest management and the global trend towards using edible and biodegradable food protection technologies.

Keywords: Aloe vera; Ceylon Olive; Cinnamon; Edible Coating; Soft Rot; Turmeric

ICSD26_082

SUSTAINABLE FOOD SYSTEMS: INTEGRATING FOOD SCIENCE, NUTRITION, AND ENVIRONMENTAL STEWARDSHIP FOR A RESILIENT FUTURE

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Abstract: The global food system faces unprecedented challenges, balancing the need to feed a growing population while minimizing environmental impacts and ensuring nutritional adequacy. This review examines the intersection of food science, nutrition, and sustainability within contemporary food systems, highlighting innovative approaches, persistent challenges, and emerging solutions. Through comprehensive analysis of recent literature, we explore how sustainable food systems can simultaneously address climate change, biodiversity loss, and malnutrition while maintaining economic viability. Key findings reveal that successful transformation requires integrated approaches combining technological innovations, policy interventions, and behavioral changes across the entire food value chain. The review identifies critical research gaps and proposes a framework for future investigations that prioritize equity, environmental stewardship, and nutritional outcomes in food systems transformation.

Keywords: Climate Change; Environmental Impact; Food Science; Food Security; Nutrition; Sustainable Food Systems

ICSD26_174

DEVELOPMENT OF RAW MANGO (*Mangifera indica)* CHEWY CANDY FILLED WITH CHILI *(Capsicum annum)* AND SALT LIQUID FILLING

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Abstract: Fruit-based confectionery systems are a viable way of integrating traditional flavors with modern food technology. A methodical experimental strategy involving liquid-center encapsulation, hydrocolloid optimization, and standardization of the ingredients was used. The chewy candy was formulated by using tropical fruit pulp that consists of raw mango (50%), sugar (30%), sugar syrup (7%), corn starch (10%), gelatin (1%), and butter (2%). For the liquid filling, solutions of sodium chloride (15%) and chili powder (20%) were prepared in optimal proportions. Sensory evaluation was conducted for three formulations that were evaluated by 50 semi-trained panelists using a 5-point hedonic scale to assess appearance, texture, sweetness, sourness, and overall acceptability. pH (3.46 ± 0.011), total sugars (Lane-Eynon) (4.14 ± 0.007%), Total Soluble Solid (TSS) (34.00 ± 0.10^0 Brix), total phenols (0.108mg GAE/g), titratable acidity (1.11 ± 0.014), water activity (0.74 ± 0.0076), and serum salt concentration were a few of the analytical parameters that were tested. The proximate analysis of the developed raw mango chewy candy revealed a moisture content of 9.17 ± 0.06%, ash content of 0.54 ± 0.02%, fiber content of 0.56 ± 0.01%, and fat content of 2.78 ± 0.02%, indicating good nutritional composition and shelf-stability. To determine mechanical integrity, texture profile analysis (hardness, cohesiveness, springiness, and chewiness) was performed on the chewy candy. Microbiological safety was evaluated using total plate count and yeast and mold enumeration. The chewy candies are stable at room temperature for two months without preservatives. The shelf life is extended to 10 months with preservatives. The target is a palatable sweet having a harmony of sour, spiciness, and saltiness, and commercial potential as a value-added tropical fruit item.

Keywords: Chewy Candy; Chili–Salt Filling; Raw Mango; Sensory Evaluation; Texture Profile Analysis

ICSD26_193

A BEHAVIOURAL STUDY OF STUDENT FOOD WASTE IN STATE UNIVERSITY CAFETERIAS IN SRI LANKA

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Abstract: University canteens generate significant food waste showing the importance of adopting sustainable food practices and effective waste-reduction strategies. This paper will examine the behavioural, perceptual, and situational concepts that influence food waste among students of nine state universities in Sri Lanka. Data were collected from 151 students using an online structured questionnaire distributed via convenience sampling. This survey measured demographics, eating habits, food waste practice, and attitudes, as well as awareness and personal interest with waste-reduction programs. Data were analysed using descriptive statistics, factor rankings, and thematic grouping. The results indicate that food waste has been identified as a problem of high importance at university level with 73.5% stating that it is a serious issue and 91% approving of the sustainability-based food waste minimization initiatives. The behavioural responses showed that more than half of the students do leave food without eating even if the quantities are minimal. Students were moderately willing to change their habits, and almost half of them were willing to use incentive-based methods. Taste was found to be the most influential factor contributing to food waste, followed by the temperature of the food, its presentation, and the quantity served. The situational factors like Limited time availability and peer influence were not that important. Three types of student groups were identified using the cluster analysis: motivated but waste-prone frequent dinners (36.4%), regular users with low wastage (27.2%) and occasional users (36.4%) with high support of awareness efforts. All groups demonstrated a high intensity to participate in reduction efforts such as portion size choices, delivering high-quality food, and composting. This research concludes that food waste from students is caused by a combination of perceptual, behavioural, and situational factors. Very cheap and easy interventions, enhancing taste, providing flexible service, and enhancing awareness could have a significant impact on minimizing food waste in university cafeteria.

Keywords: Food Waste; Student Behaviour; Student Segmentation; Sustainable Consumption; University Cafeteria

ICSD26_271

HIGH TEA AND CONSUMER PERCEPTIONS: AN INNOVATIVE MARKETING STRATEGY TOWARDS SUSTAINABILITY

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Abstract: This research explores the factors of consumer decision-making in regard to high tea in Sri Lanka, in an attempt to find out the market landscape, market segmentation strategies, and consumer perception. A descriptive survey method is used to collect the data from 50 participants, basically undergraduate students, aged between 18 - 34 years by an online questionnaire, which helped in collecting information on demographics, preferences, and perceptions about high tea. Additionally, there was also a study of analyzing digital information, comprising social media posts, to get better insights into high tea promotions. It was found that the presentation and taste of the food and beverages, the reputation of the hotel, and variety in the menu are crucial factors that influence consumer preferences. Most respondents prefer high tea in the evening, and they would like to spend below Rs 3000. It was noted that consumers want more variety in food and that the way the dishes are presented should be more appealing. The marketing landscape map, based on 7 Ps of marketing (Product, Price, Place, Promotion, People, Process, Physical Evidence), emphasizes key marketing mix factors that are required for effective high tea promotion. The research concludes that a well-defined strategy for market segmentation and a comprehensive model of consumer behavior are crucial for innovating the offering of high tea. This research not only contributes to the knowledge of consumer preference analysis but also offers concrete possibilities for improving high tea marketing strategies in Sri Lanka, with the final objective of enriching the consumer experience.

Keywords: Consumer Behaviour, Consumer Decisions, Consumer Preferences, High Tea, Sri Lanka

ICSD26_311

EVALUATING THE ENVIRONMENTAL IMPACT OF TUNA LOIN EXPORT THROUGH LIFE CYCLE ANALYSIS: A CASE STUDY OF A LARGE-SCALE MANUFACTURING PROCESS IN SRI LANKA

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Abstract: Seafood is vital for global food security, contributing significantly to the world's protein intake and public health. Rising global consumption increases environmental impacts. Limited research has been conducted on the entire life cycle of seafood production in developing countries like Sri Lanka. To address this, a Life Cycle Assessment (LCA) of tuna loin production was conducted at large – scale seafood processing company. The system boundary includes: trawler fishing, transport from port to factory, processing and packaging at the factory, and transport to the airport for export. The functional unit is one tonne of vacuum-packed, fresh tuna loins, which was used to assess both midpoint and normalized impact categories. inventory data was analyzed through the SimaPro (Version 10.2.0.2 Faculty (Demo)) software and the output figures were processed using Microsoft Excel. The study found that the tuna loin production is the major contributor with 90% of the life cycle inventory and fishing phase accounting over 80% across most categories such as global warming potential, ozone formation, acidification, eutrophication, toxicity, and fossil fuel scarcity, largely due to high diesel consumption and thermoplastic rubber bait usage. Electricity is the second large contributor in ionizing radiation, freshwater eutrophication while packaging and transport have relatively lower impacts. Sensitivity analysis shows linear responses of environmental impacts to both transport distance with each ± 10 tkm change variation of ± 18% and allocation to tuna loins varied from 80% to 100% with proportional and symmetrical changes. Consistent with previous seafood LCAs, fishing is the main contributor to greenhouse gas emissions. The findings propose mitigation strategies as using modernized fleets, the use of low-toxicity bait materials, improving fuel efficiency, optimizing electricity and ice production during processing and use of low-impact packaging materials. These measures can significantly lower the environmental impacts of tuna loin production in Sri Lanka.

Keywords: Fishing; Global Warming Potential; Life Cycle Assessment; Sri Lanka; Sustainable Practices; Tuna Loin Production

DIGITAL TRANSFORMATION, DATA ANALYTICS, AND EMERGING TECHNOLOGIES - II

ICSD26_178

A COMPARATIVE ASSESSMENT OF DRIVERS & BARRIERS INFLUENCING BLOCKCHAIN ADOPTION IN SRI LANKA'S LOGISTICS SECTOR

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Abstract: This study examines the adoption of blockchain technology within Sri Lanka's logistics sector by evaluating the key drivers and barriers that influence its implementation. Through the application of the Analytic Hierarchy Process (AHP), the research systematically structures and prioritizes the factors that shape blockchain readiness. The findings reveal how technological, organizational, and economic considerations interact within the local logistics environment highlighting 'Traceability' as the most significant driver and 'Resistance to Change' as the most critical barrier. By determining the relative importance of each driver and barrier, the study offers a valuable decision-support foundation for organizations and policymakers seeking to understand and leverage blockchain's transformative potential in Sri Lankan logistics operations.

Keywords: Barriers; Blockchain Adoption; Drivers; Logistics

ICSD26_205

IMPACT OF AI BASED PROCESS AUTOMATION (RPA) ON PERCIEVED EMPLOYEE JOB SATISFACTION

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Abstract: With the advancement of technology, robots have increasingly replaced the routine, manual tasks that humans once performed. This has also affected the IT industry; instead of robots, a computer program known as bots will mimic human activities. Hence, RPA or robotic process automation (usage of bots) has replaced humans by performing daily routine manual tasks. Even though routine tasks are completed by the bot, humans must be involved in making decisions regarding the work the bot has done. This research aimed to assess the impact of RPA on perceived employee job satisfaction. This study was carried out to find whether the technological knowledge and degree of modification in job roles have been affected after adapting RPA in their organizational processes, which will ultimately affect the perceived employee job satisfaction. This study was a quantitative approach, gathering questionnaire responses from 131 respondents who work with RPA in Dialog Axiata PLC. The analysis used multiple regression analysis via SPSS 25.0. The study findings showed that a change in job role and lack of technological knowledge have a significant impact on the perceived job satisfaction of employees. Therefore, organizations and employers need to focus on increasing perceived employee job satisfaction by providing technological knowledge using workshops and training, assisting employees to adapt to the change in their job roles. Furthermore, the study confirmed that there is a significant impact on perceived employee job satisfaction due to modifications in job role and technological knowledge after implementing RPA.

Keywords: AI based Automation; Job Satisfaction; RPA; Technological Knowledge

ICSD26_207

DEVELOPMENT AND EVALUATION OF "PM PRO": A LIGHTWEIGHT WEB-BASED PROJECT MANAGEMENT SYSTEM FOR CONSTRUCTION SMES

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Abstract: Construction Small and Medium Enterprises (SMEs) frequently rely on spreadsheets and paper-based processes for project planning, cost control and reporting. These ad-hoc workflows are error-prone, provide limited visibility of project status, and do not scale with organisational growth. This paper presents the design, implementation and evaluation of PM PRO, a lightweight web-based project management system specifically targeted at construction SMEs. PM PRO is implemented as a hybrid single-page application using HTML5, CSS3 and vanilla JavaScript frontend with PHP/MySQL backend for persistent data storage and XMPP integration for real-time multi-user collaboration, ensuring both ease of deployment and scalable infrastructure. Core modules include project and task management, a Gantt-chart based scheduling interface, materials inventory, automated billing with configurable profit margins and labour rates, and professional PDF export for invoices and Bills of Quantities (BOQ). A user-centred methodology was adopted involving requirements elicitation from site engineers, iterative interface prototyping and full-stack performance testing. Results show sub-500 ms API responses, under two seconds page load times, instantaneous client-side updates with real-time XMPP synchronization, and strong user preference for the Gantt visualisation compared with traditional tabular schedules. The system was evaluated with five construction professionals who rated it highly for ease of learning, time-saving capabilities and collaborative features. Performance benchmarks on mid-range hardware demonstrated section switching under 300 milliseconds, BOQ PDF generation within 3-4 seconds for projects with 50 tasks, and reliable multi-user concurrency. The paper concludes that PM PRO provides a practical, extensible platform for digitising project control activities in resource-constrained construction firms.

Keywords: Billing and BOQ; Construction Management; Gantt Chart Scheduling; Materials Inventory; Small and Medium Enterprises; Web Application

ICSD26_230

MACHINE LEARNING APPROACHES FOR MODELING THE DYNAMIC EFFECTS OF ECONOMIC INDICATORS ON GROSS DOMESTIC PRODUCT

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Abstract: The Gross Domestic Product (GDP) is the most common economic performance measure. Seasonally adjusted to account for changes in weather or yearly calendars, the GDP tells how an economy is doing in broad terms. This study has approved that the Machine Learning (ML) models can be used to predetermine the GDP value using the economic indicators such as the American Monetary Authority (AMA) Exchange Rate, International Monetary Fund (IMF) Exchange Rate, Economic value added, Agriculture hunting forestry fishing, Construction, Exports of goods and services, Imports of goods and services and Mining Manufacturing Utilities of 130 counties around the world. This work is a full systematic review and in-depth analysis of the most related literature involving complex relations of economic indicators and GDP utilized three ML algorithms. Models were implemented with Gradient Boosting Machine (GBM), Gradient Boosting Regressor (GBR), and Artificial Neural Network (ANN). Of them all the ANN model gave us the best results in our study. It has been shown that the ANNs model analysed was able to represent a high amount of variation with Coefficient of determination (R^2) value 0.92 of GDP, stimulated by adjustments in the attributes. The very low Mean Square Error (MSE) of the ANN model 0.0079% and the small error range of 0.32% Mean Absolute Error MAE, reveal to a great extent the capabilities of the model to predict GDP figures almost exactly the real numbers. These excellent results can be also verified from a minimum predicting of the ANN model, 0.32% of MAE and 0.0079% of MSE, although some deviation is observed between the calculating values and the actual values. The results demonstrate the value of ML techniques in economic modelling and forecasting, especially about the ANN's capacity to capture the dynamic influence of economic variables on GDP, providing analysts with a useful analytical tool.

Keywords: Artificial Intelligence; Economic Indicators; Exchange Rate Fluctuations; Gross Domestic Product; Machine Learning

ICSD26_243

CONSENSUS-BASED COORDINATION FOR PROACTIVE DEADLOCK DETECTION IN DISTRIBUTED QUEUEING SYSTEMS

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Abstract: Distributed queueing systems provide the basis for many current computing platforms, where multiple nodes with asynchronous access compete for common resources. In these types of environments, deadlocks can cause systems to be blocked for extended periods of time and cause severe performance degradation. Identifying deadlock-prone states is therefore important at an early stage, but it is difficult because of partial observability and decentralized decision-making. Conventional deadlock detection approaches rely mainly on global cycle detection, which detects deadlocks only after system progress has been stalled. Although probabilistic local predictors can indicate early risk, the fact that they are not coordinated often leads to conflicting decision-making and the high rate of false early warnings. This research is a proposal for an intelligent, consensus-based coordination framework for early deadlock detection, which incorporates a combination of Markov-based state transition modelling and a distributed consensus algorithm. In the proposed framework, the probability of entering a deadlock prone state is estimated independently by each node by analysing local resource waiting behaviour. These probabilistic risk estimates are periodically distributed among neighbour nodes and validated using a consensus algorithm which aggregates a multiple system-wide views throughout the system. A condition of deadlock is confirmed only if the consistent pattern of risk is observed by multiple nodes over a series of observation windows. By enforcing collective agreement, the consensus mechanism works as a validation layer that screens the transient congestion effects and stabilizes early detection decisions. The framework is tested based on parameters such as detection lead time, detection accuracy, false positive rate and inter-node consistency under different workload conditions. Experimental results show that the proposed approach detects the deadlock prone conditions up to four observation intervals before traditional cycle-based methods. The average early deadlock detection accuracy is approximately 83%, while the final hybrid framework achieves a classification accuracy of 93.33%. The findings prove that the integration of a consensus algorithm is important when it comes to reliable and coordinated early deadlock detection in distributed environments. By converting individual local predictions into validated decisions at the systems level, the proposed framework leads to improved and efficient resource usage, lower levels of unnecessary recovery operations and better long-term stability of the systems. These improvements are supporting the sustainable operation of distributed computing infrastructures by reducing resource wastage, reducing energy use, and fostering scalable and resilient digital systems.

Keywords: Consensus Algorithm; Consensus-Based Coordination; Distributed Queueing Systems; Distributed Systems; Early Deadlock Detection

ICSD26_247

PRECISION-ORIENTED PROACTIVE DEADLOCK DETECTION IN DISTRIBUTED SYSTEMS USING MARKOV CHAINS AND CONSENSUS PROTOCOLS

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Abstract: Deadlocks remain a critical challenge in distributed systems due to concurrent resource access and the limitations of reactive detection mechanisms. Most existing approaches identify deadlocks only after they have occurred, leading to temporary system stalls and performance degradation. This paper proposes a proactive deadlock forecasting framework that integrates Markov chain modelling, machine learning, and distributed consensus mechanisms. The Markov model estimates future deadlock risk based on system state transitions, while machine learning models analyse both raw system metrics and analytically derived features to capture complex deadlock patterns. A consensus-based validation layer improves prediction reliability across distributed nodes. Experimental evaluation demonstrates that the proposed hybrid framework achieves higher detection accuracy than traditional reactive approaches while maintaining robustness under partial node failures. The results indicate that combining analytical modelling with data-driven learning enables effective early warning of deadlock-prone system states, supporting timely preventive intervention in distributed systems.

Keywords: Consensus Algorithms; Distributed Systems; Ensemble Machine Learning; Markov Model; Proactive Deadlock Detection

ICSD26_298

DIGITAL LANDSCAPE IN PUBLIC SERVICE IN SRI LANKA: SERVICE PROVIDER AND RECIPIENT PERSPECTIVES

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Abstract: Digital public service delivery is a key dimension of effective contemporary governance; however, in many developing countries, the progress of digitalization remains uneven and fragmented. Sri Lanka illustrates this challenge, where relatively high human development outcomes coexist with weak performance in digital governance, indicating structural and institutional deficiencies in public service delivery. This study addresses the problem of low public awareness, inconsistent adoption, and partial implementation of digital public services by examining both service recipient and service provider perspectives within a medium-level administrative context. Using a convergent mixed-methods approach, the study combines quantitative survey data from 109 public service recipients with qualitative evidence from in-depth interviews and key informant interviews conducted among divisional-level public officials at the Kelaniya Divisional Secretariat Office. Descriptive statistical techniques and thematic analysis were applied to examine customer awareness and perceptions of online services, levels of digitalization and manual processes, communication tools and techniques, and institutional challenges affecting service delivery. The findings demonstrate that public awareness of existing digital services is notably low, although citizens generally hold positive attitudes toward digital public service delivery. From the institutional perspective, public officials express strong willingness to advance digitalization; however, implementation is constrained by inadequate infrastructure, limited internet connectivity, fragmented systems, reliance on parallel manual processes, and the use of informal digital communication platforms. As a result, the overall level of digitalization within the study institution remains at a premature stage, restricting service efficiency and responsiveness. The study concludes that effective digital transformation in Sri Lanka's public sector requires integrated policy frameworks, investment in infrastructure, institutional capacity building, and citizen-focused awareness initiatives, alongside the establishment of secure and standardized digital service and communication systems. By capturing ground-level realities from both service recipients and providers, this study offers empirical insights and practical implications for strengthening digital public service delivery in developing country contexts.

Keywords: Digital Public Service Delivery; E-governance; Service Recipient Awareness; Institutional Challenges; Public Sector Digitalization; Sri Lanka

ICSD26_306

MAPPING THE KNOWLEDGE LANDSCAPE OF BLOCKCHAIN IN SUPPLY CHAINS: BIBLIOMETRIC INSIGHTS AND EMERGING TRENDS

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Abstract: Blockchain technology has emerged as a transformative enabler of transparency, traceability and trust with in supply chains. Simultaneously, the advent of Industry 4.0 has accelerated the integration of advanced digital technologies, such as artificial intelligence, cloud computing and the Internet of things into global supply chain systems. Despite the growing volume of research on blockchain applications in supply chain management, comprehensive bibliometric syntheses that consolidate the intellectual structure of the field remain limited, resulting in fragmented knowledge. To address this gap, the present study conducts a bibliometric analysis of 1858 Scopus indexed publications published between 2014 and 2024. The analysis employs the bibliometric package (Biblioshiny in RStudio) alongside the PRISMA framework to examine development. The findings reveal a substantial growth in scholarly output, with significant contributions from China, India and the United States. These primary research clusters emerge (1) blockchain foundations and distributed ledger technologies, (2) blockchain applications in supply chain operations and logistics and (3) governance mechanisms, trust dynamic and performance implications. Thematic mapping further indicates that while the technological foundations of blockchain are relatively mature, emerging areas such as sustainability, circular economy practices and such as sustainability, circular economy practices and integration with IoT and AI represent promising avenues for future inquiry. Overall, this study provides a comprehensive synthesis of research trends, clarifies the theoretical landscape and proposes future research directions for blockchain enabled supply chains.

Keywords: Bibliometric Analysis; Blockchain; Digital Transformation; Industry 4.0; Supply Chain Management

ENVIRONMENTAL TECHNOLOGIES, RESOURCE MANAGEMENT, AND SUSTAINABLE ENGINEERING SOLUTIONS

ICSD26_102

E-SHIELD – THE SMART LOW-FREQUENCY ELEPHANT REPELLENT FOR RAILWAYS

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Abstract: Elephant-train collisions are a significant problem in Sri Lanka, threatening both wildlife and railway operations. To tackle this issue smartly and ethically, E-SHIELD – The Smart Low-Frequency Elephant Repellent for Railways has been created as an intelligent acoustic system mounted on trains. This innovative solution utilizes targeted low-frequency signals, eliminating the need for expensive sensors, cameras, or fencing, while ensuring reliability and effectiveness. The primary aim is to keep the system straightforward, employing behaviourally informed, data-driven acoustic deterrence to avert collisions. E-SHIELD sends out infrasonic signals specifically designed for elephants (below 20 Hz) that are inaudible to humans but can be detected by elephants from distances of 1 to 3 kilometres, depending on the terrain and vegetation. As the train nears forested areas or known elephant crossing points, the system automatically activates through GPS-based geofencing. The low-frequency vibrations replicate natural warning and discomfort calls, prompting elephants to steer clear of the tracks well before the train arrives. To achieve greater accuracy, E-SHIELD employs a directional phased-array speaker system that directs sound beams toward areas where elephants might be, all while keeping the experience comfortable for passengers and nearby communities. It features an adaptive module that fine-tunes the volume and pitch based on the train's speed, surrounding noise, and its current location. A built-in microcontroller takes care of everything on its own, ensuring reliable operation with minimal human oversight. E-SHIELD offers a simple, durable, and cost-effective alternative to camera or radar systems. Its modular, train-mounted design enables easy installation and runs on the train's power or a separate module. Using adaptive acoustic control, it safely reduces elephant-train collisions and protects wildlife.

Keywords: Acoustic Signals; Animals Safty; Elephant Repellent; Elephant Train Collisions; GPS based Geofencing

ICSD26_126

DEVELOPING A CODE OF PRACTICE IN USING FLAMMABLE/ TOXIC REFRIGERANTS IN HVAC/R SECTOR IN SRI LANKA

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Abstract: The Sri Lankan Refrigeration and Air-Conditioning sector is undergoing a crucial transition from ozone-depleting substances and high-GWP refrigerants to comply with the Montreal Protocol and the Kigali Amendment. This transition introduces low GWP alternatives like hydrocarbons, ammonia, and carbon dioxide, which present significant flammability and toxicity hazards. The existing national code of practice, SLS 1337:2008, was developed during the CFC/HCFC phase-out, focusing primarily on ODS containment. It does not imply the necessary framework to manage the distinct safety risks of next-generation refrigerants. This paper details the systematic development of SLS 1337:2025 as the first revision, to address this critical safety gap. The methodology includes a comprehensive literature review of current international standards, such as ISO 817, IEC 60335, and ASHRAE handbooks. This established a baseline of global best practices, with a detailed comparative analysis of the 2008 and 2025 documents to quantify the scope of the revision. The analysis shows a strategic evolution from a code, mainly focused to prevent ODS leaks, to a comprehensive, risk-based code of safety. Key findings confirm the proposed code of practice introduces a robust safety framework, including enhanced installation and maintenance requirements for domestic, commercial, industrial, mobile, transport, and marine RAC systems, refrigerant-specific protocols for hydrocarbons, ammonia, and CO_2, risk-based charge size limitations calculated from room area, and the provision of explicit procedures for handling natural refrigerants. The publication of SLS 1337:2025 provides an essential, updated safety framework that enables the Sri Lankan RAC industry to adopt sustainable technologies. This paper specifies standardized practices designed to minimize risks and enhance technician competency, ensuring a safe, sustainable, and nationally compliant transition.

Keywords: Code of Practice; Flammability; Low-GWP; Refrigerants; Safety

ICSD26_157

A COMPREHENSIVE REVIEW ON RECENT ADVANCES IN FLEXIBLE SELF-POWERED ENERGY SYSTEMS: INTEGRATION STRATEGIES OF TRIBOELECTRIC NANOGENERATORS WITH SUPERCAPACITORS FOR NEXT-GENERATION WEARABLE ELECTRONICS

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Abstract: The growing demand for sustainable, energy-efficient, and flexible power solutions in wearable electronics has accelerated research into self-powered energy systems that overcome the limitations of conventional batteries. Among emerging approaches, triboelectric nanogenerators (TENGs) have attracted significant attention for their ability to harvest biomechanical and environmental energy through contact electrification. However, their intermittent power output necessitates effective integration with supercapacitors (SCs) to achieve stable and continuous energy delivery. This review presents a comprehensive overview of recent advances in flexible self-powered energy systems that combine TENGs with SCs for next-generation wearable electronics. Key focus areas include the working principles, integration architectures, material innovations, and performance optimization strategies enabling efficient energy harvesting, storage, and management. Developments such as helix-belt, textile-based, and micro-patterned designs, along with stretchable elastomers, conductive polymers, and nanostructured electrodes, have markedly improved mechanical resilience, charge density, and energy conversion efficiency. The synergistic coupling of TENGs and SCs offers a promising route toward eco-friendly, self-sustaining, and scalable power platforms for applications in health monitoring, smart textiles, and personalized Internet-of-Things (IoT) systems. Finally, the review identifies current challenges and future directions in material durability, integration efficiency, and system miniaturization, highlighting the transformative potential of hybrid TENG-supercapacitor technologies in powering the next generation of flexible electronics.

Keywords: Energy Harvesting; Self-Powered Systems; Supercapacitor; Wearable Electronics

ICSD26_210

STUDY OF THE CHEMICAL ASPECTS OF ACCELERATED ROCK WEATHERING AT THE VICINITY OF SAMANALAWEWA RESERVOIR

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The Samanalawewa Reservoir, one of the major hydropower facilities in Sri Lanka, has been negatively affected by accelerated rock weathering in the dam and adjacent quarry areas. So, the rock weathering rate is higher than the natural rock weathering rate. This phenomenon has increased significant concerns about the long-term structural integrity and safety of the dam. Despite its significant implications, no scientifically validated mechanism has yet been established to explain the rapid weathering process. Therefore, this study aims to investigate the chemical and mineralogical characteristics of rocks and water from the Samanalawewa dam site and nearby quarry, with the objective of developing a geochemically plausible mechanism for the observed rapid weathering. A total of twenty weathered and unweathered rock samples and water samples were collected from the dam and quarry sites. Mineralogical and Surface features of the rock samples were examined using the analytical instrumental techniques. The mineralogical and chemical compositions were characterized through Powder X-ray Diffraction (XRD) and X-ray Fluorescence (XRF) spectroscopy. Additionally, twenty water samples seeping through the rocks were analysed. Major ion concentrations were measured using Atomic Absorption Spectroscopy (AAS) and Ion Chromatography (IC), while water acidity and alkalinity were determined using a calibrated pH meter. The mineralogical and chemical analyses revealed notably high concentrations of calcium oxide, silicon, iron, and sulfur in the weathered rock samples. In addition to these major components, trace amounts of several rare earth elements, including gadolinium (Gd), terbium (Tb), and thulium (Tm), were also detected, suggesting a complex and enriched geochemical profile. XRD analysis confirmed the presence of mineral phases such as natural gypsum ($CaSO_4 \cdot 2H_2O$), kaolinite ($Al_2Si_2O_5(OH)_4$), and quartz (SiO_2) in the weathered rock materials, all indicative of advanced chemical weathering processes. Sulfate (SO_4^{2-}) was identified as the dominant anion in the water samples, with concentrations ranging from 38.8 to 74.5 mg/L, significantly exceeding those of other detected anions. This suggests a strong correlation between sulfide oxidation and the formation of secondary sulfate minerals, particularly gypsum, within the weathered rock matrix. The identification of natural gypsum, along with the potential presence of pyrite (FeS_2) and pyrrhotite ($Fe_{1-x}S$), highlights the potential for sustained acid generation through oxidative weathering processes. This can be controlled using the following techniques. Such as chemical neutralization and rock blending, introducing physical barriers to reduce oxidative reactions, and chemical coating of the rocks to reduce oxidative reactions.

Keywords: Acid Mine Drainage; Natural Gypsum; Pyrite, Rapid Weathering; Sulfide Oxidation

ICSD26_272

A NOVEL AVIAN - INSPIRED DOUBLE WISHBONE ELECTROSTATIC PARADIGM FOR ENHANCED FOG HARVESTING AND SUSTAINABLE WATER RECOVERY

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Abstract with global freshwater demand projected to outstrip supply by 40% by 2030, the development of highly efficient atmospheric water generation technologies has shifted from a scientific novelty to a humanitarian necessity. Traditional passive mesh collectors are limited by an "aerodynamic efficiency ceiling," typically capturing less than 10% of available liquid water content due to droplet diversion around mesh fibers. This research introduces a novel hybrid paradigm that transcends these physical limitations by integrating a biomimetic Double Wishbone structural frame with active electrohydrodynamic (EHD) enhancement. Drawing inspiration from the vibration-damping properties of an avian wishbone and automotive suspension kinematics, the system utilizes a compliant, 3D - printed frame (ASA/ABS+) that dynamically sheds wind loads while maintaining the critical 20 – 40 mm inter-electrode spacing required for stable electrostatic operation. The core novelty of this approach lies in decoupling droplet capture from wind velocity through a + 15 kV positive corona discharge. By ionizing air molecules and imparting a charge to fog micro-droplets (< 20 μm), the system utilizes Coulombic forces to actively drive water onto the grounded mesh. Theoretical analysis indicates this enhancement increases collection efficiency to over 50% a five-fold improvement over passive systems while maintaining a remarkably low power consumption of less than 50 W/m^2. Beyond immediate potable use, this high-yield recovery facilitates precision micro-irrigation for high-altitude agriculture (SDG 8) and provides a scalable framework for the restoration of degraded arid ecosystems (SDG 15), bridging the gap between advanced structural dynamics and decentralized water security.

Keywords: Additive Manufacturing; Corona Discharge; Double Wishbone Structure; Electro-hydrodynamics; Fog Harvesting

ICSD26_273

SPATIOTEMPORAL ANALYSIS OF FOREST COVER LOSS IN ANURADHAPURA DISTRICT (2000 - 2024) USING GOOGLE EARTH ENGINE

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Abstract: The dry zone forests of Sri Lanka, predominantly in the Anuradhapura District, are suffering substantial anthropogenic pressure due to agricultural expansion and infrastructure development, along with rapid urban expansion. Despite the urgency of the situation, a serious data gap exists in high-resolution and long-term monitoring at the local administrative level. The administrative level analysis is essential to capture the spatially concentrated loss and to provide actionable data for effective conservation. This research addresses the problem by conducting a comprehensive spatiotemporal analysis of forest cover loss over 24 years (2000 - 2024). The Hansen Global Forest Change dataset within the Google Earth Engine (GEE) cloud computing platform was employed in this research. Accordingly, the study was able to incorporate a "wall-to-wall" mapping approach to quantify Gross Forest Cover Loss (GFCL) across five-year intervals relative to the year 2000 baseline. To ensure administrative relevance, a detailed analysis was conducted at both the Divisional Secretariat Division (DSD) and Grama Niladhari Division (GND) levels in the Anuradhapura District. The methodology was validated against high-resolution Google Earth Pro imagery, achieving an overall accuracy of 89.8%. Results show a cumulative forest cover loss of 355.45 km^2 for 24 years. It represents a 9.56% reduction from the year 2000 forest extent. Spatial analysis identified Horowpathana as the most affected DSD, with a loss of 39.6 km^2, while Kanugahawewa appeared as the serious GND-level hotspot, losing 5.45 km^2 of forest cover. The principal drivers of this degradation were identified as chena cultivation, infrastructure development, and urbanization in the region. This research concludes that deforestation in the region is spatially concentrated rather than uniform, requiring targeted conservation. The overall impact of this work lies in providing a precise, validated baseline for local authorities to prioritize interventions in high-risk administrative zones, while demonstrating the high-fidelity utility of GEE for national environmental monitoring frameworks. Future research will involve the Net Carbon Flux (NCF) calculation by further analysing the total forest gain of the region for the period, which is a crucial limitation of the study. Moreover, the research will focus on the identification of the underlying causes of forest loss through ground-level surveys.

Keywords: Divisional Secretariat Divisions (DSD); Google Earth Engine (GEE); Grama Niladhari Divisions (GND); Gross Forest Cover Loss (GFCL); Hansen Global Forest Cover Change; Remote Sensing (RS)

ICSD26_291

COMPARATIVE PERFORMANCE AND SUSTAINABILITY OF MICROPLASTIC REMOVAL TECHNOLOGIES IN AQUATIC SYSTEMS: A PRISMA-BASED SYSTEMATIC REVIEW

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Abstract: Microplastic (MP) pollution is a severe global environmental concern, with an estimated eight million metric tons entering the world's oceans annually. Microplastics (0.05 – 5 mm) are persistent and pose risks to the marine environment and human health through bioaccumulation in the food chains. Although increasing research on this, the most efficient removal technology is yet to be decided because different methods of treatment exhibit distinct levels of efficacy and sustainability as well as scalability. Methods vary physically, chemically, and biologically and this must be done systematically by comparing the various methods, identifying optimal methods based on removal efficiency, sustainability, cost-effectiveness, and practical scalability. Following PRISMA guidelines, a comprehensive literature search was conducted across ResearchGate, Google Scholar, Scopus and Web of science databases for English-language publications (2020 - 2025). Search terms included "aquatic ecosystems", "microplastic removal", "marine pollution" "membrane bioreactors" and "natural coagulants" combined using Boolean operators (AND/OR). Twenty peer-reviewed studies were selected. Most efficient physical techniques were membrane bioreactors (99.9%), ultrasound-assisted agglomeration (90%), microbubble flotation (85 - 96%). As chemical methods electrocoagulation (99.24% at pH 7.5), metal-organic framework (> 95% and over 90% efficiency at 10 reuse cycles), and advanced oxidation processes (100% to CO_2/H_2O and 15 – 30 kWh /m^3). Extended periods were less productive using the biological approach, cases of bacterial degradation (6 - 35% at 40 - 168 days), fungal systems (30 - 36%), and algal-based approaches (42 - 81%). Use of natural coagulants (*Moringa oleifera*, chitosan) was ecofriendly with 89 - 94% efficacy and 40 - 60% cut in carbon footprint. Salinity increased the removability, with 99% in sea. Particle sizes are crucial in removal rates, efficient methods when using large particles (> 100 µm) were much less effective with small particles (< 10 µm). Membrane Bioreactor–Natural Coagulant Systems maximize the removal of microplastic (> 95% efficiency, sustainable, scalable). Specific to context: electrocoagulation on small WWTPs (> 99%), ultrasound for emergencies (5 s), Metal Organic Frameworks in future mineralization. Research gaps remain in standardization, toxicity, sustainability, and hybrid optimization, while deploying AI-optimized MBR–natural coagulant systems with advanced MOFs in municipal treatment supports zero discharge and a circular economy.

Keywords: Aquatic Ecosystems; Marine Pollution; Membrane Bioreactors; Microplastic Removal; Sustainable Technology

ICSD26_354

INTEGRATING DIGITAL TWIN AND MACHINE LEARNING IN WATER RESOURCE MANAGEMENT: A SYSTEMATIC REVIEW OF METHODS AND APPLICATIONS FOR FLOOD FORECASTING

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Abstract: Riverine systems controlled by dams require quick and precise forecasting of floods in order to protect communities downstream. However, the traditional hydraulic models are still computationally expensive and unsuitable to make emergency decisions. The systematic review is a compilation of the current literature on machine-learning based digital-twin systems in flood forecasting. With the use of PRISMA method, comprehensive search of databases in Scopus, Web of Science, and Google Scholar, which included 55 relevant publications, the search process has narrowed down to 32 papers based on rigorous inclusion criteria, such as the necessity of designing a digital-twin architecture, the selection of machine-learning algorithms, and the method of validation. Through the analysis, there is a certain utilization of ensemble learning models, especially the Random Forest and Gradient Boosting algorithms, which are effective in the mitigation of the computational risks of the traditional hydraulic models like the HEC-RAS and MIKE FLOOD, and the provision of fast predictions that can be operational to the decision-making process. Although the effectiveness of these methods is demonstrated, the current applications have a significant geographical bias towards developed countries and flood management in urban areas, and a notable lack of models to adapt to dam-influenced riverine systems in resource-restrained developing regions. The review outlines the following critical research gaps: the lack of digital-twin architectures to operate in data-sparse settings, the insufficiency of connecting real-time monitoring infrastructure with predictive models, the lack of protocols to validate dam-release conditions, and the absence of the operational deployment frameworks of the insecure river basins. Future research should focus on hybrid modelling schemes that combine principles of physics with principles of data-driven efficiency, the creation of scalable digital-twin schemes that can be adjusted to resource-constrained scenarios, and the creation of operational frameworks of flash-flood prediction downstream of large hydraulic structures in vulnerable areas.

Keywords: Data-Driven Modeling; Digital Twin; Flood Forecasting; Machine Learning; Systematic Review; Water Resources Management

SUSTAINABLE ENTREPRENEURSHIP, TOURISM, AND INNOVATION FOR ECONOMIC DEVELOPMENT - I

ICSD26_010

ASSESSING THE POTENTIAL FOR EMISSION REDUCTION AND ENERGY OPTIMIZATION IN THE DESICCATED COCONUT MANUFACTURING INDUSTRY OF SRI LANKA

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Abstract: Climate change is a major challenge, which has necessitated collective effort to reduce Greenhouse gas (GHG) emissions. In Sri Lanka, Desiccated coconut manufacturing is a key sector contributing to the export revenue, nevertheless, quantitative information regarding energy consumption trends and the industry's capacity to reduce greenhouse gas (GHG) emissions is lacking. This study intends to address this knowledge gap by assessing the GHG emission reduction potential through energy efficiency improvement and renewable energy integration in the Sri Lankan desiccated coconut industry. In this study, a gate-to-gate carbon footprint analysis was performed considering scope 1 and 2 emissions, using primary data from 9 factories. An annual energy usage of 4.49 GWh, with an energy intensity of 5.08 kWh/kg was measured. The total GHG emissions were 273.7 tons/year, and the emission intensity obtained was 0.31 $kgCO_2e/kg$. Motor system optimization yielded average efficiency improvement potentials of 8%, resulting in an overall GHG reduction of 6.79%. The main renewable energy source considered was solar photovoltaic (PV) systems. The industry's total solar energy generation capacity was recorded to be 60285.28 kWh/year, which could reduce grid electricity consumption by 19.44% and total GHG emissions by 19.44%. Together, the above measures achieved a statistically significant total GHG reduction of 26.23% ($t = 4.26$, $p = 0.003$). Despite these benefits, key challenges identified in the industry were high upfront investment for solar installation, low solar tariffs, limited coconut supply, and limited coconut shell availabitity as an alternative source to purchased firewood due to exportation. The study recommended low-interest green financing, stable rooftop solar tariff regulations, mandated energy audits, improved public-private partnerships, capacity training, and raising employee knowledge to address these issues. These results validate the importance of adopting renewable energy sources and focused energy-efficient technology in lowering greenhouse gas emissions and improving competitiveness in the DC market.

Keywords: Climate Change; Desiccated Coconut; GHG Emissions; Energy Efficiency; Renewable Energy

ICSD26_134

EVALUATING THE EFFECTIVENESS OF TEA CULTURE TOURISM ON LIVELIHOOD DEVELOPMENT OF LOCAL COMMUNITY: A CASE STUDY OF AMBA ESTATE

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Abstract: Tea culture tourism has emerged as an effective strategy for rural development in tea-producing countries like Sri Lanka, where the tea industry remains a key economic driver. Despite its significance, estate communities often face challenges such as low productivity, limited infrastructure, and income instability. AMBA Estate in Uva Province presents an innovative model that integrates organic tea cultivation with community-based tea culture tourism to enhance local livelihoods. This study aimed to evaluate the effectiveness of tea culture tourism in promoting sustainable livelihood development at AMBA Estate. Specific objectives included identifying key influencing factors, examining community perceptions, conducting a multiple linear regression analysis and providing practical recommendations. A mixed-methods, cross-sectional approach was employed, collecting data from 102 purposively sampled respondents, including farmers, estate workers, and stakeholders. Data collection tools included a structured Likert-scale questionnaire, in-depth interviews, and focus group discussions, with reliability confirmed through a pilot survey (Cronbach's alpha > 0.7). Analyses were conducted using descriptive statistics, Pearson's correlation and multiple linear regression via SPSS. Key findings revealed high community satisfaction: 68% were extremely satisfied with job creation, 85% with skill development, over 90% with cultural preservation, and 96% with income improvement. Regression results ($R = 0.913$, $R^2 = 0.834$) showed that 83.4% of livelihood variation was explained by factors including marketing strategies ($\beta = 0.158$) and community participation ($\beta = 0.166$), while occupation negatively affected some groups ($\beta = -3.431$). Correlation analysis highlighted strong positive relationships for marketing strategies ($r = 0.634$) and tourism activities ($r = 0.484$). In conclusion, tea culture tourism effectively enhances livelihoods at AMBA Estate, fostering income stability, skill development, and cultural pride. Recommendations include formalizing partnerships, expanding training programs, and strengthening marketing strategies to ensure inclusive, sustainable benefits for the community.

Keywords: Community Engagement; Economic Diversification; Livelihood Development; Rural Community; Sustainable Tourism; Tea Culture Tourism

ICSD26_145

BRIDGING COMMUNITIES AND INDUSTRY FOR SAFE WATER ACCESS: EVALUATING HOUSEHOLD SHIFTS FROM TRADITIONAL TO REVERSE OSMOSIS AND BOTTLED WATER IN RESPONSE TO CHRONIC KIDNEY DISEASE CONCERNS WITHIN KURUNEGALA DISTRICT, SRI LANKA

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Abstract: Chronic Kidney Disease of unknown aetiology (CKDu) is a significant public-health challenge in Sri Lanka's dry zone, particularly in areas with limited access to safe drinking water. Household decisions regarding water consumption are increasingly shaped by CKDu awareness and the availability of industrially supported water solutions, such as Reverse osmosis (RO) purified and bottled water. This study investigates the adoption of these safer water sources in two CKDu-affected areas: the urbanized Kuliyapitiya and the rural Polpithigama. A mixed-methods, cross-sectional design guided by Saunders' Research Onion was employed, integrating quantitative surveys (n = 316; 158 per area) and qualitative insights. Significant differences in water-source adoption were observed. In Kuliyapitiya, 65.6% (n = 104/158) of households primarily used RO or bottled water, compared to 47.2% (n = 75/158) in Polpithigama, while 34.4% (n = 54/158) and 52.8% (n = 83/158), respectively, continued relying on traditional wells or surface water. A Chi-square Test of Independence confirmed these differences were highly significant ($p < 0.05$), highlighting a strong correlation between urbanization, awareness, and adoption of industrial water solutions. CKDu concerns influenced 49.1% (n = 77/158) of households in Kuliyapitiya and 38.4% (n = 61/158) in Polpithigama to shift their water source. Perceived water quality (40.2%, n = 127/316) and CKDu risk awareness (31.25%, n = 99/316) were the primary factors influencing this shift. Education level strongly affected adoption, with the highest usage among households with higher education (28.57%, n = 90/316). Public-health program participation was limited, reported by only 35.6% (n = 56/158) in Kuliyapitiya and 30.8% (n = 49/158) in Polpithigama. These findings reveal marked urban–rural disparities in adopting safer drinking-water practices and underscore the importance of university–industry–government collaboration to enhance awareness, accessibility, and trust in sustainable water technologies for CKDu-affected communities.

Keywords: CKDu's; Public Health; RO Water; Sustainable Water Management

ICSD26_237

DEVELOPMENT OF BIODEGRADABLE SANITARY NAPKIN USING NATURAL FIBERS

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Abstract: Development of Biodegradable sanitary napkins are the sustainable alternative to synthetic pads. There is an urgent need for sustainable alternatives for synthetic pads as it causes skin allergies for some individuals and environmental pollution when disposed. This study aimed to develop biodegradable sanitary napkins incorporating corn husk and arecanut shell fibers. This research evaluated physical and chemical properties of the extracted fibers, performances of developed napkin absorbent cores and microbial safety of the developed napkin. Five percent NaOH was used for softening and 5 percent H_2O_2 used for bleaching of the fibers. Averagely 5 g of fiber amount extracted from 100g of corn leaves.Parameters including cellulose, lignin, ash content, moisture regain, absorbency, and water retention were measured in the extracted fibers. There were five treatments including corn fiber 50% : wood pulp 50%, corn fiber 30%: wood pulp 70%, Areca fibers 50%: wood pulp 50%, areca fibers 30%: wood pulp 70%, corn fiber 25%: areca fiber 25%: wood pulp 50%. The performance of the developed absorbent cores were evaluated by measuring, pH, disposability, absorbency and microbial safety, including aerobic plate count, yeast and mold count. The extracted corn fibers showed strong fluid-handling performance with a moisture absorption time of 8.77 ± 0.60 s, water retention of 89.42 ± 2.96%, and moisture region value of 4.02 ± 0.17, while manually extracted corn fibers (1.21 ± 0.04 s) and areca-nut fibers (1.29 ± 0.01 s) exhibited extremely rapid absorption. The combination corn fiber 30%: wood pulp 70% achieved the highest absorbency (144.43 ± 5.18 g) and spread diameter (4.00 cm), where as Treatments of Areca fibers 50%: wood pulp 50%, areca fibers 30%: wood pulp 70% showed the best biodegradability with disposability values of 88.70 ± 3.53% and 79.93 ± 1.57%, respectively. Microbiological analysis confirmed that all napkins were free from *Candida albicans* and *Staphylococcus aureus*, ensuring hygiene safety.Corn fiber 30%: wood pulp 70% showed superior absorbency and fluid distribution, while all prototypes met hygiene, indicating strong potential for sustainable, eco friendly menstrual products.

Keywords: Absorbency Performance; Biodegradable Sanitary Napkins; Microbial Safety; Natural Fibers; Sustainable

ICSD26_282

PRIORITIZING SERVICE QUALITY FACTORS FOR DESTINATION LOYALTY IN ELLA, SRI LANKA

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Abstract: Ella has rapidly emerged as one of Sri Lanka's most popular tourist destinations; however, accelerated tourism growth has also generated increasing complaints related to environmental cleanliness, infrastructure reliability, inconsistent service delivery, and perceived price unfairness. Local tourism authorities and businesses operate under limited resources and therefore face a critical challenge in prioritizing which service quality factors should be addressed first to improve tourist satisfaction and destination loyalty. This study aims to develop a structured, evidence-based decision-support framework to identify and prioritize the key service quality criteria influencing tourist satisfaction and recommendation behaviour in Ella. The research adopts a mixed-method approach. In the first phase, the Analytic Hierarchy Process (AHP) is used to collect expert judgments from local tourism professionals through pairwise comparisons in order to determine the relative importance (weights) of seven destination-specific criteria: Trail & Site Management, Environmental Cleanliness, Local Infrastructure Reliability, Information Accuracy, Service Reliability (Keeping Promises), Personnel Conduct & Expertise, and Perceived Value & Price Fairness. In the second phase, a survey of foreign tourists will be conducted to measure perceived performance of these criteria and destination loyalty using the Net Promoter Score (NPS). Importance–Performance Analysis (IPA) will then be applied to integrate expert-defined importance with tourist-reported performance to identify critical operational gaps requiring immediate attention. The findings are expected to support data-driven prioritization and sustainable tourism development strategies for Ella.

Keywords: Analytic Hierarchy Process; Destination Loyalty; Ella Tourism; Importance–Performance Analysis; Tourism Service Quality

ICSD26_284

SUSTAINABLE SUPPLY CHAINS IN COTTAGE INDUSTRIES: PRACTICES, CHALLENGES, AND AREAS FOR FUTURE RESEARCH

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Abstract: In recent years, sustainable supply chains have gained global attention for their environmental, social, and economic impacts. Also, different perspectives-such as sustainable supply chain management, green supply chains, and environmentally responsible supply chains emerge, highlighting various approaches to integrating environmental protection, social responsibility, and economic viability across supply chain operations as a contribution to sustainable supply chain. On the other hand, cottage industries are small-scale, family/community-based enterprises that are inherently built on sustainability due to their localised, resource-dependent, and socially embedded nature. Their reliance on manual labour, indigenous knowledge, and traditional skills supports rural livelihoods, supporting sustainable supply chain principles. Despite their significant contribution, cottage industry-based sustainable supply chains remain largely underexplored in existing literature. Most research focuses on large-scale, formalized enterprises, addressing supply chain topics such as global value chains, efficiency, and regulatory compliance. Therefore, this study aims to address this gap by reviewing existing literature to explore "how sustainable supply chains are discussed in cottage industry-related literature." A structured literature review was conducted using keyword searches in major databases, followed by title and abstract screening to identify studies related to cottage industries. The selected literature was then analysed using common codes related to "sustainability", "cottage industries", and thematically grouped to identify key patterns and discussions within the literature. The review findings indicate that existing sustainable supply chain discussions related to cottage industries primarily focus on practices such as the use of local resources, cooperative production structures, and cleaner production methods. The literature also highlights major challenges in implementing sustainability in cottage industry-supply chains, such as fragmented value chains, limited financial and technological resources, difficulty meeting sustainability standards, unequal value distribution, and poor traceability within informal networks. Accordingly, prior studies commonly emphasize the need for stronger external support and targeted policies to strengthen cottage industry-sustainable supply chains and support rural development. However, the review reveals that no existing study has holistically examined cottage industry supply chains, highlighting the need for further research to better understand sustainability practices, challenges, and overall supply chain dynamics.

Keywords: Areas for future research; Cottage industries; Implementation challenges; Sustainability practices; Sustainable supply chains

ICSD26_307

DIGITAL TECHNOLOGIES AND GREEN ENTREPRENEURSHIP: EVIDENCE ON THE ROLE OF ARTIFICIAL INTELLIGENCE, BLOCKCHAIN, AND IOT IN SME SUSTAINABILITY IN SRI LANKA

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Abstract: Digital technology and its application reshaped the traditional business operations in to smarter based with sustainable appearance specially in the emerging context of small and medium sized enterprises operated in Sri Lanka. Despite the ample of prevailing digital tools adoption and practice of artificial intelligence, Blockchain and Internet of Things mediating the SMEs to the sustainable concerned efficient environment from its every dimension. This investigation intends how these digital aligned technologies affect sustainability practices and performance among the SMEs operated in the northern province of Sri Lanka through a quantitative research design using 200 entrepreneurs in Northern province of Sri Lanka following structured questionnaires. This study deploys confirmatory factor analysis, correlation analysis and regression modelling to examine the relationship in relation to digital technology adoption, green entrepreneurial practices and sustainability outcomes from the sectors. The study routes the fundamental theories in corresponding on comprehension of the process and outcomes of the study. Findings outlines that AI, blockchain and IoT extensively adds value on green entrepreneurial practices, where AI explores the significant and strongest influence. Green entrepreneurial practices consequently influence economic, environmental and social sustainability positively. The results signify that the digital technologies indirectly stimulate sustainability across the mediation of green technology practices with encountered constraints of resources and expertism in the context.

Keywords: Artificial Intelligence; Blockchain; Digitalization; Green Entrepreneurship; Internet of Things

SUSTAINABLE INFRASTRUCTURE, GREEN CONSTRUCTION, AND ENVIRONMENTAL MANAGEMENT

ICSD26_094

ASSESSMENT OF FTIR-TGA FOR SCREENING-LEVEL CHARACTERIZATION OF AIRBORNE PARTICULATE MATTER USING ACTIVE AND PASSIVE SAMPLING

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Abstract: Airborne particulate matter (PM) is commonly regulated and reported based on mass concentration, while its chemical composition is less frequently characterised, particularly in regions with limited access to advanced analytical instrumentation. This study evaluates Fourier Transform Infrared Spectroscopy (FTIR) and Thermogravimetric Analysis (TGA) as complementary, low-cost screening tools for characterising PM collected through active and passive sampling. Samples were obtained from a range of environments, including industrial sites, urban traffic corridors, construction and transport areas, coastal locations and near-pristine settings, using short-duration active sampling and long-term passive deposition. Passive samples displayed clear site-specific thermal and spectroscopic patterns. Organic-dominated PM from a plastic recycling facility showed strong aliphatic C–H stretching near 2920 cm^{-1} and substantial mass loss between approximately 200 and 600 °C. In contrast, mineral-dominated PM from quarry and construction environments exhibited prominent silicate and carbonate absorption bands (approximately 900 - 1030 cm^{-1} and 870 cm^{-1}) and high residual mass values greater than 90 percent after heating to 800 °C. Interpretation of active samples, however, was limited by low particle loadings below 0.1 mg and interference from the polycarbonate filter, which obscured PM-specific spectral and thermal features. The findings show that FTIR and TGA offer a consistent framework for screening-level characterisation of passively collected PM, allowing clear differentiation between organic-rich and mineral-rich particles across different environments. For active samples collected at low loadings, these techniques are insufficient on their own and must be supported by additional morphological and elemental analyses. Overall, the study defines the practical scope, strengths and limitations of FTIR and TGA for PM characterisation and provides guidance for their effective use in air pollution monitoring.

Keywords: Active Sampling; FTIR; Particulate matter; Passive sampling; TGA

ICSD26_109

IDENTIFICATION OF CULTURABLE BACTERIAL SPECIES INVOLVED IN WEATHERING OF ROCKS AT SAMANALA WEWA RESERVOIR DAM, SRI LANKA

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Abstract: This is the first microbiological study of Microbially Influenced Rock Weathering (MIRW) occurring at the Samanala Wewa Reservoir Dam, Sri Lanka, where ongoing leakage and deterioration of the foundation are evident. The samples were gathered from the weathered rock surfaces of the dam and the seepage water. Bacterial isolation was done using standard microbiological techniques. Biochemical tests of the different isolates resulted in acid production, phosphate solubilization, enzyme activity and nitrate reduction, all important processes for mineral dissolution and rock weathering in the long run. Molecular characterization by 16S rRNA gene sequencing identified that the prevailing bacterial community was affiliated to the *Bacillus cereus* group, namely *B. wiedmannii, B. pumilus, B. subtilis and B. cereus*, along with *Exiguobacterium indicum*. Phylogenetic analysis revealed that the majority of isolates were closely related to previously reported mineral weathering bacteria worldwide. These Bacteria are well studied as microorganisms that can excrete organic acids, chelators, and biofilms that modify rock microstructures and speed geochemical transformations. Observations of the dam rocks by SEM correlated these results, showing different levels of advancement in bio-weathering such as surface etching, fracturing and Micropores. Taking altogether of biochemical, molecular and physical data strongly supports that micro communities, in particular *Bacillus spp*., have a role in the weathering of the dam's Rocks. This work establishes important principles for the comprehension of microbiological mineral degradation in engineered systems. Although additional indepth studies and large scale field validation are still necessary, this evidence points out the importance of accounting for microbial activity in dam safety management programs, planning for long term water management strategies under tropical regions and routine maintenance cascading programs.

Keywords: 16S rRNA Gene Sequencing; Environmental Microbiology; Microbial ecology; Rock Weathering Bacteria; Samanala Wewa Reservoir.

ICSD26_113

ENGINEERING APPROACHES FOR A CLIMATE-RESILIENT WATER SUPPLY SYSTEM FOR COLOMBO: INTEGRATING RISK-BASED MANAGEMENT AND INNOVATIVE TREATMENT

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Abstract: Colombo's water supply system relies predominantly on the Kelani River as its principal raw water source, making it highly vulnerable to climate-induced hydrological and water quality changes. Climate change has intensified stresses on the river system through altered rainfall patterns, rising temperatures, sea level rise, flood events, and increasing pollution loads. These factors have significantly increased the risks of salinity intrusion during low-flow condition and extreme turbidity during flood events, particularly affecting the Ambatale conventional water treatment facilities. This paper presents a risk-based engineering assessment of Colombo's water supply system and proposes climate-resilient operational and treatment strategies by Water Safety Plan (WSP) principles, Integrated Water Resources Management (IWRM), and innovative yet context-appropriate engineering solutions. Based on the analysis of production data, raw water quality trends, operational experience, and climate risk profiles, two dominant vulnerabilities are identified: (i) high turbidity and contamination pulses during flood events, and (ii) saline water intrusion during dry periods. As a key finding, the study demonstrates that flood-related high turbidity can be effectively managed through a multi-barrier treatment approach combining pre-sedimentation, enhanced coagulation with polymer assistance, lamella clarification, powdered activated carbon dosing, and parallel ultrafiltration units for critical flows, thereby significantly reducing treatment failure risks under rapidly fluctuating raw water quality conditions. For salinity intrusion, the study finds that risk-based abstraction control including tidal-cycle-based intake operation, selective abstraction during low-salinity windows, and strategic blending with reservoir sources provides an effective interim engineering solution, recognizing that conventional treatment processes cannot remove dissolved salts and that permanent structural measures such as salinity barrier are required for sustainable solution. The results highlight that climate resilience in urban water supply systems cannot be achieved through treatment plant upgrades alone but requires adaptive risk-based management and flexible multi-barrier treatment configurations. The proposed engineering framework offers a practical and scalable pathway for strengthening water security in Colombo under increasing climate uncertainty.

Keywords: Climate resilient; Salinity intrusion; Turbidity; Water Supply

ICSD26_198

AN ASSESSMENT OF AWARENESS, BEHAVIOUR, AND DETERMINANTS OF SUSTAINABLE ENERGY CONSUMPTION AMONG SRI LANKAN UNIVERSITIES

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Abstract: Sustainable energy consumption has become a critical focus of contemporary global development, requiring both technological advancement and behavioural transformation to achieve long-term environmental balance. As centres of knowledge creation and dissemination, universities serve as influential agents in promoting sustainable energy consumption by shaping awareness, behaviour, and policy within and beyond their communities. This study examines the awareness, behavioural practices, and influencing factors related to sustainable energy consumption among universities in Sri Lanka. A descriptive cross-sectional design was applied, with data gathered from 120 both university students and staff using an online structured questionnaire. Quantitative data were analysed using descriptive and comparative statistical methods to evaluate awareness, behavioural patterns, and influencing factors. The findings revealed high awareness levels, with 86.8% of respondents having heard the term "sustainable energy consumption" before. However, deeper conceptual understanding of advanced energy-saving measures remains moderate. Behavioural analysis indicates strong engagement in habitual energy-saving actions, with a mean score of 4.53 for turning off lights and 4.20 for unplugging appliances. A moderate positive correlation ($R^2 = 0.49$) was identified between awareness and behaviour, suggesting that increased understanding contributes to improved practices but is insufficient alone to ensure consistency. Respondents highlighted lack of facilities, habitual patterns, and forgetfulness as major barriers to improving their energy-efficient behaviour, and financial savings emerged as the strongest motivator for energy-saving behaviour. The findings highlight that awareness initiatives should be complemented by structural improvements and behavioural reinforcement mechanisms. Strengthening institutional policies, promoting peer engagement, and facilitating affordable access to energy-efficient technologies are essential to bridge the gap between awareness and action, fostering a sustainable energy culture within university communities.

Keywords: Barriers; Determinants; Sustainable Energy Consumption; University Student and Staff.

ICSD26_216

AI-DRIVEN FIRE BEHAVIOR ANALYSIS AND SAFETY OPTIMIZATION IN LIGHT STEEL FRAME WALLS FOR SUSTAINABLE BUILDING INFRASTRUCTURE

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Abstract: Light steel frame (LSF) walls provide sustainable building solutions through lightweight, recyclable construction but require enhanced fire safety because cold-formed steel rapidly loses strength above 550°C. This study develops a hybrid ABAQUS–MLP framework that couples nonlinear finite element thermal analysis with a multi-layer perceptron neural network to enable real-time fire behavior prediction and fire protection optimization for LSF walls. Parametric datasets generated from 25 ABAQUS simulations under ISO 834 standard fire exposure are used to train the MLP, which achieves $R^2 = 0.97$ in predicting steel temperature histories and time-to-critical-temperature (600°C). Compared with conventional prescriptive fire protection configurations, the proposed framework identifies optimized gypsum protection thicknesses (28–32 mm) that extend fire resistance by 8–10 times (to 90+ minutes), reduce gypsum usage by about 18%, and deliver a computational speedup of approximately 25,000× (45 minutes per ABAQUS run versus 0.1 seconds per AI prediction).Beyond previous AI-based fire engineering work focused mainly on smoke, compartment conditions, or global hazard indices, this research is the first to explicitly integrate validated ABAQUS parametric thermal data for LSF walls into an AI model targeting member-level steel temperature and time-to-failure predictions, thereby providing a structural design-oriented decision tool. The framework supports performance-based design for LSF walls, minimizes over-specification of protection systems, and contributes to embodied carbon reduction in net-zero construction, with extensibility to loadbearing systems, realistic fire curves, and broader code environments.

Keywords: ABAQUS; Fire Resistance; Fire Safety Optimization; Light Steel Frame; LSF Walls; Machine Learning; Neural Network; Performance-based Design; Sustainable Construction

ICSD26_310

SUSTAINABLE NATURAL FIBER ROOF INSULATION: DESIGN AND PERFORMANCE EVALUATION OF COIR FIBER-BASED COMPOSITE

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Abstract: The use of natural fiber reinforced composites for thermal insulation applications has improved because of the need for energy efficient and sustainable materials in building industry. In this study, Coir Fiber (CF) reinforced Deproteinized Natural Rubber (DPNR) latex composites were created and experimentally validated for roof insulation of buildings in tropical climatic conditions. Also, thermal and mechanical properties of the composites were examined in this research work. The effects of CF length were investigated using three CF lengths of 2 cm, 4 cm and 6 cm. Also, Hand Layup (HL) technique and Vacuum Assisted Resin Transfer Molding (VARTM) manufacturing methods were utilized to manufacture CF-DPNR composite mats. CF weights varying from 200 g to 325 g and corresponding Coir Fiber and Deproteinized Natural Rubber (CF/DPNR) ratios were employed to produce CF-DPNR composite mats. The thermal conductivity (ASTM D7896) and tensile strength (ASTM D638) of the composite materials were tested with the support of ANSYS numerical simulation and analytical modelling. The 4 cm CF with a CF/DPNR weight ratio of 70/30, made by VARTM was selected as the best design. This specific sample provides balanced performance of ~0.06 W/mK thermal conductivity, >1.1 MPa tensile strength. A model test hut was built to experimentally measure the thermal performance of the CF-DPNR composite insulation. Temperature data from each sensor was averaged across 10-minute intervals to minimize random variations brought by momentary changes in wind or solar irradiance. The validation exercise verified that the temperature distribution inside the scaled down test hut is accurately predicted by the CFD model. An excellent agreement was found between the numerically predicted temperature distribution and the measured experimental data. The study helps to promote sustainable materials in green building design by bridging the gap between laboratory research and real-world application by combining experimental data with analytical and simulation models.

Keywords: Coir Fiber; Deproteinized Natural Rubber; Energy Efficient; Sustainable; Vacuum-Assisted Resin Transfer Molding

SUSTAINABLE ENTREPRENEURSHIP, TOURISM, AND INNOVATION FOR ECONOMIC DEVELOPMENT - II

ICSD26_063

DEVELOPMENT OF ECO-FRIENDLY INTERLOCK BRICKS FROM TEXTILE INDUSTRY SLUDGE AND FLY ASH: PRODUCTION, CHARACTERIZATION, AND APPLICATION FEASIBILITY

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Abstract: The textile industry generates large quantities of hazardous sludge and fly ash, leading to severe disposal challenges and environmental pollution. Converting these wastes into construction materials offers an eco-friendly and economically viable solution aligned with circular economy principles. This study aimed to develop and evaluate sustainable interlocking construction bricks produced using textile wastewater treatment sludge and biomass boiler fly ash as partial raw material substitutes. Four brick formulations (A1 – A4) were prepared by maintaining constant cement and fly ash levels at 25% each, while varying sludge and gravel proportions as follows, A1 (10% sludge, 40% gravel), A2 (20% sludge, 30% gravel), A3 (30% sludge, 20% gravel), and A4 (40% sludge, 10% gravel). The mixtures were molded into interlock units and allowed to dry under controlled conditions. A completely randomized experimental design with five replicates was used. Mechanical and durability properties were analysed through compressive strength, water absorption, and leachability testing. Results showed that compressive strength ranged from 0.05 to 1.67 N/mm^2, with Sample A2 recording the highest value of 1.67 N/mm^2, while A4 exhibited the weakest structural integrity. Water absorption varied from 6.12% to 15.84%, where A1 demonstrated the lowest absorption (6.12%) and A4 the highest (15.84%), indicating reduced durability. Leachability analysis revealed that all brick samples exhibited very low metal release, with Cr, Cu, Cd, Ni, and Pb consistently below detection limits, and Fe and Zn detected only in trace amounts (0.04 – 0.12 mg/L and 0.01 – 0.04 mg/L). pH values ranged from 7.0 to 7.3, while EC and TDS were low (155 – 212 µS/cm and 102 – 142 mg/L), indicating minimal soluble salts. Overall, the A2 Interlock bricks formulation achieved optimal performance, proving to be the most promising option for durable, water-resistant, and environmentally sustainable interlocking construction applications aligned with the circular economy.

Keywords: Compressive Strength; Circular Economy; Fly Ash; Interlocking Bricks; Textile Industry Sludge

ICSD26_125

EVALUATING THE CARBON FOOTPRINT OF MEDIUM-SCALE GARMENT FACTORIES IN SRI LANKA AND THE POTENTIAL OF SOLAR ENERGY FOR EMISSION REDUCTION

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Abstract: The textile industry is characteristically carbon-intensive, with the fast fashion trend being a significant contributor to greenhouse gas (GHG) emissions. In Sri Lanka, there is a lack of comprehensive carbon footprint studies for textile factories, making it difficult to develop evidence-based mitigation options for the industry. In this research, an attempt is made to quantify the entire carbon footprint of a medium-scale garment factory, considering both direct (Scope 1) and indirect (Scope 2 and Scope 3) emissions, such as indirect greenhouse gas emissions from purchased electricity, as well as indirect greenhouse gas emissions from employee commuting, waste management, water use, etc. The GHG emissions were quantified in accordance with the GHG Protocol and ISO 14064, using primary data collected from the operation of the garment factory, supplemented with secondary data sources. The carbon footprint of the garment factory was found to be 176 tCO_2e annually, with Scope 1 being the dominant source of greenhouse gas emissions. The company vehicles, used for commuting employees to the workplace and for transporting raw materials, accounted for 41.90% of the total greenhouse gas emissions from the garment factory. Mitigation recommendations targeting Scope 1 include localizing labor to minimize travel, optimizing vehicle scheduling, deploying energy-efficient or electrified transport, and enforcing systematic vehicle maintenance. Scope 2 emissions contributed 29.62%, primarily from grid electricity; a 100 kWp rooftop solar PV system could generate approximately 144,000 kWh annually, offsetting up to 90% of Scope 2 emissions and reducing operational costs by 59%, demonstrating the effectiveness of renewable energy as a high-impact decarbonization strategy. Scope 3 represented 8.06%, with commuting using personal vehicles contributing 7.73%. Complementary interventions such as vertical gardens, waste segregation and recycling, greywater reuse, and structured employee engagement programs enhance overall carbon mitigation, improve operational sustainability, and support Sri Lanka's national low-carbon development and climate resilience objectives.

Keywords: Carbon Footprint Assessment; Renewable Energy; Scope 1, 2, 3 Emissions; Sustainable Industrial Practices; Textile and Apparel Sector

ICSD26_139

TAKING DRY FISH TO THE NEXT LEVEL: PERSPECTIVES OF SOCIAL ECOLOGICAL SYSTEMS FRAMEWORK ON CO-CREATION OF KNOWLEDGE

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Abstract: Social ecological value of dry fish processing and women as a key actor of the value chain were ignored, unrecognized and undervalued throughout the generations. Dry fish value chain commences from the raw material supplies from man dominated fisheries of both India and Sri Lanka and women in fishing communities start the processing, as a next step of dry fish value chain, using earned traditional knowledge while performing all household chaos. The study aimed to explore the artisanal women dry fish value chain through the lens of social ecological system framework, especially co-creation of value. Two case studies, South and West coast of Sri Lanka and South and East coast of Sri Lanka were instrumental and participatory rapid research methodology designed to collect and analysed the community level data. Method facilitated the dry fish value chain actors to share knowledge, define needs and find solutions. Holistic approach identified unique relationships between resource system, resource units, governance system and actors, opening new avenue to explore the possible interventions on value chain upgrading to ensure fair returns to actors while minimizing the fish loss and waste. Appropriate interventions were, folding drying rack for processors with limited drying yard space, roof top drying facility for the areas proven to heavy coastal erosion as seen, solar tent dryers for the areas of heavy unpredicted rains to ensure quality products, boiling jars and utensils for safe smooth handling, range of value added products, from ready to eat and cook, packing, labelling, branding and distribution options.

Keywords Co-creation of Knowledge; Dry Fish; India; Social-Ecological System; Sri Lanka; Women Processors

ICSD26_262

A SEMI-AUTOMATED BAMBOO STRAWS MANUFACTURING MACHINE AS A SUSTAINABLE ALTERNATIVE TO PLASTIC DRINKING STRAWS

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Abstract: Single-use plastic straws contribute significantly to global plastic pollution, creating a need to adopt for eco-friendly alternatives. Recent data indicate that approximately 500 million single-use plastic straws are consumed daily in the United States, while Sri Lanka ranks in the 5th place on the list of countries contributing to oceanic plastic pollution. As a result, the demand for sustainable substitutes such as drinking paper straws, bamboo straws, and glass straws has increased. Among these options, bamboo straws are preferred due to their reusability, biodegradability, and aesthetic appearance that make them attractive to foreign tourists and thereby contributing positively to tourism industry in developing countries like Sri Lanka. Manual bamboo straw manufacturing in Sri Lanka leads to low efficiency and high costs. Therefore, this project addresses this challenge through a design and fabrication of a semi-automated bamboo straw manufacturing machine aimed at optimizing productivity and improving operational efficiency for small-scale bamboo straw manufacturing industry in Sri Lanka. Unlike existing machines, this design integrates all essential processes including cutting the straws into required lengths, edge trimming, outer surface sanding, and inner surface cleaning within a single compact workstation. A systematic design methodology was followed incorporating morphological analysis and weighted decision matrices to evaluate alternative designs and select the optimum configuration. The fabrication process followed a structured approach involving component manufacturing, assembly, iterative testing, and performance optimization. Performance evaluation indicates a significant increase in production capacity with the proposed machine producing approximately 7000 straws per month compared to manual production yield of 1050 straws per month. The results illustrate that this machine has significantly enhance the production rate while maintaining the quality. This initiative represents a practical, scalable and sustainable step towards reducing single-use plastic straw consumption by providing an eco-friendly bamboo alternative.

Keywords: Bamboo straws; Eco-friendly; Plastic pollution; Reusability; Sustainability

ICSD26_296

LIFE CYCLE ASSESSMENT OF RICE PROCESSING INDUSTRY IN SRI LANKA'S HAMBANTHOTA DISTRICT: A CASE STUDY ON RAW AND PARBOILING MILLING

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Abstract: Rice constitutes the primary dietary staple for nearly 90% of Sri Lanka's population, emphasizing the need for sustainable practices in the rice value chain. The milling industry is critical for converting paddy into consumable rice, but it consumes substantial resources and generates environmental burdens. This study evaluates the environmental impacts of medium-scale raw rice milling in Hambantota District, a major rice-producing region, using a gate-to-gate Life Cycle Assessment (LCA) approach, with a functional unit of 70 kg of processed rice. Primary data were collected through on-site surveys and interviews with mill operators to quantify material and energy inputs, emissions, and waste flows, complemented by secondary data from literature and standard databases. Midpoint impact assessment in Open LCA identified terrestrial ecotoxicity (408.83 kg 1,4-DCB), global warming potential (156.78 kg CO_2-eq), land use (108.88 m^2a crop-eq), human non-carcinogenic toxicity (43.99 kg 1,4-DCB), and fossil resource scarcity (30.17 kg oil-eq) as the major environmental impacts. These impacts are linked to high energy consumption, fossil fuel use, and accumulation or open disposal of rice husks and bran, which release toxic compounds and greenhouse gases. A complementary strengths, weakness, opportunities and treats (SWOT) analysis highlighted operational and strategic considerations: strengths include reliance on local paddy, regulatory compliance, and waste valorization through bioenergy and animal feed; weaknesses are high electricity demand, limited pollution control, and non-biodegradable packaging; opportunities lie in renewable energy adoption, energy and water efficiency, eco-friendly packaging, and biodiversity collaborations; threats involve environmental non-compliance, air pollution, climate-induced crop variability, and risks to human health and ecosystems. Integrating LCA results with SWOT insights provides a comprehensive understanding of the environmental and management challenges in raw rice milling, offering practical strategies to improve sustainability and resilience in southern Sri Lanka.

Keywords: Environmental Impact; Life Cycle Assessment; Rice Processing; Sustainability

ICSD26_302

DIGITAL ENTREPRENEURIAL INTENTION AMONG UNDERGRADUATES IN SRI LANKA: ROLE OF ENTREPRENEURIAL ALERTNESS

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Abstract: In Sri Lanka Government and many educational institutions take efforts to provide management and entrepreneurship skills and knowledge to the youngsters via many avenues, however still there is a significant gap persists between academic preparation and the actualization of entrepreneurial ventures among graduates. With the rapid growth of digital economies, understanding the factors influencing students' intention to pursue digital entrepreneurship has become increasingly relevant. This study employed quantitative cross-sectional research design. Data were collected using pre tested structured self-administered questionnaire. The questionnaire was circulated among selected degree programme across five universities in Sri Lanka using a purposive sampling technique by means of both Google Forms and physical surveys. Total of 381 undergraduate students responded to the survey. The data were analysed through descriptive statistics, Pearson correlation, and multiple regression techniques to determine the strength and direction. Structural Equation Model (SEM) was employed to tests the direct and indirect relationships between the variables. Findings indicate that all three antecedent factors have significant strong to moderate positive effects on digital entrepreneurial intention. Entrepreneurial alertness partially mediates these relationships, strengthening the effect. The total effects of antecedents on intention ($\beta = 0.769$, $p < 0.001$) diminishes to $\beta = 0.331$ ($p < 0.001$) upon introducing the mediator, while alertness maintains a strong direct effect ($\beta 0.622$, $p < 0.001$). This research highlights the importance of enhancing self-efficacy, entrepreneurial knowledge, and education in promoting digital entrepreneurship among undergraduates. Meantime identified that alertness is a powerful mechanism though which the antecedents could be translate in to actual venture The results offer valuable insights for educators, policymakers, and entrepreneurship program developers aiming to empower the next generation of digital entrepreneurs.

Keywords: Digital Entrepreneurial Intention; Entrepreneurial Alertness; Entrepreneurial Knowledge; Self-Efficacy

FOOD PROCESSING, PRODUCT DEVELOPMENT, AND FOOD TECHNOLOGY INNOVATIONS - I

ICSD26_002

EMPOWERING PALM OIL PROCESSING THROUGH MICROWAVE AND ULTRASOUND PRETREATMENTS

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Abstract: Palm oil is the highly popular oil used in food industry due to their physicochemical nature. However conventional processing has limited its nutritional quality. This study investigated the effect of novel pretreatment methods on the quality of Crude Palm Oil (CPO). Prior to the steam sterilization for lipase inactivation, palm fruits were subjected to the ultrasound (45 kHz for 5, 10, 15 and 20 minutes) and microwave pretreatments (90, 270, 450 W for 3 minutes) separately. Crude Palm Oil (CPO) was extracted using Soxhlet apparatus and evaluated for quality parameters with control (no pretreatment) and industry crude palm oil sample. Results show that pretreatment method significantly improve the oil yield ($p < 0.001$). Only the ultrasound pretreat sample at 45 kHz for 20 minutes reached to industry sample on DOBI (Deterioration of Bleachability Index). Overall oxidative stability was improved in pretreated samples measuring primary and secondary oxidation products. CIELab colour parameters shows significant improvement ($p < 0.001$) in both microwave and ultrasound treated samples compare to industrial sample. Free Fatty Acid (FFA) content of sample except industrial sample demonstrates higher values ranges from 5 - 8%. Better retention of bioactive compounds was observed under low microwave power (90 W) and longer ultrasound duration in terms of total flavonoid and β-carotene content. DPPH radical scavenging activity demonstrates complex relationship with treatment parameters while 270 W microwave treated for 3 minutes, and 45 kHz for 20 minutes shows higher antioxidant retention range over 500 µmol TE/g of CPO. In conclusion, both microwave and ultrasound pretreatments were found to have a prospect of improving the quality of CPO in respect of higher yield, color, oxidative stability and preservation of bioactive compounds also further purification step needed to reduce the FFA content to match with industry standards. These results have indicated that the adoption of innovative pretreatment in the traditional palm oil processing can provide a better and healthier alternative to the industry which is more sustainable.

Keywords: Bioactive Compounds; Microwave Pretreatment; Palm Oil; Ultrasound Pretreatment

ICSD26_083

COMPARATIVE EVALUATION OF PROCESSING EFFECTS ON ANTIOXIDANT ACTIVITY AND GRAIN QUALITY IN TRADITIONAL AND IMPROVED RICE (*Oryza sativa*) VARIETIES IN SRI LANKA

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Abstract: Rice (*Oryza sativa*) is a staple food in Sri Lanka, and its quality is determined by various parameters, including nutritional value and antioxidant potential, both of which influence consumer acceptance and market value. This study evaluated the impact of processing methods (raw polished and parboiled polished) on antioxidant activity and grain quality characteristics of ten traditional and improved rice varieties (*Rathu Heenati*, *Rankahawunu, Suwandel,* Bg 252, Bg 374, Bg 366, Bg 309, At 362, At 409, and Ld 368), representing red and white bran types. Both rice variety and processing methods had significant effects ($p < 0.05$) on grain length, width, physical properties, and milling performance, whereas the length-to-width ratio remained largely unchanged. Grain types ranged from short to extra-long, with shapes varying from round to slender. Key physical traits, such as moisture content and 1000 - grain weight, varied with both rice variety and processing method, whereas bulk density was significantly affected only by variety. Among the varieties, *Suwandel* recorded the highest bulk density (1.163 g/mL), while At 309 showed the lowest value (0.726 g/mL). The parboiling process improved milling performance, resulting in higher brown rice yield (79.39%), total milled yield (75.70%), and head rice percentage (73.40%) compared to raw polished rice. The processing method also influenced antioxidant capacity. Parboiled samples contained higher total phenolic content (471.84 mg GAE/g) and displayed stronger DPPH radical-scavenging activity, indicated by lower IC_{50} values (49.59 µg/mL). Cooking reduced antioxidant activity across all varieties, likely due to thermal degradation. Red bran varieties, particularly *Rathu Heenati*, At 362, Bg 252, and Ld 368, demonstrated superior antioxidant properties, attributed to higher anthocyanin contents. These findings emphasize the grain quality and functional attributes of selected Sri Lankan rice varieties and highlight their potential to improve dietary diversity, enhance nutritional benefits, and increase consumer awareness and utilization**.**

Keywords: Antioxidant Activity; Milling; Parboiling; Total Phenol Content; Traditional Rice

ICSD26_117

DEVELOPMENT OF AN ANTIOXIDANT-RICH FUNCTIONAL BEVERAGE USING *Sri gemunu* AND *Sri wijaya* CINNAMON CULTIVARS: OPTIMIZATION OF EXTRACTION PARAMETERS, SENSORY QUALITY, AND MICROBIAL SAFETY

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Abstract: This study aimed to produce sustainable aqueous extraction combined with sensory-guided optimization to produce, antioxidant-rich cinnamon beverage supporting scalable green functional drink development using two Sri Lankan cinnamon cultivars: *Sri Gemunu* and *Sri Wijaya*. Thirty-two samples were prepared by all the combinations of cinnamon: water (w/v) ratios (1:20 & 1:10), extraction temperatures (60 ^{0}C and 80 ^{0}C), extraction times (30 & 60 minutes), with and without hot water blanching (at 100 ^{0}C for 1 minute and dipped in cold water for another minute) of dried cinnamon bark quills. The antioxidant capacity (TEAC mg/L), total phenolic content (GAE mg/L), and pH were analysed in each sample with duplications, and the mean values were taken (one-way ANOVA, $\alpha = 0.05$). Colorimetric values (L*, a*, b*) of each sample also were taken. Sensory analysis was performed by 120 untrained panellists on a 9-point hedonic scale. Hot water blanching had reduced the total phenolic content of each sample and improved sensory qualities by reducing the bitterness and astringency. The sample prepared using blanched *Sri Gemunu* at a 1:10 ratio, heated at 60 ^{0}C for 30 minutes had 286.06 ± 0.43 TEAC mg/L antioxidant capacity, 496.08±4.51 GAE mg/L total phenolic content, and was selected as the sample with best sensory properties with the highest scores for all attributes (colour 8.10 ± 0.67, aroma 7.92 ± 0.62, cinnamon taste 7.93 ± 0.68, sweetness 8.00 ± 0.61, aftertaste 8.77 ± 0.42, overall acceptability 7.72 ± 0.82). That sample was subjected to microbial analysis. Total plate count and yeast and mould count were tested with and without the addition of 300 ppm potassium sorbate in ambient and refrigerated conditions in the initial day and after four weeks. According to the acceptable limits of Food Safety Standards Authority of India the product remained microbiologically safe for four weeks with or without preservatives at ambient or refrigerated conditions.

Keywords: Antioxidant Activity; Cinnamon Functional Beverage; *Sri Gemunu*; *Sri Wijaya*; Sustainable Aqueous Extraction

ICSD26_118

ACCELERATED SHELF STABILITY MODELLING OF CINNAMON AQUEOUS EXTRACT: POTASSIUM SORBATE AS A DUAL STABILIZER OF MICROBIAL SAFETY AND FUNCTIONAL QUALITY

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Abstract: Plant-based functional beverages often exhibit limited shelf stability due to microbial spoilage and oxidative degradation, posing challenges to sustainable commercialization. This study investigated the efficacy of potassium sorbate and applied Arrhenius-based accelerated shelf-life modelling to predict the storage stability of an antioxidant-rich cinnamon (*Cinnamomum zeylanicum*) ready-to-drink beverage. The beverage was prepared using blanched (at 100 ℃ for 1 minute and dipped in cold water for 1 minute) *Sri Gemunu* cinnamon bark (10 g/100 mL) infused at 60 °C for 30 minutes. Samples with and without potassium sorbate (300 ppm) were incubated under 33 ℃, 43 ℃, and 53 °C for 21 days, with analyses performed every 3 days for antioxidant capacity (AC), total phenolic content (TPC), and pH. Using reaction kinetics and the Arrhenius equation degradation constants were calculated and predicted the shelf stability at 35 ℃, 25 ℃, and 4 °C. End-of-shelf-stability thresholds were defined as 30% loss of AC, 40% loss of TPC, and ± 1.0 pH change. Potassium sorbate consistently reduced degradation rates across all parameters and temperatures. Model-predicted shelf stability of preserved vs. unpreserved beverages by the addition of potassium sorbate was 34 vs. 18 days at 35 °C, 66 vs. 34 days at 25 °C, and 304 vs. 137 days at 4 °C. In preserved samples, antioxidant loss was the critical factor that limited the shelf stability, whereas pH was the critical factor non-preserved formulations. There were no microbial counts were detected in the preserved samples kept at room temperature and refrigerated conditions for 28 days. There were 30 CFU/mL total plate count detected in the unpreserved sample kept at room temperature. The study validates potassium sorbate as a dual-function stabilizer that slows both microbial and oxidative degradation. These findings offer a science-based pathway to longer-lasting, antioxidant-rich cinnamon beverages with improved environmental and commercial viability.

Keywords: Accelerated Shelf-stability Testing; Arrhenius Kinetics; Cinnamon Functional Beverage; Potassium Sorbate; *Sri Gemunu*; Sustainable Preservation

ICSD26_123

EXPLORING THE PREFERENCES AND DETERMINANTS OF ICE CREAM CONSUMPTION AMONG UNDERGRADUATES: A STUDY CONDUCTED IN SRI LANKAN UNIVERSITIES

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Abstract: Food choices identified among young people become essential because youth preferences significantly shape the development of food industry demands. However, empirical research related to the behavior concerned with the consumption of ice cream for undergraduates is limited. This research study mainly strives to investigate consumer behavior concerning the Consumption and its determinants among university students. The specific study objectives include examining the influence of demographic factors on ice cream consumption patterns, identifying students' preferred purchasing locations, analyzing preferences for toppings and flavor–topping combinations, and investigating the major determinants influencing ice cream selection. Quantitative cross-sectional survey approach was adopted, and data were gathered from 696 undergraduates using an online structured questionnaire. Convenience sampling was employed, and descriptive statistics and chi-square tests were analyzed using SPSS Statistics 27 Software. Age ($x^2 = 292.137$, $p < 0.05$), gender ($x^2 = 30.042$, $p < 0.05$), and the year of study ($x^2 = 86.757$, $p < 0.05$) were seen as significant influencers in consumption. The 24–27-year group formed a significant portion (85.2%); higher regular consumption (69.9%) was reported by females and among third-year students (71.8%). Supermarkets (79.9%) and convenience stores (62.7%) were selected as the most preferred purchasing locations, while Chocolate (78.3%) was the major flavor preference, vanilla (51.2%), and fruit flavors (40.6%) were also popular. Chocolate-chocolate chips ($x^2 = 79.954$, $p < 0.05$) and fruit flavors-fruit salad ($x^2 = 63.231$, $p < 0.05$) were identified as significant flavor topping combinations. Taste (95.6%), price (64.0%), and texture (60.0%) were the leading choice factors in ice cream purchasing. In conclusion, Ice cream consumption was primarily governed by sensory attributes and demographic factors. This study provides practical insights for industry stakeholders to refine and develop new products targeting marketing strategies to better serve the young.

Keywords: Consumer Preferences; Demographic Factors; Ice cream Consumption; Purchasing Behavior; Undergraduates

ICSD26_160

PROTEIN EXTRACTION FROM SRI LANKAN DUCKWEED (*Lemna minor*) AND CHARACTERIZATION OF PHYSICO-FUNCTIONAL PROPERTIES FOR APPLICATION IN NOVEL FOOD PRODUCT

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Abstract: The global demand for sustainable, nutrient rich plant-based food sources has increased interest in alternative plant proteins derived from fast growing, underused biomass. This study examined the physicochemical and functional properties of protein isolated from *Lemna minor* (Duckweed), an aquatic plant that proliferates rapidly, known for its high protein yield and minimal environmental impact. The proximate analysis of dried *Lemna minor* biomass indicates 1.11 ± 0.03% moisture content, 21.50 ± 0.32% crude protein, 5.12 ± 0.12% crude fat, 11.70 ± 0.23% crude fiber and 13.49 ± 0.32% ash content confirming the raw material possesses substantial nutritional value. An ultrasonication-assisted alkaline extraction process was used to isolate protein suitable for food and feed applications. The extraction yielded 14.52 ± 1.89% (67 % of total available protein) with a nitrogen-protein purity of 84.41%, demonstrating the effectiveness. Protein fractions showed the emulsifying activity index (EAI) was 17.53 ± 0.31 m^2/g and the emulsifying stability index (ESI) was 77.09 ± 0.11% indicating a strong capacity to form stable interfacial films, a critical requirement of emulsion-based food systems. Water holding capacity (3.34 ± 0.17%) and oil holding capacity (4.67 ± 0.10%) further indicated its potential to enhance moisture retention ability, texture and flavour absorption in formulated foods. The foaming properties were particularly impressive with a foaming capacity of 92.50 ± 0.13% and a foaming stability of 46 ± 0.15% demonstrating its suitability for aerated food products. Antioxidant activity of extracted *Lemna minor* protein revealed a total phenolic content of 2.48 ± 0.11 mg GAE/g and DPPH radical scavenging rate of 19.32 ± 0.16%, indicating a moderate antioxidative potential that contributes to oxidative stability in food applications. Overall, the results demonstrate that *Lemna minor* protein possesses a favourable functional profile for use as a sustainable plant-based ingredient, offering a viable alternative to a conventional protein sources in the food industry.

Keywords: Duckweed; Physico-Functional Properties; Plant-Based Proteins; Ultrasonication Assisted Extraction

ICSD26_162

IMPLEMENTATION OF GERMINATION-ASSISTED KOJI BIOPROCESSING TO PRODUCE A FUNCTIONAL UMAMI-RICH ADDITIVE FROM THE SRI LANKAN COWPEA: WARUNI (V*igna unguiculata* L. WALP*)*

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Abstract: Cowpea, an underutilized, nutrient-dense legume in Sri Lanka offers potential as a multifunctional additive due to its high protein content. The study investigates a novel bioprocess integrating germination and koji fermentation (*Aspergillus Oryzae*) to produce a functional umami-rich ingredient from cowpea cultivar WARUNI (*Vigna Unguiculata* L Walp). The following treatments were used to examine the effect of germination and fermentation on the functional and nutritional properties of cowpea. T1: 12-hour soaking (12 h-S) of cowpea followed by steam blanching for a minute (SB-1 min), T2: 12 h-S with 48 - hour germination (48 h-G) followed by SB-1 min, T3: 12 h-S, mixing with the koji spores in a ratio 5 g:15 kg Cowpea, 72 – hour fermentation (72 h-F) followed by SB-1min, T4:12 h-S, 48 h-G, mixing koji spores in a ratio 5 g:15 kg Cowpea, 72 h-F followed by SB-1 min. All samples were dehydrated at 50 °C and ground to 180 µm. Protein, ash, fat content, titrable acidity, pH, water holding capacity (WHC), water solubility index, emulsifying capacity, and color were measured. The protein content (PC) of T1 was 28.12%, while T2 contained 28.81%. Koji-fermented treatments T3 and T4 showed significant increases in PC by 65.44% and 78.05% respectively, indicating vigorous proteolytic activity by *Aspergillus Oryzae*. Fat, fiber, and ashes, decreased due to fermentation. Titrable acidity increased in T4 than significantly. The lowest pH (5.42) shown in T4 confirms of acidic conditions. WHC rose from 137% (T1) to 417% (T4). The lowest lightness (L = 67.72) in T4 indicates Maillard-derived savory compounds and glutamate-related volatiles. Sensory evaluation demonstrated that T4 perceived the highest umami intensity. In conclusion, germination-assisted koji fermentation (T4) significantly enhanced WARUNI cowpea's functional and sensory properties, especially umami-enhanced ingredient suitable for flour and food formulations. This research illustrates a novel sustainable bioprocessing approach to valorize underutilized Sri Lankan cowpea into a high-value functional, clean label umami ingredient for plant-based food systems.

Keywords: Cowpea; Fermentation; Flavor Enhancement; Functional Food Ingredient; Germination; Umami

ICSD26_191

DEVELOPMENT AND QUALITY DETERMINATION OF YOUNG JACKFRUIT (*Artocarpus heterophyllus* Lam.) BASED MICROBIALLY FERMENTED FOOD PRODUCTS

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Abstract: Natural lactic acid fermentation offers a cost-effective strategy for adding value, enhancing safety, and improving sensory quality. This study was conducted to determine the effects of salt level and acetic acid on fermentation, and to develop fermented young jackfruit products. Eight treatments were prepared using salt concentrations of 6, 8, 10, and 12% (w/v), each with and without 0.2% acetic acid, and fermented for 7 days at 27 ± 3 °C. Brine and particle pH, titratable acidity (TA), salinity, and °Brix were measured on Days 1, 3, 5 and 7. Data were analysed by two-way ANOVA (factors: Treatment, Day; $\alpha = 0.05$). At day 5, ATR-FTIR spectra qualitatively confirmed the availability of lactic acid. Sensory evaluation used 9-point hedonic scores for fermented samples and a ranking test (n = 30) for product prototypes. Day and Treatment significantly affected all chemical parameters, with significant interactions ($p < 0.01$). pH declined rapidly and stabilised by Day 5, while TA reached maximum at Day 5; °Brix decreased with time; salinity diminished as salt diffused into the tissue. Acetic-acid treatments achieved significantly lower pH and higher TA than non-acetic pairs, with 8% and 10% salt with acetic giving the strongest acidification at Day 5. ATR-FTIR confirmed availability of lactic acid (≈ 1730, 1550, 1410 cm^{-1}) at Day 5. Day 5 is an optimum endpoint for young jackfruit fermentation. Brine at 8% and 10% with 0.2% acetic acid yields superior chemical profiles and consumer acceptance. Sensory means favoured Day-5 ferments; product ranking indicated the highest acceptance for 8% salt with acetic-treated fermented young jackfruit chutney, and then 8% salt with acetic-treated fermented young jackfruit curry, as third strong liking was for 10% salt with acetic-treated fermented young jackfruit pickle.

Keywords: Lactic Acid Fermentation; Product Development; Sensory Evaluation; Young Jackfruit

ICSD26_194

DETERMINATION OF FACTORS CONTRIBUTING TO TITRATABLE ACIDITY IN COCONUT MILK EXTRACTION IN INDUSTRIAL SCALE

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Abstract: Coconut milk is an essential food commodity in Sri Lanka used for coconut milk powder production. Titratable acidity (TA) is a major quality parameters which monitors the freshness of coconut milk as high titratable acidity causes emulsion instability, microbial spoilage, and processing issues. This study aimed to identify the most critical stages and factors driving to the increase in TA in industrial scale coconut milk extraction, handling and storage conditions. Three Sri Lankan coconut milk processing mills were monitored. Samples were taken every 30 minutes from major processing points: the balance tank, steam blancher, chiller storage, bowser loading/unloading and storage silos. Titratable acidity was measured from Soxhlet Henkel Method. Physicochemical, microbial, and processing parameters for coconut milk (pH, total solids, fat, ash, protein, Total Plate Count, temperature, agitator speed, holding time) were continuously evaluated. The results were analyzed to identify significant factors using statistical methods. A statistically significant ($p < 0.05$) increase was recorded for TA values, which were during the balance tank and chiller storage periods. TA values increased from 6.33°SH to 6.83°SH over a 90 minute period. This increase appears to have some correlation with continued enzymatic activity and microbial development during holding. Supporting this assertion, total plate counts were recorded to have increased significantly from 8.0×10^5 to 1.2×10^6 CFU/mL over the same period. Processing lines that included steam blanching were recorded to have lower TA values compared to those without blanching (6.67°SH vs. 6.83°SH). This shows that steam blanching was effective for enzyme inactivation. Furthermore, extended bowser transportation (more than six hours) was recorded to have resulted in an increase in TA by an average of 0.39°SH. Temperature variations between compartments were identified as a key factor. From the study, it was concluded that acidity development was attributed to microbial development, enzymatic activity, temperature control, and extended holding time. The study also showed that steam blanching and temperature control were effective for maintaining TA values at ≤ 7°SH.

Keywords: Coconut Milk; Industrial Extraction; Microbial Spoilage; Process Optimization; Titratable Acidity

FOOD PRESERVATION, PACKAGING, AND SMART FOOD QUALITY TECHNOLOGIES

ICSD26_008

INFLUENCE OF STORAGE TEMPERATURE AND TIME DURATION ON CHLOROPHYLL DEGRADATION DYNAMICS IN GOTU KOLA (*Centella asiatica*)

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Abstract: The status of chlorophyll severely affects the visual attributes, nutritional properties, and shelf life of leafy greens. *Centella asiatica*, a valuable herb that is a popularly consumed leafy vegetable in Sri Lanka due to its nutritional and pharmaceutical properties. Its pigment content deteriorates more severely during storage, leading to reduced consumer acceptance. This study evaluates the effect of chlorophyll status on *Centella asiatica* under various storage temperatures (2 °C, 27 °C, and 32 °C) and time durations (24, 48, and 72 hours). Chlorophyll was extracted using 100% acetone, and absorbance was detected at 663 nm and 645 nm using a spectrophotometer. Chlorophyll concentrations (mg/g) were computed using Arnon's (1949) equations. Data analysis was conducted and results show that chlorophyll a (Ch-a), chlorophyll b (Ch-b), and total chlorophyll contents were depleted by 0.299 ± 0.0297, 0.301 ± 0.0447, and 0.599 ± 0.032 at 2 °C, 0.352 ± 0.015, 0.459 ± 0.0157, and 0.811 ± 0.0232 at 27 °C, and 0.427 ± 0.0187, 0.503 ± 0.0281, and 0.930 ± 0.019 mg/g fresh weight at 32 °C after 72 hours. ANOVA results indicate both time and temperature are statistically significant ($p < 0.05$) on chlorophyll content. According to the individual factors, Ch-a is more temperature-sensitive ($F = 31.53$, $p < 0.005$), Ch-b is more time-sensitive ($F = 19.72$, $p < 0.01$), and both factors (Time: $F = 46.22$; Temperature: $F = 30.16$; $p < 0.005$) synergistically affect the total chlorophyll. According to Tukey's HSD test ($\alpha = 0.05$), there is no any significant difference for Ch-b (< 0.1782) in terms of temperature, but time duration has a greater effect. 24 hours is a critical period (> 0.1782). Ch-a has a higher significant difference at 2 °C (> 0.083), and 24 hours (> 0.083). Total chlorophyll content has a significant difference at all time durations (> 0.1596) and 2 °C (> 0.1596). Lower temperature storage (2 °C), lowered chlorophyll degradation and had a greater effect on maintaining pigment content compared to higher temperatures. Findings highlight the importance of maintaining optimal storage conditions in postharvest handling to preserve their visible and nutritional attributes.

Keywords: *Centella asiatica*; Chlorophyll; Degradation; Duration; Hours; Temperature

ICSD26_031

IDENTIFICATION AND CHARACTERIZATION OF MAJOR VOLATILE COMPOUNDS IN SPIRITS COMMONLY AVAILABLE IN SRI LANKA

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Abstract: Volatile compounds in raw spirits influence the flavour, aroma, and sensory attributes of distilled alcoholic beverages. This study aimed to characterize 18 major volatile compounds and analyse three physicochemical properties (pH, alcoholic strength, and density) in five spirits commonly available in Sri Lanka: Extra Neutral Alcohol (ENA) from sugarcane molasses and maize, Rectified Spirit (RS) from sugarcane molasses, coconut spirit, and palmyrah spirit. Volatile analysis was conducted using Gas Chromatography with Flame Ionization Detection (GC-FID). ENA from sugarcane molasses contained only acetaldehyde and methanol, while ENA from maize included acetaldehyde, methanol, and 1-propanol. RS primarily contained methanol, acetaldehyde, and ethyl acetate. Coconut spirit exhibited a broader volatile profile, including acetaldehyde, 1-propanol, ethyl acetate, 2-methyl-1-propanol, 3-pentanol, 3-methyl butanol, and ethyl lactate. Palmyrah spirit, the most volatile-rich, contained these compounds along with unique volatiles such as linalool, 2-phenyl ethanol, ethyl octanoate, and ethyl dodecanoate. Statistical analysis revealed distinct volatile profiles, with ENA, RS, coconut, and palmyrah spirits forming separate clusters. Physicochemical results showed that ENA and RS had the highest alcohol strength (96.20 ± 0.06% v/v), nearly neutral pH (6.70 ± 0.1 and 7.57 ± 0.21, respectively), and low density (0.806 ± 0.001 g/cm³). Coconut and palmyrah spirits had lower alcohol strengths (73.17 ± 0.06% and 79.97 ± 0.06% v/v), acidic pH (3.53 ± 0.15 and 4.00 ± 0.1), and higher densities (0.859 ± 0.001 and 0.878 ± 0.001 g/cm^3). One-way ANOVA with Tukey's test confirmed similarities between ENA and RS, while coconut and palmyrah spirits exhibited significant differences. These findings highlight ENA's suitability for neutral spirits, while coconut and palmyrah spirits serve as bases for traditional beverages. RS demonstrated intermediate characteristics, with high alcohol strength but elevated volatile content. Future studies should explore additional spirits, analyse a broader range of volatiles, and incorporate sensory evaluations for enhanced product differentiation.

Keywords: Coconut Spirit; Extra Natural alcohol; GC-FID; Palmyrah Spirit; Rectified Spirit

ICSD26_095

EVALUATING THE SUITABILITY OF CELLULOSE NANOCRYSTALS EXTRACTED FROM CORN HUSK TO IMPROVE THE BARRIER PROPERTIES OF SUSTAINABLE PACKAGING

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Abstract: Due to environmental impacts, the food industry is shifting towards sustainable alternatives, such as biodegradable packaging. However, these biodegradable films exhibit poor barrier and mechanical properties. This research aims to study the ability of cellulose nanocrystals (CNCs) to improve the barrier and mechanical properties of seaweed-based biodegradable films. A bi-layered film composed of agar and alginate was produced using a layer-by-layer casting technique incorporating CNCs extracted from corn husk using the sulfuric acid hydrolysis method. The inner layer contained agar, cinnamon oil, glycerol, and tween 80, while the outer layer contained sodium alginate, sorbitol and CNCs (0%, 0.2%,0.4%,0.6%,0.8% and 1%) with 1% $CaCl_2$ applied as a spray on the outer layer. The bi-layer provides water barrier properties from the outer layer, sealing ability from the inner layer, and mechanical integrity from both. CNCs were characterized by XRD, SEM and FTIR analysis. The crystallinity index of CNCs was reported as 73.31%, which contributed to better barrier properties. The effect of CNC content on various properties of bi-layered films were tested, including mechanical properties, water vapor permeability, UV transmission, contact angle of water, and water solubility. Increasing the content of CNCs significantly enhanced UV-blocking properties ($p < 0.05$), potentially preventing oxidative reactions in foods. Higher concentrations of CNCs increased the film's contact angle of water, indicating a significant reduction in the film's hydrophilic nature, from 29.00 to 43.65 ($p < 0.05$), while reducing water vapour permeability. This performance improvement was observed at refrigerated temperatures compared to room temperature. The incorporation of CNCs decreased the water solubility of films, enhancing their functionality as food packaging material. However, films exhibited low tensile strength despite increased crystallinity. Nevertheless, these values remain adequate for food packaging applications with limited mechanical stress required, like wrapping fresh-cut fruits and vegetables, single-use sachet applications, offering a sustainable alternative to conventional polythene materials.

Keywords: Agar; Alginate; Biodegradable Packaging; Environmental Pollution; Nanoparticles; Sustainability

ICSD26_151

1-METHYLCYCLOPROPENE (1-MCP) AS AN ETHYLENE ACTION INHIBITOR: APPLICATIONS IN POSTHARVEST MANAGEMENT OF FRUITS AND VEGETABLES, LIMITATION AND FUTURE DIRECTIONS; A REVIEW

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Abstract: 1-Methylcyclopropene (1-MCP) application is commonly identified as one of the most effective postharvest solutions for preserving the quality and freshness of agricultural crops. This chemical compound is a synthetic cyclic olefin that binds irreversibly to ethylene receptors in plant tissues. This prevents signaling pathways that lead to ripening and senescence of the agricultural crops. This makes 1-MCP a powerful inhibitor of ethylene metabolism. Climacteric fruits, including bananas, apples, tomatoes, and avocados, in addition to several ethylene-sensitive vegetables and non-climacteric fruits (citrus fruits, strawberries, plums, pineapple etc.), have demonstrated to extremely be beneficial in this approach. With the successful delaying in ripening, softening, colour change, and physiological changes, 1-MCP treatment elevates marketability and shelf life while minimizing postharvest losses. The gaseous composition of 1-MCP facilitates simple integration into transportation and cold storage systems, enhancing the efficacy of global supply chains. Despite mentioned advantages, several limitations prevent its widespread application. Different cultivars, and maturity stages exhibit significant variations in the responses to 1-MCP. Treatment can hinder consistent ripening, the formation of desired flavors, or the efficiency of subsequent ethylene dependent processes, including degreening in some food commodities. To obtain a consistent result, environmental parameters, treatment levels, and exposure times are required to be carefully optimized. Additionally, there are some research evidences about the limited or reduced effectiveness of 1-MCP in non-climacteric crops and its inability to reverse the effects of existing ethylene. Future studies have to be more concise on establishing monitored release approaches for industrial or small-scale applications, enhancing formulation stability, and understanding the dynamics of the ethylene receptors. Combining 1-MCP with existing postharvest strategies, such as nanocarrier technologies, modified-atmosphere packaging, and natural bioregulators creates an efficient platform for sustainable postharvest management.

Keywords: 1-Methylcyclopropene (1-MCP); Ethylene Inhibition; Fruit and Vegetable Ripening; Postharvest Management; Shelf-life Extension

ICSD26_165

DEVELOPMENT OF A pH-RESPONSIVE SMART LABEL USING JACKFRUIT (*Artocarpus heterophyllus*) SEED STARCH AND BEETROOT (*Beta vulgaris*) EXTRACT

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Abstract: Smart labelling system is a method which is used to monitor the food freshness while supporting food safety and waste reduction. Most of existing indicators are made from artificial colors and synthetic polymers, creating many environmental problems and lack of sustainability. In this study, a natural and biodegradable pH-responsive smart label was developed using beetroot extract (BE) as a natural colorimetric indicator and jackfruit seed starch (JSS) as the base material. Four formulations of bio polymeric films were prepared as; Control (without BE), F1 (10 ml BE), F2 (7 ml BE), and F3 (4 ml BE). Fourier transform infrared spectroscopy indicated the characteristic changes in O–H and C=O functional groups showing the successful incorporation of beetroot pigments into the starch matrix. The reactivity of buffer solutions over a pH range of 1-13 was used to confirm pH sensitivity. All indicator formulations showed a noticeable reaction between acidic and alkaline pH values. F1 film with highest BE level showed color changes, shifting from reddish purple at pH 1, to red at pH 6, and brownish yellow at pH 13. The beetroot extract showed moderate pH variations (6.10 – 6.34) while incorporation into the films produced significantly lower pH values (2.15 – 2.34). According to the color analysis, increasing beetroot extract brought a significant decrease in lightness (ΔL), increase in red color (Δa) and yellow color (Δb*). All formulations showed uniform thickness (0.109 – 0.118 mm), despite beetroot extract incorporation. F2 had the greatest hardness (422.40 g) which indicate the mechanical stability of the label. According to the biodegradability test all formulations showed rapid biodegradation, with F1 degrading the fastest (94.84%). Overall, the beetroot based JSS films show effective pH response and mechanical stability and quick biodegradation which makes them suitable to be used as sustainable smart labels that monitor meat product freshness.

Keywords: Beetroot Extract; Biodegradability; Jackfruit Seed Starch; pH Sensitivity; Smart Labelling

ICSD26_221

INTERGRATION OF PSYCHROMETRIC AND IOT-ASSISTED HEAT PUMP DRYING FOR DEEP-BED DRYING OF REFUSED TEA

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Abstract: Refused tea (RT) is a valuable by-product in black tea production, but the final stage of the drying process is challenged by energy inefficiency and risk of quality degradation due uneven moisture removal inherent in conventional deep-bed drying systems. This study presents an integrated, optimized approach to deep bed drying of refused tea by combining psychrometric analysis with an IoT-based real time monitoring system and Heat Pump Drying (HPD). The initial investigation utilized a closed-loop HPD system (1.45 kW) to precisely control the drying environment, with psychrometric evaluations confirming its capability to generate exceedingly dehumidified air, achieving a low Relative Humidity (RH) of 7% at 52 °C at the heat pump outlet, which is crucial for reaching the final target moisture content. A steady state drying environment was achieved after approximately six hours of continuous operation, with consistent enthalpy changes indicating effective energy utilization. Subsequently, the deep-bed drying process was implemented on refused tea samples, utilizing this optimized air and integrating of an IoT-assisted system featuring DHT11 sensors and an ESP32 microcontroller for real-time monitoring of temperature and humidity across multiple deep-bed layers. Results demonstrated the HPD system's effectiveness, reducing the refused tea moisture content from an initial 16.45% to approximately 6.54% (dry basis) over a period of 33 hours under controlled low-temperature conditions (Dehumidified air at 38 °C and 29% RH). The precise, layer-specific IoT monitoring enabled the investigation of moisture variation and ensured uniform product quality across the deep bed. This successful integration of precise psychrometric control and layer-specific IoT monitoring confirms the technology's potential as an energy-efficient and controllable solution for industrial-scale drying of refused tea.

Keywords: Deep bed drying; Heat pump drying; Internet of things; Psychrometric properties; Refused tea

ICSD26_275

A NON-MEMBRANE SEPARATION STRATEGY FOR MICROPLASTICS VIA ATOMIZATION AND DIELECTRIC-BASED ELECTROSTATIC DEFLECTION

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Abstract: The proliferation of microplastics (MPs) in global water systems presents a critical environmental challenge, threatening marine ecosystems and human health through bioaccumulation. Conventional removal methods such as membrane filtration, coagulation, and density separation often face limitations regarding clogging, high maintenance costs, and the inability to effectively separate nano-scale particles. This project proposes a novel, high-efficiency separation technique that diverges from traditional hydro-mechanical filtration, operating instead on the principles of phase transition and electrostatic precipitation. The proposed solution outlines a four-stage process designed to isolate microplastic contaminants from water. First, the contaminated aqueous solution undergoes atomization, increasing the surface area-to-volume ratio of the fluid. Second, the atomized mist is subjected to thermal energy, inducing rapid evaporation to yield a dry solid-particle mixture (microplastics and other dissolved solids) in water vapor. Third, the mixture is passed through a high-voltage corona discharge, where gas ionization imparts a specific electric charge to the particles based on their dielectric properties. Finally, the ionized particles traverse a static electric field, where they are deflected and separated onto collection plates. This methodology represents a paradigm shift similar in impact to Reverse Osmosis (RO) but distinct in mechanism. While RO relies on osmotic pressure and physical barriers, this method leverages the dielectric differences between organic polymers (plastics) and other particulates in a dry state. This approach aims to eliminate membrane fouling issues and offers a scalable solution for high-purity water treatment. This pollutant-removal technology addresses SDGs 3, 6, 9, and 14 by improving water quality, protecting marine life, enhancing public health, and promoting sustainable industrial infrastructure.

Keywords: Atomization; Dry Solid-Particle Mixture; Electric Field; High-Voltage Corona Discharge

ICSD26_277

COMPARATIVE STUDY OF THERMAL, VISUAL, AND GRAYSCALE FUSION IN DEEP CNNS: OPTIMIZING ACCURACY AND PARAMETER COUNT FOR FRUIT RIPENESS DETECTION

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Abstract: Accurate, non-destructive fruit ripeness detection is paramount for minimizing post-harvest losses and advancing quality control in precision agriculture. Traditional inspection methods rely on subjective visual cues, leading to inconsistencies, which advanced Deep Learning (DL) models are increasingly designed to overcome. This study systematically evaluates the performance trade-off between accuracy and parameter efficiency across five deep neural network architectures including deep networks of Residual Network (ResNet) and VGG16, general models of 2-Dimensional Convolutional Neural Network (2D-CNN), and resource-efficient variants of YOLO and MobileNet when applied to apples, guavas, and mangoes. The research focuses on the efficacy of single-modality inputs of Visual (V), Thermal (T) and Grayscale (G) against all possible multimodal fusion combinations (V + T, V + G, T + G and V + T + G). Experimental results consistently demonstrate that multimodal fusion significantly enhances predictive capabilities over single inputs. Specifically, the combination of visual and thermal modalities proved the most accurate feature set, leveraging surface appearance (Visual) and internal properties (Thermal). The highest overall test accuracy recorded was 0.93, achieved by the ResNet architecture in the large parameter configuration utilizing V + T fusion. While VGG16 models exhibited the lowest initial performance in smaller configurations, the efficiency-optimized MobileNet and YOLO architectures achieved strong accuracy levels (0.85 to 0.91 test accuracy for V + T fusion across parameter sizes), confirming their potential for deployment on resource-constrained devices. To ensure generalizability and reliability, the study implemented rigorous 5-fold cross-validation for each model and recorded exceptional consistency, with variations across folds often measuring less than 0.0035. This comprehensive analysis provides crucial comparative data, confirming that optimizing for both accuracy and efficiency requires strategic multimodal input selection, with Visual and Thermal fusion offering the optimal pathway for developing high-performing, lightweight DL solutions for real-time ripeness assessment.

Keywords: Deep Learning; Fruit Ripeness Level Detection; Multimodal Imaging; Shelf-life Prediction; Thermal Imaging

ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, AND INTELLIGENT SYSTEMS

ICSD26_029

DEVELOPMENT OF DEEP LEARNING BASED REAL-TIME DETECTION AND WARNING SYSTEM TO REDUCE ELEPHANT-TRAIN COLLISIONS IN SRI LANKA

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Abstract: Elephant train collisions in Sri Lanka present a severe threat to both wildlife conservation and railway safety, frequently resulting in the loss of endangered Asian elephants and disruptions to transportation services. This paper presents the development of a deep learning based real-time detection and warning system designed to mitigate such collisions through intelligent monitoring and communication. The proposed system utilizes the YOLOv8 object detection model, trained on a dataset comprising diverse images of Sri Lankan elephants captured under varying environmental and lighting conditions, thereby ensuring robust detection accuracy. Strategically installed cameras at high-risk railway sections transmit live video to Raspberry Pi computing units for on-site analysis.Upon detecting an elephant, the system automatically initiates a dual warning mechanism by transmitting a wireless alert to approaching trains via Long Range (LoRa) communication offering coverage up to 2 km and activating visual warning indicators at nearby towers to alert ground personnel. Experimental validation confirms high detection precision, low latency, and reliable communication performance, demonstrating the system's suitability for real-world deployment in rural and remote areas. This cost-effective, energy-efficient solution integrates artificial intelligence and embedded systems for sustainable wildlife protection and improved railway operational safety. The findings underscore the potential of the system to significantly reduce fatal elephant train collisions, promote coexistence between humans and elephants, and contribute to national conservation and sustainable transportation initiatives.

Keywords: Deep Learning; Elephant Train Collision; LoRa Communication; Railway Safety; Real-time Detection; Yolov8

ICSD26_044

CAMERA-BASED ADAPTIVE LIGHTING CONTROLLER USING MACHINE LEARNING AND LINEAR OPTIMIZATION FOR ENERGY EFFICIENCY

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Abstract: Intelligent lighting controllers play a significant role in modern industry. They enable efficient lighting control while maintaining user comfort. These systems perform the task of determining the perfect balance between sustainability and user comfort. Many occupancy-based lighting systems rely on PIR based sensors and switching based control methods. PIR sensors are known for their false negatives. which can pose a significant safety hazard. Switching-based controllers lack precision in lighting intensity control. The paper proposes the use of computer vision with Machine Learning (ML) and linear optimization for precise and reliable control of lighting. The overall structure of the controller is divided into sectors according to functions such as detection and control. The proposed solutions are individually applied to each of these components with the aim of solving existing bottlenecks in efficiency and control. The proposed system uses a camera combined with TensorFlow Lite based ML model to detect occupants and their area of presence, while a linear optimization algorithm is used to determine the optimal level of lighting necessary for each light source. The use computer vision eliminates the need for decentralized sensors. Linear optimization-based control algorithm uses only calibration values without relying on any sensors. The wireless lighting controller increases the design scalability and ease of deployment. experimental testing of the theoretical solution is performed with an ESP32-CAM low-cost microcontroller to determine the potential of the system to be viable solution. The results show a TensorFlow Lite model running on an ESP32-CAM module can perform a human detection with an acceptable level of accuracy and the integrated gradient descent based linear optimization can reliably operate with data from the ML model.

Keywords: Computer Vision; Lighting Control; Lighting Optimization; Machine Learning; Occupancy Detection.

ICSD26_051

THE IMPERATIVE NEED OF EXPLAINABLE AI (XAI) FOR HEALTHCARE

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Abstract: Machine Learning (ML) and Artificial Intelligence (AI) have undeniably transformed the world over the past decade. The rapid rise of AI has generated widespread attention across various sectors. Today, AI technologies are deeply embedded in a broad spectrum of applications, from enhanced systems used in industries to everyday mobile features like selfie cameras. This pervasive presence means that millions of people rely on AI in their daily lives, reflecting its growing usefulness and convenience. The remarkable benefits of AI are the primary reasons for its extensive adoption and integration across diverse domains. However, despite these advancements, there remains a significant grey area concerning whether AI development has adequately addressed the ethical implications tied to its impact on moral values, privacy, and security. One major challenge is that decisions made by ML models are often described as 'black boxes', their inner workings and the rationale behind their predictions are not always transparent or easy to understand. This lack of explainability is particularly concerning in critical fields such as healthcare, finance, and agriculture, where the consequences of AI-driven decisions can directly affect human lives, economic stability, and food security. As AI continues to evolve, addressing these transparent and ethical issues is essential to ensure its responsible and trustworthy use.

Keywords: AI; Clinical AI; Governance in AI; ML; Responsible AI; XAI

ICSD26_052

VIBRATION ANALYSIS FOR AUTOMOBILES USING MACHINE LEARNING APPROACHES FOR FAULT DIAGNOSIS

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Abstract: Fault diagnosis in automobile gearboxes plays a crucial role in improving vehicle reliability, preventing unexpected breakdowns, and minimizing maintenance costs. Gearbox bearing or gearwheel faults produce distinct variations in vibration signals, enabling vibration analysis to serve as an efficient tool for identifying mechanical problems. This study presents a comprehensive vibration analysis framework integrated with machine learning techniques to detect and classify faults in automobile gearbox bearings. A controlled experimental setup was developed using a Daihatsu Mira gearbox coupled with a single-phase motor to simulate real operational conditions. Vibration data were collected using a GY-521 Motion Processing Unit (MPU - 6050) three-axis accelerometer and transmitted through a Node Microcontroller Unit (MCU) Espressif Systems Platform (ESP8266) microcontroller for real-time data acquisition and signal processing. The acquired vibration signals corresponding to both healthy and faulty bearings were analyzed across X, Y, and Z coordinates to identify unique fault patterns and deviations in signal amplitude and frequency. Feature extraction techniques were applied to characterize vibration signatures, and the dataset was trained using machine learning algorithms to improve classification accuracy. Experimental results illustrated that the proposed system successfully identified between normal and defective bearings, achieving an average fault classification accuracy of approximately 83.3%. The results validate the capability of the developed model to identify early-stage gearbox faults based on low-cost hardware and efficient signal analysis. The proposed system's adaptability, cost-effectiveness, and simplicity make it suitable for real-time condition monitoring and predictive maintenance applications in automotive and industrial environments. Future enhancements may include integrating advanced sensors, applying deep learning algorithms, and deploying the system for in-vehicle testing under dynamic driving conditions.

Keywords: Condition Monitoring; Fault Diagnosis; Predictive Maintenance; Signal Processing; Vibration Analysis

ICSD26_100

NOVIRA: AN AI-DRIVEN PARENTAL MONITORING SYSTEM FOR ENHANCING CHILD SAFETY AND EMOTIONAL WELL-BEING

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Abstract: Social media has become an integral part of modern communication, especially among youth under the age of eighteen. However, the increasing exposure of minors to online platforms has also introduced serious risks such as cyberbullying, harassment, hate speech, and exposure to inappropriate content. These harmful interactions can severely impact the mental and emotional health of young users, sometimes leading to long-term psychological consequences. This research aims to address these issues by using Artificial Intelligence (AI) and Natural Language Processing (NLP) techniques to detect and moderate toxic content in social media communications automatically. A dataset consisting of over 20,000 real social media comments was manually annotated based on categories of online harm, including profanity, hate speech, harassment, and sexually explicit material. The annotated data was used to train a machine learning based NLP model capable of identifying and classifying toxic comments with a high degree of accuracy. Experimental results revealed that the proposed model demonstrates promising performance in distinguishing harmful content from safe interactions. As a future extension, the model will be integrated into a mobile application that serves as an AI-powered communication assistant for young users. This app will provide real-time message filtering, emotional guidance, and positive communication recommendations. The study not only contributes to the development of safer online spaces but also highlights the potential of AI-industry collaboration to promote sustainable digital well-being and responsible technology use among younger generations.

Keywords: Abuse Child; Cyber Bullying; Digital Parenting; Emotional Analysis; Natural Language Processing

ICSD26_274

BEYOND STATIC DETECTION: ROBUST TRACKING OF OVERLAPPING WASTE ON MOVING INDUSTRIAL CONVEYORS

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Abstract: The transition to a circular economy in the construction sector depends on the efficient recovery of materials from Construction and Demolition (C&D) waste. However, the automation of this process is severely challenged by the high heterogeneity, continuous motion, and frequent occlusion of debris in operational recycling plants. Although deep learning–based object detectors perform well on static image benchmarks, their reliability degrades in real-world conveyor-based environments where object identities are difficult to maintain over time. To address this implementation gap, this study presents and validates a real-time computer vision pipeline designed for continuous detection and tracking of overlapping C&D waste materials on moving conveyors. A YOLOv11-L detector, trained using a dataset of 1,630 high-resolution images, was utilized to provide frame-level detections, which was then integrated with the ByteTrack algorithm to maintain consistent object identities through temporal occlusions. Real-time validation demonstrated robust tracking performance at a conveyor speed of 0.25 m/s, with the system operating at 15 FPS on standard hardware and exhibiting negligible identity flicker (< 3 instances per 100 frames). Detection performance under cluttered conditions achieved a mean Average Precision (Map @ 0.5) of 0.967 across five material categories. These results confirm that combining advanced real-time detectors with robust tracking algorithms enables reliable perception of occluded C&D waste in dynamic environments, providing a validated foundation for scalable, intelligent robotic sorting systems in industrial recycling facilities. This work was supported by the NSF–NSFC Joint Research Program under Grant No. ICRP/NSF-NSFC/2024/EA&ICT/03.

Keywords: Computer Vision; Construction and Demolition (C&D) Waste; Deep Learning; Dynamic Tracking; Occlusion Handling

ICSD26_281

DEEPMINEAI: A DEEP LEARNING - BASED GEMSTONE CLASSIFICATION MODEL FOR DIGITAL GEM TRADING PLATFORMS

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Abstract: To identify gemstones and determine their quality, the gemstone industry continues to heavily depend on manual inspection and expert-based evaluation of its products mostly subjective, time-consuming and difficult to scale in digital marketplaces. The lack of automated, trustworthy, and impartial gemstone verification processes in current online gem trading platforms leads to problems with trust and uneven quality evaluation. DeepMineAI, an AI-based gemstone classification algorithm created as the central intelligence component of the Gemora digital gemstone marketplace, is presented in this study. Using images uploaded by sellers, the suggested system uses deep learning-based image classification to automatically identify gemstone categories and estimate quality-related visual attributes. Because of its lightweight design, a MobileNet architecture was initially chosen; however, experimental evaluations showed that it was not accurate enough to handle complex gemstone textures, inclusions, and color variations. EfficientNetB0, which applies transfer learning with fine-tuning to improve feature representation while preserving computational efficiency, was used to improve the model in order to get around these restrictions. To improve generalization, input gemstone images are represented as normalized RGB tensors, resized to a fixed resolution, and enhanced with rotation, flipping, zooming, translation, and contrast adjustments. A SoftMax based classifier is used to classify gemstones after the EfficientNetB0 backbone extracts hierarchical visual features like edges, color distributions, and texture patterns. Experimental results indicate that the proposed model is much more effective than the baseline MobileNet model since the proposed model reaches training accuracy of 97.75% and validation accuracy of 77.78%. Although the existing application is based on the estimation of the type and quality of gemstones, improvements in the future will be made to DeepMineAI to identify synthetic and fake gem stones and ensure better trust, transparency, and reliability in the trade of gemstones online.

Keywords: Artificial Intelligence; Deep learning; Digital Gem Trading; Image Recognition; EfficientNet; Gemstone Classification

ICSD26_312

EFFECTIVENESS OF STEP-SHAPED TRENCHES IN REDUCING PILE-INDUCED VIBRATION: NUMERICAL INVESTIGATION AND MACHINE LEARNING (ML) PREDICTION

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Abstract: Pile driving generates ground vibration that cause damage to nearby structures and sensitive equipment, highlighting controlling of vibration during pile driving is an imperative need. This study aims to explore the effectiveness of step-shaped open trenches in controlling ground vibration and to integrate machine learning (ML) for vibration predictions. Methodology consists of Finite Element (FE) model development, FE model validation, ML model training and performance evaluation. Various step-shaped trench geometries were used to determine screening of vibration propagation. The potential of Artificial Neural Networks (ANNs) and Extreme Gradient Boosting (XGB) ML algorithms to predict vibration was studied. The peak particle velocity (PPV) between the source (i.e., pile) and trench was higher than that of the free field in the longitudinal direction, and it was lower in the vertical direction. The percentage of vibration reduction (Ar) decreased in longitudinal and vertical directions with increasing step height. Among the ML models, ANN demonstrated the best predictive performance, with an R^2 of 0.9956, an RMSE of 0.1679 mm/s, and an MAE of 0.2131 mm/s.

Keywords: Construction Vibration; Machine Learning Prediction; Numerical Modelling; Vibration Controlling

BIOTECHNOLOGY, BIOMEDICAL SCIENCE & NATURAL PRODUCTS - II

ICSD26_015

EVALUATION OF ANTIBACTERIAL AND PHYTOTOXIC ACTIVITY OF PURE AND BISMUTH DOPED COPPER OXIDE NANOPARTICLES

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Abstract: Bacterial resistance to antibiotics is one of the major problems in the world. Alternative antimicrobial solutions are essential to address this problem. Among the possible options, metal oxide nanoparticles (NPs) have received significant attention due to their strong antimicrobial properties. However, their effectiveness and environmental compatibility have not fully discovered yet. In order to address these gaps, copper oxide (CuO) and bismuth-doped copper oxide (Bi-CuO) NPs were synthesised using co-precipitation method. Synthesized NPs were characterized by using X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FT-IR) and UV - Vis spectroscopy. According to XRD analysis, the average crystalline sizes of CuO and Bi-CuO NPs were 20.35 nm and 18.42 nm. Disk diffusion assay was used to evaluate the antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. The treatments, 100, 200, 400 mg/mL concentrations of NPs were used together with the Streptomycin sulfate as the positive control. Phytotoxicity was evaluated by using seed germination assay conducted on *Zea mays* and *Capsicum annuum* at concentrations of 250, 500, and 1000 mg/mL for both NPs. Each treatment was replicated three times for both assays. The disk diffusion test revealed that 400 mg/mL Bi-CuO NPs showed the strongest inhibition compared to that of pure CuO NPs, confirming improved antimicrobial properties by doping treatment. According to the seed germination assay, germination rates were unaffected, but when concentrations were increased, significant reductions in root and shoot growth were observed for both crops. Bi doped CuO NPs showed significantly higher toxicity than pure CuO NPs at high concentrations. These findings confirmed the increasing antimicrobial efficacy by doping with Bi in CuO NPs while raising concerns regarding their toxicity issue. Further research is necessary to optimize the concentrations and increase the environmental sustainability.

Keywords: Antibacterial Activity; Disc Diffusion; Pure and Bi-doped CuO Nanoparticles; Seed Germination Assay

ICSD26_057

IN VITRO APPROACHES FOR EVALUATING ANTICANCER ACTIVITY: A COMPREHENSIVE METHODOLOGICAL REVIEW

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Abstract: Cancer is one of the main causes of death worldwide. There were an estimated approximately 19-20 million new cases within a year, among them, breast cancer and lung cancer were highly distributed than the other types globally. Due to the high global burden caused by cancer, successful anticancer agents must be discovered and utilized. This review aims to assess the various scientific methods used to assess anticancer activity through *in vitro* techniques. This methodological review was conducted using PubMed, Google Scholar, and Hinari. We explored the databases using "anticancer activity," "*in vitro* assays," and "cell culture". The initial 135 articles were narrowed down to 55 after careful filtering based on the topic and abstract, following the PRISMA flowchart. Annual publication trends include a gradual increase in research interest over the years, beginning with a few articles found in 2014, and peaking in 2020. Notably high outputs were also observed in 2023 and 2016. The MTT (3-[4, 5-dimethylthiazol-2-yl] -2,5-diphenyl tetrazolium bromide) assay was among the available methods; this is one most widely used approaches for assessing cell viability and cytotoxicity. Other often used assays include the SRB (Sulforhodamine B) assay, migration assays, flow cytometry, and polymerase chain reaction (PCR), which is crucial for assessing apoptosis and cell proliferation studies. The variety of *in vitro* techniques used to evaluate anticancer potential in laboratory settings is further demonstrated by the frequent use of techniques like live/dead staining, trypan blue exclusion assay, and colony-forming assays. *In vitro* anticancer tests offer important information on the biological and cytotoxic effects of medicinal substances. *In vitro* anticancer assays provide a valuable tool for potential therapeutic agents while minimizing the need for animal experimentation. Compared to *in vivo* techniques, these methods offer a more ethical, cost-effective, and rapid approach to preliminary screening.

Keywords: Anticancer Activity; Cell Culture; *In vitro* Assay; MTT Assay

ICSD26_062

ANTIOXIDANT ACTIVITY OF *Plectranthus amboinicus* (KAPPARAWALLIYA) PLANT AQUEOUS EXTRACTS

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Abstract: *Plectranthus amboinicus* Lour. (Sinhala Kapparawalliya) is a semi-succulent perennial plant found in the tropical regions of Africa, Asia, and Australia. Since ancient times, this plant has been widely used in Ayurvedic medicine, with over 50 recipes in the Ayurvedic pharmacopeia featuring it as a major ingredient. Studies conducted to date have identified several phytoconstituents, including phenolics, terpenoids, phenolic acids, flavonoids, flavones, and tannins. This present study was conducted to evaluate the *in vitro* antioxidant activity of *Plectranthus amboinicus* plant extracts using two distinct assays: 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging and Ferric Reducing Antioxidant Power (FRAP). Healthy *P. amboinicus* Lour plants were collected from Kuliyapitiya in the Kurunegala district. The collected plants were washed, dried, ground, and subjected to aqueous extraction by simple maceration. The antioxidant activity was assessed using the DPPH and FRAP assays for a concentration series ranging from 20 µg/mL to 120 µg/mL, and triplicated. Results of the DPPH radical scavenging assay revealed that the half-maximal inhibitory concentration (IC_{50}) of *P. amboinicus* plant extract was 83.88 ± 0.18 µg/mL. This result was compared to the positive control, ascorbic acid (IC_{50} 6.31 ± 0.11 µg/mL). In the FRAP assay, *P. amboinicus* plant extract exhibited an IC50 of 125.31 ± 0.46 µg/mL, while the ascorbic acid positive control exhibited an IC50 of 7.72 ± 0.16 µg/mL. In conclusion, the *P. amboinicus* plant extract demonstrated strong *in vitro* antioxidant activities in DPPH and FRAP assays. These findings justify the traditional medicinal uses of *P. amboinicus* and highlight its potential as a valuable natural source of antioxidants for various health applications.

Keywords: Antioxidant; DPPH; FRAP; IC_{50}; *Plectranthus amboinicus*

ICSD26_090

CHARACTERIZATION OF COPPER NANOPARTICLES SYNTHESISED USING AQUEOUS EXTRACT OF THE *Croton aromaticus* LEAVES

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Abstract: Traditional chemical nanoparticle synthesis methods pose a high environmental risk because of the utilization of hazardous chemicals and high-energy processors. Copper nanoparticles are a remarkable material in various fields because of their low toxicity and high effectiveness, enabling their use in electronics, catalysis, and biomedical applications. The research aims to produce Copper/Copper oxide nanoparticles through a sustainable green synthesis method, utilizing the aqueous leaf extract of *Croton aromaticus*, a plant recognized for its bioactive components and antifungal properties. Qualitative testing for phytochemicals of the leaf extract revealed the presence of alkaloids, saponins, reducing sugars, tannins, flavonoids, glycosides, and phytosterols. The total polyphenol content was 3.09 mg/g GAE, highlighting its function as both a reducing and a capping agent. The nanoparticle synthesis was followed by mixing the aqueous leaf extract with a 0.1 M $CuSO_4$ solution at a 3:1 ratio and allowing the reaction proceed in complete darkness for 24 hours at room temperature. Then the percent yield was calculated and characterized using UV-Vis spectroscopy, SEM, EDS, and FTIR. Visual observations revealed that nanoparticle formation occurred when the reaction mixture changed from yellow to a blackish-green color, yielding 41.23%. UV-Vis analysis revealed absorbance maxima at 330 nm (Copper oxide nanoparticles) and 530-593 nm (Copper nanoparticles). SEM analysis showed that the nanoparticles were quasi-spherical in shape, and FTIR spectra showed functional groups that acted as capping agents for the nanoparticles in the form of O-H, C-H, and Cu-O bonds. The EDS spectrum displayed the elemental composition, indicating 29.65% copper and trace amounts of silicon (Si), sulfur (S), calcium (Ca), and zinc (Zn). The presence of oxygen (26.24%) suggests partial oxidation, due to less-controlled synthesis conditions and longer reaction periods. This study concludes that the potential of *Croton aromaticus* aqueous leaf extract lies in the sustainable, eco-friendly synthesis of Copper/Copper oxide nanoparticles.

Keywords: Copper/ Copper Oxide Nanoparticles (Cu/CuO NPs); *Croton aromaticus*; Green Synthesis; Percent Yield; Phytochemicals; Polyphenol

ICSD26_137

EFFECT OF A POLYHERBAL EXTRACT (TRIPHALA) AGAINST DRUG-RESISTANT ESCHERICHIA COLI

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Abstract: Triphala is an herbal formula that is used in traditional medicine for the treatment of diseases, wound and acting as a laxative agent. It contains fruits of *Terminalia chebula, Terminalia bellirica,* and *Phyllanthus emblica*. The objective of the present study was to evaluate the inhibitory effect of the combination and constituent fruit extracts of Triphala on antibiotic-resistant *Escherichia coli*. The antimicrobial activity was estimated using the agar dilution assay, using 100% (extract boiled down to 1/8th of initial volume) and 50% strengths of the dried fruit aqueous extracts separately and in combination on one Multidrug-Resistant (MDR - resistant to at least one agent in three or more antibiotic classes) and nine Drug-Resistant (DR - resistant to one antibiotic) isolates, previously isolated from river water. Ciprofloxacin (8 µg/ml) served as the positive control, and sterile distilled water was the negative control. X-Ray Fluorescence (XRF) analysis was used to test the chemical composition of the three fruits. The results revealed that the aqueous extract (100%) of Triphala and individual extracts (100%) of *T. chebula* and *P. emblica* exhibited strong antibacterial activity against the MDR *E. coli* isolate resistant to antibiotics ciprofloxacin (class; Fluroquinolone), amikacin (class; Aminoglycoside), and Co-amoxicillin/clavulanate potassium (class; β-lactam) and all nine DR *E. coli* isolates. The extracts of *T. bellirica* did not exhibit inhibition against the isolates tested. The XRF analysis revealed differences in elemental composition between the three extracts. The respective elemental composition could not be attributed to the differences in activity of the three different extracts. In conclusion, all three constituents of Triphala in combination with two of its constituents (*T. chebula* and *P. emblica*) showed activity against drug-resistant *E. coli*, exhibiting their potential to be used as antibacterial agents, particularly in the treatment of infections that are intractable to synthetic antibiotics.

Keywords: Ayurvedic Medicine; Ciprofloxacin; Drug-Resistant *E. coli*; MDR *E. coli;* Triphala

ICSD26_146

COMPARATIVE LITERATURE REVIEW OF SECONDARY METABOLITE PRODUCTION FROM CALLUS CULTURE AND CONVENTIONAL PLANT MATERIALS OF *Salacia reticulata* (KOTHALAHIMBUTU)

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Abstract: *Salacia reticulata* (Kothalahimbutu) is an endangered plant, taxonomically classified to the family Celastraceae. It is a therapeutically significant plant due to the wide range of secondary metabolite content. Secondary metabolite content is the major reason for being a *S. reticulata* as a medicinal plant. Mangiferin, salacinol, kotalanol and polyphenols are the major individual secondary metabolite compounds in *S. reticulata* which are essential for healing diabetes, controlling obesity and hyperlipidaemia. Secondary metabolite production can be enhanced using *in vitro* cultivation system compared to a conventional cultivation system. This study aims to systematically review and compare the secondary metabolite production from *in vitro* callus culture and filed grown plant materials. *In vitro* callus culture is the most successful approach to produce secondary metabolites targeting large scale production. Even though many more individual studies evaluate secondary metabolite production in *S. reticulata* with *in vitro* and *in vivo* cultivation systems, there is no systematic comparison of phytochemical production between *in vivo* and field grown cultivation systems. To conduct this study peer-reviewed journals, books and reports in databases related to secondary metabolites production in *S. reticulata* were used along with three major stages, including a systematic literature survey, data screening and selection, data extraction and synthesis. Relevant articles documented over 25 years (2000 - 2025) were used for this review. Few studies have been conducted for *S. reticulata* and most studies have focused on other *Salacia* species. Optimized callus cultures, followed by elicitation strategies, can enhance the production of secondary metabolites. This review also exposes gaps in present knowledge regarding metabolic pathway characterization, scaling of bioreactors and the genetic stability of cultured tissues, proposing pathways for the future commercial utilization of *in vitro* callus-based metabolite production in *S. reticulata*. Surely these findings will open up many more research opportunities making a significant contribution in pharmaceutical industry.

Keywords: Conventional cultivation; *In vitro* callus culture; Kothalahimbutu; *Salacia reticulata*; Secondary metabolites

ICSD26_239

FERMENTED BUFFALO CURD (MEEKIRI) AS A SOURCE OF PROTEOLYTIC BACTERIA WITH POTENTIAL THROMBOLYTIC APPLICATIONS

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Abstract: Cardiovascular diseases and thrombosis remain major causes of global mortality, while conventional antiplatelet and anticoagulant therapies are often costly and associated with serious adverse effects such as haemorrhage. These limitations have increased interest in alternative thrombolytic agents derived from natural sources, particularly fermented foods. Previous studies have shown that traditional fermented foods in other countries are rich sources of fibrinolytic enzyme producing bacteria. As Meekiri, traditional Sri Lankan buffalo curd, has not been previously investigated, this study focuses on evaluating its proteolytic and potential fibrinolytic properties. Buffalo curd samples were systematically collected from Gampaha District. Microorganisms were isolated via two-fold serial dilutions and screened for proteolytic activity on skimmed milk agar, indicated by clear zones of casein hydrolysis. Ten distinct proteolytically active colonies were isolated and cultured on nutrient agar plates. The isolated pure colonies were subjected to biochemical tests and gram staining. Wizard SV Genomic DNA Purification Kit was used to extract genomic DNA and was quantified via NanoDrop spectrophotometry and amplified by PCR targeting the 16S rRNA gene with 63F and 519R primers. Amplicons were verified through agarose gel electrophoresis and subjected to unidirectional Sanger sequencing employing the 63F primer. Using BLAST (Basic Local Alignment Search Tool) we identified *Bacillus* spp., *Acinetobacter* spp. and *Enterococcus* spp. genera previously reported in literature to possess fibrinolytic potential. Other bacteria identified included *Gordonia* spp., *Cytobacillus* spp. and *Klebsiella* spp. These genera lack direct evidence of fibrinolytic activity in existing literature and require further investigation to determine their true potential. Nevertheless, these indigenous isolates from traditional buffalo curd represent promising candidates for fibrinolytic enzyme production so further fibrinolytic enzyme assays should be done to all identified bacteria. Harnessing native biodiversity may enhance cardiovascular health outcomes, improve treatment accessibility, reduce healthcare costs and support sustainable medical advancements in resource limited developing regions.

Keywords: Fermented Foods; Fibrinolytic Enzymes; Meekiri; Sri Lankan Buffalo Curd; Thrombosis

RENEWABLE ENERGY SYSTEMS, SOLAR TECHNOLOGIES, AND ADVANCED ENGINEERING INNOVATIONS

ICSD26_041

MAXIMIZING SOLAR ENERGY OUTPUT THROUGH OPTIMAL PANEL TILT ANGLE AND ORIENTATION UNDER DIFFERENT CLIMATIC CONDITIONS

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Abstract: Harnessing solar energy efficiently is important to global sustainability in that it offers a renewable and abundant solution to reduce emissions of greenhouse gases. Among the environmental factors, Solar Photovoltaic (PV) systems are most susceptible to changes in solar irradiance levels and variations in the tilt angle of their panels. The tilt angle has a direct impact on the amount of solar radiation absorbed by the PV surface, hence its energy output. Dynamic tracking systems that may optimize energy collection by adjusting panel orientation are not as suitable for developing countries since they are highly expensive, complex, and require very frequent maintenance. To address this challenge, the study investigated the impact of tilt angle optimization on solar PV output power efficiency across three climatically diversified regions of Sri Lanka, namely Nuwara Eliya, representing cool and high-altitude conditions; Marawila, which is tropical and coastal; and Kilinochchi, which is dry and arid. Both a fixed PV panel set at a 10° tilt angle and a variable PV panel with tilt angles ranging from 10° to 90° are installed at all three locations for ten days to measure real-time parameters, including voltage and current, and hence the power output, using a smart metering system. The collected data is used to analyze solar PV power output over an eight-month period from January to September and Matrix Laboratory (MATLAB) software is used to compare and validate the recorded data. The results confirm that intermittently adjusting the PV panel tilt angle has a significant impact on solar power output, leading to increased energy generation over time and highlighted the 10° as the most practical and efficient tilt angle for installations in all three regions. Comparing fixed and variable tilt angle solar panels, the angle of tilt had the highest influence in Marawila at 3.43%, followed by Nuwara Eliya at 2.78%, while Kilinochchi showed the lowest influence at 0.87%. Overall, this research provides a strong scientific basis for area-specific optimization of solar panel orientation, enhancing energy efficiency and reliability to support sustainable solar energy deployment across Sri Lanka for both household and industrial applications.

Keywords: MATLAB; Solar Irradiance; Solar Photovoltaic; Tilt Angle Optimization

ICSD26_054

DESIGN AND IMPLEMENTATION OF AN IOT BASED SOLAR SITE ANALYZER FOR REAL-TIME FEASIBILITY ASSESSMENT

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Abstract: Accurate solar site assessment is vital for optimizing the design and performance of solar power plants. Conventional methods rely heavily on manual data collection, which is time consuming, error-prone, and limited in temporal resolution. To overcome these challenges, this study presents the design and implementation of an Internet of Things (IoT) based Solar Power Plant Modelling Analyser that automates real-time data acquisition and analysis of key environmental and operational parameters. The system integrates an Espressif (ESP32) microcontroller with different sensors including a temperature sensor, humidity sensor, current sensor, Light Dependent Resistor (LDR), and an anemometer for wind speed measurement. A low power solar panel coupled with a servo motor enables automated solar tracking, while the Real-Time Clock (RTC) module and Wi-Fi interface ensure accurate time-stamped data logging and remote accessibility via cloud storage. Experimental results demonstrate that the system effectively measures voltage, current, irradiance, temperature, humidity, and shading to evaluate solar site feasibility. Comparative observations reveal that voltage and current outputs closely correlate with variations in irradiance and shading, validating the system's sensitivity and reliability. The integration of automated sun tracking significantly enhances energy capture efficiency, while real-time data visualization via an Liquid Crystal Display (LCD) supports immediate on-site decision making. Overall, the proposed system offers a cost-effective, accurate, and scalable solution for solar resource assessment. By minimizing manual intervention and improving data accuracy, it provides a valuable tool for researchers, engineers, and planners in optimizing solar power plant design and deployment.

Keywords: Automatic Monitoring; Data Analysis; Real Time Data Collection; Solar Irradiance; Solar Power Plant Model

ICSD26_056

INTELLIGENT MONITORING AND SELF-MAINTENANCE SYSTEM FOR SOLAR PV SYSTEMS: DESIGN, DEVELOPMENT, AND SURVEY BASED ANALYSIS

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Abstract: However, conventional PV monitoring and maintenance methods rely heavily on manual inspection, leading to inefficiencies, delayed fault detection, and reduced system performance. To address these challenges, this study presents an intelligent monitoring and self-maintenance system designed to enhance the performance and reliability of solar PV installations. The proposed approach is based on sensor-driven data acquisition, where multiple sensors, including a Light-Dependent Resistor (LDR), temperature sensor, light intensity sensor, rain sensor, and DHT11 humidity sensor, are integrated to continuously collect environmental and operational data such as panel temperature, ambient temperature, humidity, light intensity, rainfall duration, and dust accumulation. Data communication and control are achieved using the SIM800L GSM module and ESP32 Wi-Fi microcontroller, enabling real-time monitoring, automated alerts, and IoT-based management through Firebase, Google Sheets, and a custom Flutter mobile application. The 20x4 LCD display and ESP32 web server provide a user-friendly local interface, while the Flutter app offers remote access to data visualization and control. The system incorporates automatic cooling and cleaning mechanisms that activate based on sensor readings, reducing manual intervention and ensuring optimal power generation efficiency. Field testing conducted on fifteen solar PV systems across Sri Lanka demonstrated measurable improvements in energy output and a significant reduction in manual maintenance requirements. Furthermore, an AI-based analytical framework was introduced to evaluate performance trends and generate predictive maintenance recommendations using data from cloud storage platforms, supporting proactive maintenance decisions. This intelligent and cost-effective self-maintenance system minimizes human involvement, lowers operational costs, and enhances the lifespan and efficiency of solar panels, thereby improving the overall sustainability of solar PV systems. The proposed approach provides a sustainable and scalable solution for smart solar management, making it highly suitable for developing countries like Sri Lanka, where maximizing renewable energy utilization and reducing maintenance costs are critical objectives.

Keywords: Cloud Storage; Intelligent System; Internet of Things; Real-Time Monitoring; Self-Maintenance

ICSD26_069

MECHANOCHEMICAL AND SOLVOTHERMAL SYNTHESIS OF METAL ORGANIC FRAMEWORKS; A COMPARTIVE ANALYSIS AND SCALE-UP CONSIDERATIONS

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Abstract: Metal organic frameworks (MOFs) have gained significant attention in engineering circles due to their high specific surface area ranging from 1000 m^2/g to 10,000 m^2/g. However, conventional synthesis methods, primarily solvothermal techniques, have identified challenges in achieving higher yields, purity, specific surface area and scalability in production. Therefore, mechanochemistry as a viable chemical synthesis approach has extended to MOF synthesis. This literature review includes a comprehensive quantitative analysis to compare the specific surface area variations between solvothermal and mechanochemical synthesis methods of several types of MOFs including IRMOFs, ZIFs and MILs and among different mechanochemical synthesis methods such as neat grinding, liquid assisted grinding and ion and liquid assisted grinding as well. This also discusses how different aspects of mechanochemical synthesis such as metal: ligand molar ratio, grinding time, grinding speed affect specific surface area optimization. The study revealed that mechanochemical methods offer considerably higher specific surface areas compared to solvothermal methods for different types of MOFs while agglomeration can be minimized using only a catalytic amount of solvent. Furthermore, it showed that crystallinity of the mechanochemically synthesized MOFs could be enhanced by experimenting with different milling times. Despite the widespread use of MOFs across various engineering disciplines, challenges are there in achieving industrial-scale production. The final results showed that extrusion as a mechanochemical method has shown prospect in scaling-up while having approximately three times higher space time yields compared to solvothermal methods.

Keywords: IRMOF 5; Mechanochemistry; Metal Organic Frameworks; Liquid Assisted Grinding; Specific Surface Area; ZIF 8

ICSD26_107

DESIGN AND DEVELOPMENT OF A HYBRID DRYER (BIOMASS - ELECTRICITY) AND PERFORMANCE EVALUATION

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Abstract: Postharvest losses remain a significant issue, with 30 - 40% of perishable agricultural produce wasted due to inadequate preservation and value addition provisions in Sri Lanka. Traditional sun drying, though widely practiced, is slow, weather-dependent, and prone to contamination, resulting in substandard quality produce. Mechanical dryers offer better control but are often inaccessible to smallholder farmers due to high initial investment and operational costs. Hybrid drying systems that combine biomass and electricity provide a practical, resilient alternative for continuous operation under fluctuating energy conditions. This study presents the design, fabrication, and performance evaluation of a 25 kg-capacity cabinet-type hybrid dryer developed for farm-scale postharvest processing. The dryer integrates an indirect biomass combustion chamber for wood chips, a high-efficiency heat exchanger, a 1 kW electric heating element, a centrifugal blower, an automated temperature control mechanism to maintain the dryer temperature between 50 - 60 °C, and a three-shelf drying chamber. This dual-energy configuration enables seamless switching between biomass and electric heating, ensuring uninterrupted drying during refilling and in adverse weather. Drying trials conducted for jackfruit, turmeric, and garcinia successfully reduced moisture content from approximately 80% to below 10% (wet basis), achieving a maximum drying efficiency of 70% and reducing drying time by 45% compared to traditional sun drying. Final products reached 8 – 9% moisture (wet basis) with no smoke contamination, confirming the effectiveness of the indirect heating design. Energy consumption averaged 750 watt-hour per batch in hybrid mode and 6.7 kg of wood chips in biomass-only mode. Overall, the developed hybrid dryer offers an affordable, efficient, and reliable solution for smallholder farmers, enhancing product quality and reducing postharvest losses.

Keywords: Biomass and Electric Heating; Drying Efficiency; Hybrid Dryer; Postharvest Processing

ICSD26_115

ANALYSIS OF A HYBRID SUSPENSION SYSTEM WITH ENERGY REGENERATION AND ACTIVE CONTROL FOR ELECTRIC VEHICLES

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Abstract: Active suspension systems are designed to apply controlled forces to the vehicle body to minimize the effect of road-induced vibrations, thereby enhancing ride comfort. Regenerative suspension systems aim to harvest the vibrational energy present and convert it into useful electrical energy, enhancing energy efficiency of electric vehicles. Although active suspension significantly enhances ride comfort, its high energy consumption presents a drawback. This motivates a study of a hybrid suspension system that integrates active and regenerative suspension. This research focuses on the simulation and experimental validation of such a hybrid suspension system. In this approach a quarter-car suspension model was designed in MATLAB Simulink to compare the performance of active, passive and regenerative suspension systems particularly focusing on the vertical heave of the vehicle body. A PID controller was tuned within the simulation environment to minimize the sprung-mass displacement of the car body, which serves as the key performance metric for ride comfort. Subsequently, a scaled down physical quarter-car model was developed to validate the simulated behavior. In the physical model, a motor coupled with a rack and pinion mechanism was used both as an actuator to provide control forces and as generator to convert linear motion into rotational motion and generate electricity. To evaluate the overall performance both simulation and physical setups were subjected to three road excitation profiles, and the maximum response was recorded at each stage. The regenerated energy was presented as a non-dimensional quantity by calculating it as a percentage of the energy consumed by the active suspension under identical time and conditions. Energy analysis revealed that up to 24% of the power consumed by the active suspension system could be recovered through the regenerative suspension system. The novelty of this study lies in designing a hybrid suspension system which combines both energy harvesting and active control and experimentally validating it. The results show the feasibility of such a system and propose it as a meaningful approach to enhance ride comfort and energy efficiency, thereby contributing to sustainable mobility and the circular economy.

Keywords: Active Suspension; Energy Harvesting; MATLAB Simulink; Regenerative Suspension; Vehicle Dynamics

ICSD26_166

DESIGN AND IMPLEMENTATION OF AN INDEPENDENT ENERGY MONITORING AND FAULT DETECTION SYSTEM FOR DOMESTIC SOLAR PLANTS

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Abstract: The growing adoption of residential solar photovoltaic (PV) systems (5 kW-40 kW range) necessitates effective monitoring solutions to ensure optimal power generation. While commercial systems often fail to address underperformance issues and traditional mobile applications not showing the root causes of low energy generation in domestic site systems, this research project develops a standalone fault analysing and identification device that identifies causes of power loss and provides actionable alerts without requiring technical expertise from users. The system utilizes low-cost components including a 5V mini solar panel (for irradiance measurement), (Linear Monolithic) LM 35 temperature sensor, and Allegro Current Sensor (ACS) 712, integrated with an (Espressif) ESP32 microcontroller for real-time performance analysis. Over a 30-day evaluation period, the device continuously tracks power output, solar irradiance, temperature parameters, and inverter efficiency. Collected data is compared against theoretical performance to detect underproduction. When generation falls below expected levels, the system identifies specific causes including shading effects, soiling accumulation, or inverter faults and provides targeted recommendations for corrective action. Through innovative server-side timestamping, the system successfully identified performance anomalies and provided actionable insights via Short Message Service (SMS) alerts without requiring technical expertise from users. The monitored system recorded 742 kilowatt-hours (kWh) monthly generation, exceeding the 550 kWh threshold by 35.1% and maintaining 87.2% operational efficiency. This solution maintains economic feasibility while significantly improving operational oversight for residential installations. By eliminating dependence on complex monitoring platforms and addressing the needs of non-technical users, the research establishes practical standards for fault detection in domestic PV systems. The standalone design ensures reliable operation without requiring internet connectivity or smartphone applications, making it particularly suitable for diverse user groups. Findings demonstrate how simple, cost-effective monitoring can enhance system performance and return on investment for household solar installations.

Keywords: Fault Detection; Performance Optimization; Residential Solar; Solar Photovoltaic; Standalone Monitoring

FUNCTIONAL FOODS, NUTRACEUTICALS, AND HEALTH-ORIENTED FOOD INNOVATIONS

ICSD26_009

BIOACTIVE COMPOUNDS, ANTIOXIDANT CAPACITY AND PHYSIOCHEMICAL PROPERTIES OF SELECTED EDIBLE AQUATIC PLANT FLOWERS ACROSS SELECTED LOCATIONS IN SRI LANKA

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Abstract: Bioactive compounds play a significant role in protecting human health. While plants are valuable sources of these compounds, underutilized edible aquatic plant flowers have the potential to become primary sources. This study evaluated the Total Phenolic Content (TPC), Total Flavonoid Content (TFC), and Total Antioxidant Capacity (TAC) of the flower parts of eight aquatic plant species found in the North Central and North Western provinces of Sri Lanka. The species analyzed were *Nymphaea nouchali*, *Nymphaea pubescens*, *Nymphaea rubra*, *Nelumbo nucifera*, *Aponogeton crispus*, *Pontederia hastata*, *Lasia spinosa*, and *Ipomoea aquatica*. TPC was measured using the Folin-Ciocalteu assay, TFC was determined using the aluminium chloride assay, and TAC was assessed using the ferrous-reducing power assay. Additionally, physicochemical properties, including moisture, ash, crude protein, crude fat, crude fiber, and carbohydrate content, were analyzed using AOAC methods. The results indicated *N. pubescens* exhibited the highest TPC (34.26 ± 0.73 mg GAE/g), while *N. pubescens* also recorded the highest TFC (55.45 ± 1.67 mg Rutin/g) among the aquatic flowers. However, *Hibiscus sinensis* demonstrated a higher flavonoid content (134.92 ± 5.82 mg Rutin/g). The highest TAC was observed in *N. nouchali* (247.20 ± 0.81 mg Trolox/g). A positive correlation was found between TPC and TAC (r = 0.889) and between TFC and TAC (r = 0.446). Among the physicochemical properties, the highest ash and crude protein contents were recorded in *L. spinosa* (12.65 ± 0.02% and 4.23 ± 0.26%, respectively). The highest moisture and crude fat contents were found in *P. hastata* (92.11 ± 0.18% and 9.02 ± 0.33%, respectively). The highest crude fiber content was recorded in *N. nucifera* (26.27 ± 0.16%), while the highest carbohydrate content was found in *N. pubescens* (61.25 ± 0.19%). These findings suggest that edible aquatic plant flowers are rich in bioactive compounds and nutrients, with potential applications in both food and pharmaceuticals.

Keywords: Antioxidant Capacity; Aquatic Plant flowers; Bioactive Compounds; Proximate Composition

ICSD26_045

ENERGY DRINK CONSUMPTION AND HUMAN HEALTH: A SYSTEMATIC REVIEW OF MULTI-SYSTEM ADVERSE EFFECTS AND TOXICOLOGICAL COMPOSITION

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Abstract: The consumption of energy drinks has increased rapidly over the recent years. These beverages contain high levels of caffeine, sugar, and other stimulants like taurine and guarana, typically. Despite being marketed as performance-boosting products, they possess a controversial safety profile due to significant multi-systemic adverse health effects being observed in long term energy drink consumers. This review addresses the need to explore and summarize the adverse effects of energy drink consumption. Seven online databases (Google Scholar, PubMed, etc.) were used to conduct this systematic search. Relevant articles published between 2015 and 2025 were selected using keywords such as "energy drinks," "adverse effects," and "health risks." Out of 177 articles, 25 original studies that fulfilled the inclusion criteria were selected according to the PRISMA 2020 guidelines. The review shows that energy drink consumption causes various adverse effects including cardiovascular, neurological, metabolic, endocrine, gastrointestinal, hepatic and renal disorders. Cardiovascular toxicity includes hypertension, QTc prolongation; all risk factors for life-threatening conditions. Sleep disturbances, increased levels of stress, and a significantly high rate of suicidality in adolescents were some of the neurological effects observed. Metabolic changes such as insulin resistance and metabolic syndrome often occurred with increased levels of hepatic enzymes and possible compromise in glomerular filtration. It is evident from the data that energy drink consumption, especially among vulnerable populations within developing societies, is an alarming public health risk. In order to address these public health concerns, aside from public health awareness, policy interventions will be needed. This review has also provided a framework for future studies including cytotoxic assays to better understand the toxic effects that are caused at the cellular level by energy drinks.

Keywords: Adverse Effects; Caffeine; Energy Drinks; Health Risks; Public Health

ICSD26_061

A SYSTEMATIC REVIEW ON THE PROXIMATE NUTRITIONAL COMPOSITION AND FUNCTIONAL BIOACTIVE PROPERTIES OF SRI LANKAN TRADITIONAL RICE (*Oryza sativa L.)* VARIETIES

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Abstract: Sri Lankan traditional rice (*Oryza sativa L*.) varieties are recognized for their cultural and agricultural significance other than their rich nutritional and bioactive profiles exhibit high nutrient level. However, limited systematic analysis has been conducted to combine the existing knowledge on their proximate nutritional and mineral composition. This review aimed to synthesize available scientific data on the protein, fat, carbohydrate, ash, moisture, and fiber content of selected traditional rice varieties in Sri Lanka, while highlighting their associated functional and therapeutic properties. Relevant studies were identified through comprehensive searches of PubMed, Google Scholar, ScienceDirect, Research4Life, and the Cochrane Library, yielding 322 articles, of which 315 met inclusion criteria after removing duplicates. The findings are exibited that traditional rice varieties such as *Sudu Heenati*, *Madathawalu*, *Kaluheenati*, and *Maa Wee* shows superior nutritional quality compared to modern improved varieties. Their high content of bioactive compounds including anthocyanins, phenolics, and flavonoids contributes to antioxidant, anti-inflammatory, cardioprotective, and anticancer activities. These results underscore the potential of traditional rice as a sustainable functional food resource, promoting nutrition security and supporting the prevention of chronic diseases.

Keywords: Bioactive Compounds; Health Benefit Properties; Nutritional Composition; *Oryza sativa L.*; Sri Lanka Traditional Rice Varieties

ICSD26_086

FORMULATION AND EVALUATION OF AYURVEDA INSPIRED SODAS AS A SUSTAINABLE APPROACH TO HEALTHY BEVERAGE DEVELOPMENT

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Abstract: This study aimed to formulate and evaluate a range of Ayurveda inspired soda products using 3 herbal formulations based on coriander seeds, dried tamarind pulp and green apple respectively, targeting soda consumers in USA without using any chemical preservatives for the enhancement of social sustainability. After selecting the best sweetening option for each formulation by conducting a nine-point hedonic sensory evaluation, physicochemical parameters, bio-active compounds and shelf-life stability were analysed. Sugar and stevia used sweetening option was selected as the best sweetening option and as the physicochemical parameters pH, soluble solids amount, sugar contents, titratable acidity, proximate composition, carbonation level and sodium (Na) content were analysed and compared with "Cola" (highly consuming soda type in USA). Each product was shown a medium sugar content which was in the range of 11 g to 2 g per 100 mL. Coriander, tamarind and green apple sodas demonstrated higher values in antioxidant properties, total phenolic content and vitamin C content respectively during bio-active compounds analysis. The CFU count from total plate count method were analysed weekly for the microbial safety of each formulation with the storage time, but a significant variation could not be identified. The pH variation of each product with the storage time at different storage temperatures (4 ℃, 25 ℃ and 40 ℃) were analysed to estimate the shelf-life of the products. All soda formulations demonstrated a higher shelf-life at the chilling (4 ℃) storage condition.

Keywords: Ayurveda inspired soda; Carbonation level; Cola; Herbal formulations; Stevia

ICSD26_097

HUMAN EVIDENCE FOR THE ANTI-UROLITHIATIC EFFICACY OF *Garcinia cambogia*: A RANDOMIZED, PLACEBO-CONTROLLED CLINICAL TRIAL IN HEALTHY ADULTS

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Abstract: Urinary stone disease is a common health issue, and urinary oxalate is assessed as a significant contributing factor. The rate of recurrent urinary stones is higher among those who form calcium-containing stones, and of those, 80% contain calcium oxalate. The tropical fruit *Garcinia cambogia*, containing a great quantity of HCA, has been recently found as an effective agent in chelating and inhibiting urinary stones in animals and *in-vitro*. The aim of the study was to evaluate the safety and efficacy of standardized *Garcinia cambogia* supplementation regarding the reduction of lithogenic risk in the urine of healthy adults. A randomized, placebo-controlled clinical study was performed involving a group of 20 healthy adults aged from 20 to 30 years old, receiving a randomized regimen of *Garcinia cambogia* supplementation or a placebo over a course of 16 days, as approved by the ethics committee (ECC/2025/E/034). Calcium, uric acid, creatinine, and estimated glomerular filtration rate (eGFR) were measured in serum biochemical parameters at baseline and endpoint. The ratios of calcium-to-creatinine, oxalate-to-creatinine, and uric acid-to-creatinine were among the urinary lithogenic markers assessed. Urinary oxalate levels were significantly lowered by Garcinia cambogia from 1.34 ± 0.16 to 0.92 ± 0.28 mg/dL, $p < 0.05$, while the placebo group showed no significant change. There were no significant changes in either urinary calcium or uric acid, and renal function markers did not change adversely, reflecting systemic safety. A decrease in urinary WBC counts was also seen, indicating less subclinical urinary inflammation. In conclusion, this first-in-human clinical study demonstrates that *Garcinia cambogia* supplementation for brief periods is safe and selectively reduces urinary oxalate. These findings point out its potential as a standardized nutraceutical for preventing recurrence of calcium-based urinary stones.

Keywords: *Garcinia cambogia*; Hydroxycitric Acid; Nutraceutical Intervention; Urinary Oxalate; Urolithiasis

ICSD26_103

DEVELOPMENT AND CHARACTERISATION OF LOW-CALORIE, LOW-GLYCAEMIC INDEX BANANA CAKE FORMULATIONS FOR HEALTH-CONSCIOUS CONSUMERS

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Abstract: Type 2 diabetes, affecting 23% of Sri Lankan adults, is strongly associated with consumption of high-sugar, high-fat bakery products including traditional cakes. This research developed a low-calorie, low-Glycaemic Index (GI) banana cake alternative using sucralose as a sweetener, inulin as a fat replacer and fibre source, and sunflower oil replacing margarine. Formulations were evaluated using proximate composition analysis (AOAC methods), physicochemical characterisation, in vivo glycaemic index determination (ISO 26642:2010 protocol), and sensory evaluation (35 panellists). Treatment banana cakes achieved a fat reduction of 42.2% (25.42 ± 0.03 to 14.70 ± 0.03 g/100g dry basis), whilst protein content increased by 55.2% (7.55 ± 0.13 to 11.72 ± 0.03 g/100g dry basis). Glycaemic index improvements were exceptional, with treatment banana cakes reduced from 75.80 ± 2.28 to 48.49 ± 3.73 (36.0% reduction), transitioning from the high GI (≥ 70) to the low GI (<55) category. Glycaemic load decreased from 35.42 (high GL, ≥ 20) to 13.47 (medium GL, 11-19), representing a 61.9% reduction. Caloric content was reduced by 47.9% (643.61 kcal to 335.38 kcal per serving). Treatment formulations exhibited superior moisture retention (30.6% increase to 61.29 ± 2.30% dry basis) and minimal texture degradation (14.5% hardness increase), demonstrating that fruit-matrix polysaccharides and pectin synergy with hydrocolloids enhance structural stability superior to traditional butter-based systems. Sensory evaluation confirmed sucralose formulations achieved superior acceptability compared to alternative sweetener systems. These findings position treatment banana cakes as therapeutic alternatives for type 2 diabetes management and health-conscious consumers seeking indulgent foods without metabolic compromise, while establishing fruit-based cake matrices as superior platforms for reduced-fat formulation compared to conventional butter systems.

Keywords: Functional Foods; Glycaemic Index; Inulin; Low-Calorie Bakery Products; Sucralose; Type 2 Diabetes

ICSD26_122

ASSESSMENT OF MICRONUTRIENT DEFICIENCIES AND CONSUMER REQUIREMENTS FOR A PROPOSED VITAMIN A, D AND E–ENRICHED DRINK FOR SCHOOLCHILDREN IN KEGALLE, SRI LANKA

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Abstract: Micronutrient deficiencies persist as an important concern in public health among school-aged children, particularly in Kegalle district of Sri Lanka, where inadequate intake of vitamins A, D, and E may impair immune function, growth, skeletal development, and cognitive abilities. This study aimed to determine the prevalence of vitamin deficiencies among schoolchildren and to explore the feasibility of developing a vitamin-enriched functional drink as a targeted nutritional intervention. Data were collected using a cross-sectional design among 100 students aged 10 – 18 years at Atulugama Mayadunna Maha Vidyalaya using a structured questionnaire that gathered data on demographic characteristics, dietary habits, awareness of vitamin deficiencies, and associated health concerns. Findings revealed that 67% of participants were unaware of their vitamin status, while 33% had previously been diagnosed with a deficiency. Vitamin A deficiency was the most prevalent (30%), followed by vitamin D (15%) and vitamin E (1%). Health issues such as weak bones, fatigue, and vision problems were reported by 56% of respondents and were perceived by 73% to be resolvable through appropriate supplementation. Preferences regarding product development were also assessed, indicating that orange flavour, bottle packaging, and a price of Rs. 500 were most acceptable to students. Based on the results, the study supports the development of an affordable, culturally acceptable drink enriched with vitamins A, D, and E as a practical intervention to improve nutritional status among schoolchildren. Such an initiative could contribute to enhancing immunity, academic performance, and overall well-being. Collaboration with schools, public health authorities, and community stakeholders is recommended to ensure effective implementation and sustainability.

Keywords: Micronutrients; Schoolchildren; Vitamin A; Vitamin D; Vitamin Deficiency; Vitamin E

ICSD26_140

EXPLORING LINKS BETWEEN PSYCHOLOGICAL WELL-BEING AND FOOD CRAVINGS IN POSTMENOPAUSAL WOMEN IN KANDY DISTRICT: A CROSS-SECTIONAL STUDY

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Abstract: Menopausal transition brings profound physiological and psychological changes that intensifies food cravings, yet the psychological contributors to these cravings remain limitedly explored in South Asian populations. Therefore, this cross-sectional, survey-based study assessed the relationship between psychological well-being and food cravings, assessed both as intensity and frequency of trait food cravings and cravings for specific food groups, among postmenopausal women in Kandy District, Sri Lanka (N = 80). Psychological well-being was assessed using Depression, Anxiety, and Stress Scales – 21 (DASS-21), trait food cravings using Food Craving Questionnaire – Trait – reduced (FCQ-T-r) version, and frequency of cravings for different food groups using a validated Food Craving Inventory (FCI). Results indicated that, cravings for sweets and high-carbohydrate foods were significantly higher compared to cravings for high-fat food or fast-food fat ($p < 0.05$ for all). No significant difference was observed between the craving scores for sweets and high-carbohydrate food ($p = 0.999$), nor between high-fat food and fast-food fat ($p = 0.389$). Depression score showed a moderate positive correlation with FCQ-T-r score ($r_s = 0.347$, $p < 0.01$), indicating that higher depression levels were associated with increased trait food craving tendencies. Stress score showed a weak-to-moderate positive correlation with FCQ-T-r score ($r_s = 0.288$, $p < 0.05$), indicating that higher stress levels were associated with increased trait food cravings, although the strength of this association was weaker than that observed for depression. There was no statistically significant correlation between anxiety score and FCQ-T-r score. Moreover, depression score demonstrated a weak-to-moderate positive correlation with sweet craving score ($r_s = 0.261$, $p < 0.05$), indicating that individuals with higher depression levels tended to experience stronger cravings for sweets. Stress score showed a weak-to-moderate positive correlation with fast-food fat craving score ($r_s = 0.269$, $p < 0.05$), suggesting that individuals with higher stress levels were more likely to crave fast-food-type fatty foods. These findings highlight psychological distress as an important factor that drives food cravings in women during postmenopausal stage. However, a large-scale research incorporating biomarkers is recommended to better understand the mechanisms linking psychological well-being and food cravings among postmenopausal women.

Keywords: Anxiety; Depression; Food craving; Postmenopause; Stress

ICSD26_141

MOLECULAR DOCKING AND *IN SILICO* ANALYSIS OF PHYTOCHEMICALS FROM GREEN TEA, BLACK TEA, AND CINNAMON TEA FOR THEIR POTENTIAL TO INHIBIT KEY DIGESTIVE ENZYMES ASSOCIATED WITH DIABETES

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Abstract: Diabetes continues to rise globally, intensifying the demand for safe, affordable, and naturally derived therapeutic alternatives. Tea and Cinnamon, both globally consumed and valued for their functional properties, contain diverse phytochemicals with promising antidiabetic activity. This study employed a comprehensive *in silico* approach to evaluate twenty-one phytochemicals from green tea, black tea, and cinnamon for their inhibitory potential against α-amylase and α-glucosidase which are two key enzymes responsible for postprandial hyperglycaemia. Twenty-one compounds were selected based on their documented abundance in black, green tea and cinnamon infusions, structural diversity, and relevance to glucose metabolism. Molecular docking was performed using AutoDock 1.5.7 against α amylase (PDB: 1HNY) and α-glucosidase (PDB: 5NN8). Ligands were optimized using OpenBabel and Avogadro, and interaction analysis was conducted using Discovery Studio Visualizer. Pharmacokinetic and toxicity profiles were predicted using SwissADME and pkCSM. Each ligand underwent ten docking runs, and the lowest energy conformation was compared against metformin, which was also docked under identical conditions as the standard reference drug. All phytochemicals showed negative binding energies, indicating favourable inhibitory interactions. Theaflavin-3′-gallate exhibited the strongest binding to α-glucosidase (–8.34 kcal/mol), outperforming metformin (–8.26 kcal/mol), while epigallocatechin gallate (EGCG) showed the best binding to α-amylase (–7.23 kcal/mol), again surpassing metformin (–6.99 kcal/mol). Both top performing compounds demonstrated favourable ADME characteristics and were predicted to be non-toxic. Overall, the findings highlight strong molecular level evidence for tea and cinnamon derived phytochemicals as sustainable, natural candidates for enzyme targeted diabetes management. By connecting university research with potential industrial applications, this study supports the development of value-added nutraceuticals within Sri Lanka's tea and cinnamon sectors, contributing both to public health and sustainable economic growth.

Keywords: Diabetes; *in silico*; Molecular docking; α-amylase; α-glucosidase

ICSD26_142

EVALUATING THE IMPACT OF WEIGHT REDUCTION ON TRIGLYCERIDE-GLUCOSE (TYG) INDEX AS A BIOMARKER OF INSULIN SENSITIVITY IN A MIDDLE-AGED ADULT POPULATION IN CENTRAL PROVINCE

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Abstract: The Triglyceride-Glucose (TyG) index is a validated and cost-effective biomarker reflecting insulin resistance and cardiometabolic risk, offering a practical alternative to insulin-based indices such as HOMA-IR in resource-limited settings. This sub-analysis of a six-week lifestyle intervention study examined the effect of body-weight reduction on TyG index improvement among middle-aged (30 – 45 years) Sri Lankan adults. Forty participants (26 females, 14 males) with overweight or obesity were enrolled in a structured lifestyle modification program comprising dietary counselling and physical activity guidance aimed at achieving ≥1 kg weight reduction. Fasting blood glucose and serum triglycerides were measured at baseline and post-intervention, and the TyG index was calculated as ln [fasting triglycerides (mg/dL) × fasting glucose (mg/dL)/2]. Paired t-tests demonstrated significant post-intervention improvements in body weight ($P = 0.000$), waist circumference ($P = 0.003$), and BMI ($P = 0.000$). Biochemically, fasting blood glucose levels showed a significant reduction ($p = 0.000$), accompanied by a decrease in serum triglycerides ($p = 0.036$). Consequently, the TyG index demonstrated a highly significant improvement ($p = 0.000$), reflecting enhanced insulin sensitivity following the intervention. The observed association underscores the sensitivity of TyG index to modest metabolic changes induced by short-term weight loss. Similar improvements in insulin sensitivity following modest weight reduction have been reported in intervention studies from other countries. However, this study is among the first in Sri Lanka to demonstrate such effects using the TyG index. These findings reinforce the TyG index as a reliable, low-cost biomarker for early insulin-resistance monitoring, supporting its integration into community-level metabolic screening programs. Furthermore, these findings validate weight reduction as an effective, non-pharmacological approach in improving insulin sensitivity and mitigating metabolic syndrome risk in middle-income South Asian populations.

Keywords: Insulin Resistance; Metabolic Syndrome; TyG Index; Weight Reduction

DIGITAL TRANSFORMATION, DATA ANALYTICS, AND EMERGING TECHNOLOGIES - I

ICSD26_036

SENTIMENT ANALYSIS OF WORK FROM HOME POST COVID-19 USING TWITTER DATA AND MACHINE LEARNING TECHNIQUES

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Abstract: The COVID-19 pandemic has significantly transformed traditional work practices, accelerating the adoption of the Work-From-Home (WFH) model across the globe. Understanding employee perceptions toward remote work has become essential for organizations and policymakers. This study investigates public sentiment related to WFH in the post-COVID-19 context by analysing Twitter data using Natural Language Processing (NLP) and Machine Learning (ML) techniques. A large collection of WFH-related tweets was extracted and pre-processed to perform sentiment classification. Multiple supervised ML algorithms, including Support Vector Machine (SVM), Naive Bayes, Random Forest, Logistic Regression, and Gradient Boosting, were implemented and evaluated. The experimental results indicate that the SVM classifier achieved the highest performance, with an accuracy of 0.89. to enhance the reliability of the findings, the sentiment analysis results were compared with survey responses collected from employees working in the IT sector. The analysis reveals that a majority of users express positive sentiments toward remote work, highlighting benefits such as flexibility and improved work-life balance, while also identifying challenges related to communication and collaboration. Overall, this research demonstrates the effectiveness of combining social media analytics with machine learning techniques to gain meaningful insights into employee attitudes toward remote work in the post-pandemic era.

Keywords: Machine Learning; NLP; Post-COVID-19; Sentiment Analysis; Twitter Data; Work-From-Home

ICSD26_105

CONFLICT ANALYSIS IN MULTI-MODEL SENTIMENT PREDICTION FOR SOFTWARE ENGINEERING TEXTS

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Abstract: Sentiment analysis of software engineering texts such as bug reports is important for supporting effective software maintenance, issue prioritization, and developer communication; however, these texts frequently contain domain-specific terminology, ambiguity, and mixed emotional expressions that lead to conflicting sentiment predictions across different sentiment analysis models, thereby reducing the reliability of automated tools. To address this problem, the authors proposes a multi-model sentiment alignment framework aimed at resolving inconsistencies through the integration of heterogeneous sentiment prediction classifiers. The framework incorporates advanced text preprocessing techniques to normalize informal and technical language, followed by pseudo-gold label generation using majority-based voting to enable learning in the absence of reliable human-annotated sentiment labels. In order to improve prediction robustness, a probability-based resolution mechanism is employed, allowing the framework to learn confidence patterns, disagreement structures, and uncertainty characteristics across models rather than relying solely on textual features. This design enables the framework to stabilize divergent sentiment outputs and produce a unified and consistent sentiment prediction. To further enhance the practical usability and transparency of the framework, model-agnostic explainability mechanisms, including SHAP and LIME, are applied to provide interpretable insights into the factors influencing sentiment resolution decisions. The proposed framework was evaluated using real-world software bug report data collected from multiple repositories, and the experimental results demonstrate that the meta-resolution process achieved an accuracy of 92.55%, outperforming individual sentiment classifiers while substantially reducing prediction conflicts. The findings indicate that conflict-aware sentiment resolution contributes to improved robustness, interpretability, and trustworthiness of sentiment analysis in software engineering contexts, thereby supporting more reliable AI-assisted software maintenance workflows and facilitating the broader adoption of sentiment-aware analytics within Industry 4.0–oriented development environments.

Keywords: Explainable AI; Multi-Model Sentiment Analysis; Sentiment Conflict Resolution; Software Engineering Text Mining; Transformer-based Models

ICSD26_149

HANDS-ON EMBEDDED SYSTEMS EDUCATION WITH A MODULAR AUTONOMOUS GROUND VEHICLE PLATFORM

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Abstract: In the journey to become an engineer, embedded systems play a pivotal role in undergraduate education, providing insights on how microcontroller unit (MCU) based systems are designed and developed. For many years, the teaching and learning approach of embedded systems have remained consistent using both theoretical education and practical exposure through electronic components connected onto a breadboard with a cluster of wires. This practical approach has demonstrated crucial weaknesses where a majority of time is consumed to diagnose faults caused by loose components, faulty breadboard connections and unreliable wires, thus deviating from the goal of providing an intuitive hand on learning experience. This research presents an interactive and intuitive solution based on a modular Autonomous Ground Vehicle (AGV) experiment platform to provide a superior hand on learning experience on embedded systems and its relation to real world applications. The modular platform eliminated the need for a breadboard and unnecessary wiring enabling a smooth transition from basic LED blink experiments to advanced DC motor control experiments leading to a functional AGV. This platform features a main PCB housing ATmega32A MCU along with interchangeable modules as subsystems interfaced via JST-XH connectors and programmed using embedded C. The modular construction simplifies experimentation and diagnosis whilst a significant portion of the time is allocated to understand the system integration and hardware-software interactions. This platform successfully enabled a test group of undergraduates to focus on the underlying principles of embedded systems, which would eventually lead to the development of solutions to real- world challenges.

Keywords: ATmega32A Micro-controller Unit (MCU); Autonomous Ground Vehicle (AGV); Embedded C Programming; Embedded Systems Education; Hands-on Learning; Modular Platform

ICSD26_167

DEVELOPMENT OF A SIMPLIFIED WEBSITE FOR ESTIMATING CARBON EMISSIONS IN BUILDING CONSTRUCTION PROJECTS IN SRI LANKA

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Abstract: Sri Lanka's construction sector emits approximately 12 million tons of carbon dioxide equivalent annually while contributing 8-10% to national gross domestic product, yet 95% of small-to-medium enterprise contractors lack accessible carbon estimation tools due to global platforms requiring 500-1,000 euro annual subscriptions, internet connectivity unavailable to 45% of rural users, and life cycle assessment expertise, with tools like Inventory of Carbon and Energy Database demanding 4-6 hours of manual Excel work using generic factors that ignore local Ceylon Institute of Construction Portland cement and monsoon transport conditions; this study develops Infranova25, Sri Lanka's first offline, no-login web application deployable via single XAMPP zip file using PHP 8.2, MySQL 8.0, and Bootstrap 5, featuring a localized emission factor database across 7 construction phases that generates real-time calculations, interactive charts, and Central Environmental Authority/Construction Industry Development Authority-compliant PDF reports through the validated formula $CO_2e\_phase = \Sigma(Q\_mat \times EF\_mat) + \Sigma(H\_fuel \times 2.68) + \Sigma(D\_km \times EF\_trans \times Load)$, achieving correlation coefficient of 0.94 versus manual calculations, 77% time savings (28 versus 120 minutes), and usability score of 85 out of 100 across 10 validated projects while ensuring regulatory compliance with Urban Development Authority standards, Sri Lanka Standards concrete specifications, emission reporting requirements, and GreenSL certification at 1.45 million Sri Lankan Rupees development cost yielding 4.5 times return on investment within 3 projects to transform inaccessible carbon accounting into 28-minute compliance supporting 2050 carbon neutrality for Sri Lanka's 95% small-to-medium contractors.

Keywords: Carbon Emission; Infranova25; Offline Tool; Sri Lankan Construction; Sustainable Development

ICSD26_172

ARTIFICIAL INTELLIGENCE IN AGRICULTURAL AND ENVIRONMENTAL EDUCATION: A SYSTEMATIC REVIEW OF TOOLS, PEDAGOGICAL APPLICATIONS, AND IMPLEMENTATION CHALLENGES

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Abstract: Artificial intelligence (AI) is increasingly being used in teaching and learning in fields that involve data, including agriculture and environmental science. However, research on how AI tools facilitate the translation of theoretical knowledge into practical competence is lacked. This systematic review examines current research on AI-enabled educational innovations in the agricultural and environmental sectors. Literature search was carried out by using databases such as Google Scholar, Web of Science, and the Wiley Online Library. From an initial pool of 655 studies, we examined 44 peer-reviewed English-language articles published between 2012 and 2024. The data extraction concentrated on the AI techniques used, associated learning outcomes, pedagogical frameworks, and reported implementation challenges. Several key domains of AI tool application were discussed, such as (1) adaptive learning systems that use machine learning and natural language processing to customize curricula in agriculture and environmental sciences; (2) simulations and virtual laboratories across precision agriculture modelling, pest and disease management, and virtual ecosystem environments; (3) computer-vision-based instructional tools for experiential and inquiry-based learning that use automated diagnostics of crops and biodiversity identification; and (4) AI-based decision-support systems that provide context-aware recommendations to facilitate farm management and environmental monitoring. Evidence from these domains demonstrated significant increases in systems thinking, practical skill development, and student engagement. Key constraints found included limited digital infrastructure, insufficient teacher training, the risk of overreliance on automated outputs, data privacy and fairness concerns, and the environmental costs of AI technologies. This paper emphasizes that AI has significant potential to improve practice-oriented agricultural and environmental education when implemented through ethical, pedagogically sound, and context-sensitive approaches. Realizing these benefits will depend on better digital connectivity, continuous teacher training, transparent and explainable AI systems, contextually relevant datasets, and environmentally responsible deployment. Future research should focus on rigorous outcome evaluation, equitable access strategies, and the integration of interdisciplinary curricula.

Keywords: Agricultural Education; Artificial Intelligence; Environmental Education; Pedagogy; Systematic Review

ICSD26_238

DIGITAL LIFESTYLE HEALTH ASSESSMENT FOR SUSTAINABLE WORKFORCE WELL-BEING IN SRI LANKAN IT INDUSTRY

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Abstract: This research is mainly focused to the digitalization driven lifestyle health assessment framework that is designed to support the sustainability and well-being of Sri Lanka's rapidly expanding IT workforce within the context of Industry 4.0 transformation. The increasing digitalization of work environments has introduced new challenges for IT professionals, which is including prolonged screen exposure, high cognitive load, sedentary behaviour, and reduced work life boundaries. Furthermore, Sri Lanka lacks an integrated, data-driven local mechanism to assess and understand the lifestyle health patterns of IT employees. To address this issue, this research proposes a comprehensive digital assessment model based on the six pillars of lifestyle medicine introduced by American College of Life Style Medicine such as nutrition, physical activity, stress management, sleep, social association, and substance use that augmented with demographic and occupational indicators relevant to modern IT work in Sri Lanka. A structured quantitative methodology was used, incorporating validated international lifestyle assessment tools which were adapted to the Sri Lankan context. Data is being gathered using random sampling method through a digital survey deployed to IT professionals across varying job roles, company sizes, and working arrangements and more factors related to the occupation. Statistical analysis is used to identify key lifestyle risk factors, their interrelationships, and the influence of demographic and work-related variables of IT employees. Additionally, a standardized well-being metric such as the WHO-5 is integrated to enable regression modelling and examine the predictive contribution of lifestyle dimensions and demographic factors to well-being outcomes in Sri Lanka. The research aims at making a digital lifestyle analytics assessment and platform. It can offer personalized risk insights, help with the sustainable performance of the IT workforce, and make IT industry health focused decision-making stronger. It is anticipated that the results will not only add to the digital well-being approaches but also lay the strong groundwork for future AI-powered predictive models and health optimization at the workplace.

Keywords: Digital Health Assessment; Industry 4.0; IT Professionals; Lifestyle Analytics; Occupational Well-being; Sustainable Workforce

ICSD26_245

ADAPTIVE BEHAVIOUR-DRIVEN AI FRAMEWORKS FOR PRIVACY-PRESERVINGWELLNESS E-COMMERCE IN INDUSTRY 4.0

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Abstract: Wellness-oriented e-commerce cannot rely on historical clickstream and purchase records. By using physiological and behavioural sensors, it is possible to capture this ephemeral state. However, storing or exposing these signals as long-term user attributes raises serious privacy and governance issues. The paper addresses the problem of providing high-quality, real-time, personalization of wellness e-commerce without allowing persistent profiling and the uncontrolled disclosure of sensitive user signals. We introduce AURA, a privacy-constructive, context-aware personalization reference architecture that represents user state as a transient control signal of current session. The sensor-driven behavioural context (e.g., stress/activity) is turned into time constrained representations with confidence which is calibrated as opposed to long term profiles. The architecture separates four concerns into explicit layers: context inference from sensor and interaction data, uncertainty-aware decision gating, governance and audit enforcement, and application delivery. This decomposition allows individual personalization actions to be allowed, downgraded or blocked at runtime and with respect to confidence, sensitivity, and policy, whilst ensuring that raw sensitive signals are never exposed to the e-commerce application. We measure whether or not our system is feasible by using three real world physiological and activity datasets (WESAD, UCI HAR, MHEALTH) as proxies for wearable wellness signals. Experiments detect when users were stressed with 88.55%, recognize the type of physical activities users are performing at 94.57%, and classify users' behaviour at 85.29%. Our inference latency was less than 55 ms. The results from this study show that real-time user states can be used to provide personalized recommendations to individuals based on their current context without having to collect and store enduring behavioural patterns of the user's activity. Hence, AURA offers a privacy-friendly and auditable base of real-time contextual personalization of wellness e-commerce, allowing more relevant and credible recommendations which can contribute to a better user experience and business performance.

Keywords: Artificial Intelligence; Behavioural Personalization; Context-aware e-commerce; Explainable Sustainable Digitalization; Software Architecture; Wellness Technology

SUSTAINABILITY GOVERNANCE, POLICY, AND SOCIAL DIMENSIONS OF SUSTAINABLE DEVELOPMENT

ICSD26_022

INDIA-SRI LANKA COOPARATION ON SUSTAINABLE FISHERIES AND MARINE RESOURCE MANAGEMENT

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Abstract: The Indian Ocean acts as an important ocean space and link between India and Sri Lanka due to the historical ecological, economic and cultural importance of both countries. The Indians and Sri Lankans share the Indian Ocean as a cross-border resource space and it serves as an important source of security, food security and livelihoods for the region, especially regarding marine resources and fisheries. This research seeks to explore critically the relationship between India and Sri Lanka in terms of sustainable fisheries governance and marine resource management. The study looks into the ways in which both countries have cooperated regarding sustainable fisheries governance and management by utilizing several bilateral arrangements such as the Joint Working Group on Fisheries established by India and Sri Lanka and various regional arrangements, including the Bay of Bengal Programme (BOBP) and the Indian Ocean Rim Association (IORA). The study will be guided by an examination of the existing policies and collaborative practices used to address the problems of illegal, unreported and unregulated (IUU) fishing; bottom trawling; and competing livelihoods which have contributed to an erosion of trust and impeded long-term sustainability. The study used qualitative methods such as policy document analysis, relevant treaties, and case studies conducted in northern Sri Lanka and Tamil Nadu. Through these methods, the study will demonstrate that sustainable fisheries governance requires a multi-dimensional approach that includes ecological conservation, diplomatic engagement within maritime contexts, and a greater emphasis on community-based resource management.

Keywords: Indian Ocean; India–Sri Lanka Relations; Marine Governance; Sea Diplomacy; Sustainable Fisheries

ICSD26_129

EXAMINING THE RELATIONSHIP BETWEEN ORGANISATIONAL STRUCTURE AND EXTERNAL CRISIS MANAGEMENT IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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Abstract: The Sri Lankan Construction Industry (SLCI) has been exposed to external crises such as natural disasters, political instabilities, economic downturns, and global disruptions, which have significantly impacted project continuity, organisational stability, and workforce performance. These challenges underscore the importance of a structured and proactive approach to crisis preparedness and response within construction organisations. Organisational Structure Strategies (OSS), such as crisis management teams, external consultation, and employee changes, have been identified as critical internal factors supporting crisis preparedness and organisational resilience. However, there has been a lack of empirical studies investigating the impact of OSS on External Crisis Management Strategies (ECMS), defined as structured organisational actions for preparing for, responding to, and recovering from externally driven disruptions, within the SLCI context. The relationship between OSS and ECMS in contractor organisations within the SLCI is explored in this research. Based on organisational resilience and adaptive strategy perspectives, a quantitative research approach was employed. Data was collected using an online questionnaire survey administered to construction professionals, and 101 valid responses were obtained from large-scale contractor organisations. Reliability and validity tests indicated acceptable internal consistency, and parametric assumptions were satisfied before analysis. Pearson correlation analysis was conducted to examine the proposed relationship. The results indicate a statistically significant but weak positive linear relationship between OSS and ECMS ($r = 0.222$, $\alpha = 0.026$). This suggests that while OSS contribute to ECMS practices, its overall impact remains limited in magnitude. The relatively weak association implies that structural mechanisms alone may not guarantee strong crisis management performance and that their effectiveness may depend on organisational factors such as leadership capability, cultural alignment, resource availability, and implementation consistency. Furthermore, the findings of this study should be interpreted within the large-scale contractor sector within Sri Lanka and not generalised across the entire construction industry.

Keywords: Crisis Resilience; External Crisis Management Strategies; Large-Scale Contractors Organisational Structure Strategies; Sri Lankan Construction Industry

ICSD26_158

AN ANALYSIS ON LEGAL AND POLICY FRAMEWORKS FOR AGROFORESTRY AND TREES OUTSIDE FORESTS IN SRI LANKA

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Abstract: Agroforestry and Trees Outside Forests (TOF) play a crucial role in achieving sustainable land management goals, enhancing climate resilience, and promoting livelihood diversification. As a developing country, Sri Lanka requires a coherent and effective legal and policy framework to support the development of agroforestry and TOF systems, which are essential for achieving the Sustainable Development Goals (SDGs), maintaining climate balance, and improving the income levels of rural communities. Therefore, this research aims to critically examine whether Sri Lanka has the effective and sufficient legal and policy framework in related to the Agroforestry and Trees Outside Forests. For this purpose, this research adopts qualitative research methodology, focusing on the content analysis of existing legislation, policy documents, and institutional reports relevant to agroforestry and trees outside forests in Sri Lanka. The research reveals that Sri Lanka does not yet have a specific legislation or policy directly addressing agroforestry and TOF. Nevertheless, several indirect legal and policy instruments, such as the Forest Ordinance No. 16 of 1907, Fauna and Flora Protection Ordinance No. 2 of 1937, Land Development Ordinance No. 19 of 1935, the National Forest Policy (1995), and the Sri Lanka National Environment Policy and Strategies, provide partial relevance to this sector. Further findings indicate that inadequate institutional coordination, land tenure insecurity (especially on state and encroached lands), and low public awareness significantly hinder the development of agroforestry and TOF practices in the country. Therefore, this paper recommends the introduction of a direct legislative or policy framework specifically addressing agroforestry and trees outside forests in Sri Lanka. Drawing comparative insights from countries such as India and Nepal, which have more developed legal frameworks in this area, the paper argues that the establishment of an appropriate legal and policy structure will strongly support Sri Lanka's progress towards achieving its sustainable development and climate goals.

Keywords: Agroforestry; Legal and Policy Framework; Sri Lanka; Sustainable Development; Trees Outside Forests

ICSD26_208

EVALUATING ROLE OF ANT COMMUNITY STRUCTURE AND BEHAVIOR AS BIOINDICATORS OF ECOSYSTEM HEALTH, HABITAT RESTORATION, AND BIODIVERSITY CONSERVATION

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Abstract: Ants are ecologically powerful invertebrates whose diversity, functionality, and behavioral sensitivities make them strong indicators of environmental change. Growing levels of habitat degradation due to deforestation, mining, agriculture, and climate change have led to a need for cost-effective tools to assess ecosystem well-being and restoration progress. This study aims to identify ecological integrity, habitat recovery, and biodiversity conservation using ant community structure and behavior. This is a review of over 60 studies conducted worldwide, and it focuses on standardized sampling methods such as trapping pitfalls, Winkler extraction, and baiting, as well as the use of the functional-group framework to understand disturbance responses. Findings indicate that poor habitats are likely to underpin low species richness and are almost always high in opportunistic or invasive ants such as Pheidole megacephala or Linepithema humile. By contrast, stable or recovering habitats have greater functional diversity, including delicate leaf-litter specialists such as Strumigenys species. Behavioral clues, such as changes in foraging behavior, nest construction, trailing, and interspecific behavior, provide further insight into soil conditions, microclimate, and habitat stability. Forestry, grazing regimes, mine-site rehabilitation, and fire-affected landscapes provide evidence that the response of ant assemblages to the age of restoration, disturbance intensity, and long-term climatic patterns is predictable. Despite the challenges of regional variability and taxonomic complexity, monitoring adherence to standardized protocols and the use of new molecular tools increases the reliability of ant-based monitoring. Altogether, ants serve as a useful, sensitive, and scientifically sound tool for measuring an ecosystem's state, which can contribute to adaptive management and direct biodiversity conservation.

Keywords: Ant Diversity; Behavioral Ecology; Bioindicators; Ecosystem Health; Functional Groups; Habitat Restoration

ICSD26_248

AN ASSESSMENT OF AWARENESS, BEHAVIORS, AND CHALLENGES IN GREEN PURCHASING PRACTICES AMONG UNIVERSITY COMMUNITY

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Abstract: Green purchasing has become an important part of global sustainability effort but is practiced mainly in developed countries. This study evaluated awareness, buying behaviours and barriers to green purchasing among Sri Lankan university students and academic staff to address a gap in the literature concerning research in this area that often focuses on attitudes rather than actual behaviour. A quantitative cross-sectional survey was conducted, using an online questionnaire, with the use of closed-ended and Likert-scale questions. The structured questionnaire dealt with buying patterns, motivations, reasons for cognitive barriers, levels of awareness and demographics. Using the simple random sampling technique, data was collected from 122 respondents (students and staff). Data was analysed with descriptive statistics, frequency distribution, cross-tabulations and chi-square tests. Findings indicate that awareness does not always lead to the practice of green purchasing behaviour. While 73% of respondents were familiar with the concept of green purchasing, actual engagement in green purchasing was only moderate, with most students reporting that they purchase green products occasionally (56%), reflecting a clear intention behaviour gap, Income level had a strong significant association with green purchasing behaviour ($p < .001$), meaning that persons with higher income levels were more likely to engage in eco-friendly purchasing behaviour. Green shopping behavior was not strongly correlated with gender. Although environmental issues were emphasized in decision making (53% ranked them as very important), verification techniques remained limited, as only 26.2% reported examining eco-labels or certifications prior to purchase, suggesting poor use of formal sustainability cues. Barriers were primarily structural rather than motivational. Higher prices were the most commonly mentioned barrier among students (75.6%), underscoring affordability as a major adoption barrier. In general, strengthening green purchasing in university settings necessitates actions that increase the affordability and accessibility of green alternatives in addition to focused awareness and capacity-building initiatives that improve consumers' capacity to recognize and trust reliable sustainability information (e.g., eco-label literacy) through workshops and institutional programs.

Keywords: Green Behaviour; Green Purchasing; Sustainability; University Community

ICSD26_280

EUROPEAN GREEN - DEAL ESG REGULATORY LANDSCAPE: NON - EU AGRI FOOD EXPORTERS

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Abstract: The global Environmental, Social, and Governance (ESG) regulatory landscape is evolving rapidly, with sustainability-focused regulations increasingly shaping international agri-food trade. While many of these regulations originate in the European Union (EU), their implications extend beyond EU borders, affecting non-EU agri-food export companies that depend on access to global and EU-linked markets. This study evaluates the changing global ESG regulatory environment and its implications for non-EU agri-food exporters, with particular attention to key regulatory frameworks such as the Corporate Sustainability Due Diligence Directive, the Corporate Sustainability Reporting Directive, the Carbon Border Adjustment Mechanism, the EU Deforestation Regulation, and IFRS S1 and IFRS S2 as key sustainability disclosure standards. A systematic literature review is conducted to identify and analyse relevant previous work, policy documents, and institutional reports related to ESG regulations and agri-food trade. The selected literature is examined using thematic analysis to identify dominant regulatory themes, emerging compliance requirements, and their potential operational and financial implications for exporting firms. The findings indicate that ESG regulations are increasingly integrated into international trade frameworks, influencing market access requirements, compliance and reporting practices, and the revenue structures of export-oriented agri-food companies. To enhance practical relevance, the study presents a visualization of key regulatory impacts across environmental, social, and governance dimensions, supporting clearer interpretation and decision-making. Overall, the study clarifies how evolving ESG regulations shape the global operating environment for non-EU agri-food exporters and provides insights for policymakers, industry stakeholders, and researchers concerned with sustainable trade and development.

Keywords: Agri-Food Exports; ESG Regulations; EU Green Deal; Regulatory Costs

ICSD26_308

CHALLENGES AND OPPORTUNITIES FOR SRI LANKA IN IMPLEMENTING CARBON OFFSETTING AND REDUCTION SCHEME OF INTERNATIONAL AVIATION (CORSIA)

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Abstract: The aviation industry contributes about 2.5% of global CO_2 emissions and its rapid growth makes the need for effective mitigation strategies increasingly urgent. From 2021 onwards, the International Civil Aviation Organization (ICAO) wanted airlines to offset the yearly aggregate CO_2 emission from the Airlines, exceed the CO_2 emission levels of 2019. To achieve this goal ICAO introduced the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) program, a global initiative aligned with the objectives of the Paris agreement. Research Problem of this research is to "assess Sri Lanka's preparedness for implementing CORSIA and to project the potential carbon offsetting requirements for SriLankan Airlines up to 2030 assuming the Sri Lanka participate voluntarily". Approach to obtain solutions as follows, Passenger movements and CO_2 emissions from 2019 to 2023 shows a strong linear correlation with R^2 value of 0.93. According to the passenger growth forecast by the International Air Transport Agency (IATA), the Asia pacific region is expected to experience the highest compounded annual growth rate (CAGR) of 5.3% among all global regions. Based on this projected growth in passenger movements, the CO_2 emissions of SriLankan airlines have been forecasted up to 2030. Sri Lanka is currently exempt from the CORSIA as its international aviation activity remains relatively low compared to other countries in the world accounting for just 0.26% of global revenue tonne-kilometers (RTK) in 2018, which is well below the 0.5% threshold for mandatory participation. Most of the countries are volunteered to the CORSIA program (129 countries are participating from 2025) and regional pressure is increasing to Sri Lanka to participate for the program. Key out comes of the research as below, If Sri Lanka voluntarily joins CORSIA starting in 2026, approximately 1.05 million tons of CO_2, or 86% of SriLankan airlines' total emissions, would be subject to offsetting. From 2027 onward, participation becomes mandatory for high emitting countries such as India and China, leading to a significant increase in global offsetting demand. As a result, the proportion of Sri Lankan Airlines' emissions requiring offsetting is expected to rise 93%. By 2030, it is projected that around 1.2 million tons of CO_2 will need to be offset annually. Exact offsetting requirement will vary between 12,000 tons to 250,000 tons of CO_2, depending on the sector growth factor (0.01 to 0.20). It highlights the importance of early policy intervention, including conducting cost -benefit analyses and making timely investments in emission reduction strategies such as sustainable aviation fuels and participation in carbon credit markets. The findings of this research help for aviation regulators and policymakers, enabling them to choose the best decisions that balance economic growth with international climate commitments.

Keywords: CO_2 Emission; CORSIA; IATA; ICAO; Sector Growth Factor; Sri Lanka

SUSTAINABLE RESOURCE MANAGEMENT, MATERIALS, AND ENVIRONMENTAL BEHAVIOUR

ICSD26_001

A CARBON-NEUTRALIZING ITINERARY MAP FOR SUSTAINABLE TOURISM IN NUWARA ELIYA, SRI LANKA

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Abstract: In the context of accelerating climate change and increasing pressure on fragile destinations, there is a growing global movement toward digital sustainability tools that assist travelers in making environmentally responsible decisions. However, localized, data-driven digital solutions remain limited in many developing tourism economies. This study uniquely integrates behavioral theory (TPB and TAM), stakeholder perceptions, and a prototype digital framework to propose a localized carbon-neutral itinerary mapping model that has not previously been developed within the Sri Lankan tourism context.A mixed-methods approach was employed, integrating qualitative interviews with hotel proprietors and quantitative survey data from 188 travelers. Findings indicate a robust readiness among stakeholders to adopt low-carbon solutions, with both travelers and lodging providers perceiving organized carbon offsetting as a responsible initiative and a feasible method for enhancing the tourism experience. The suggested solution, provided via a mobile and web-based platform, generates individualized eco-friendly travel itineraries by assessing an individual's carbon footprint and proposing solutions for offsetting and reduction. Findings suggest that younger guests are especially receptive to embracing digital tools, whereas hotel proprietors saw eco-friendly measures as both a moral obligation and a strategic chance to improve competitiveness. The effort is congruent with international sustainable tourism guidelines and addresses new trends in digital innovation. The study illustrates that incorporating environmental consciousness into digital trip-planning tools can achieve a balance among visitor satisfaction, local business interests, and overarching ecological care. This method establishes carbon-neutral route planning as a progressive framework for advancing sustainable tourism in locations such as Nuwara Eliya and beyond.

Keywords: Carbon Offset; Digital Innovation; Nuwara Eliya; Sustainable Tourism; Tourist Behavior

ICSD26_254

FROM WASTE TO RESOURCE: DESIGN AND FABRICATION OF A FIBERGLASS CRUSHING MACHINE FOR SUSTAINABLE APPLICATIONS

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Abstract: The accumulation of fiberglass-reinforced plastic (FRP) boat waste has become a concerning issue in Sri Lanka. This is due to the absence of practical recycling solutions thus leading to practices such as landfilling, open burning, and deep-sea dumping. These methods contribute to long-term pollution and microplastic generation highlighting the need for finding viable solutions for recycling FRP boats wastes in a sustainable and economically viable way. This study presents the design and development of a mechanical crushing machine used to recycle discarded FRP boats waste into reusable material. A structured engineering design methodology was adopted which include conceptual development, morphological analysis and weighted selection to select the best configuration. The project was based on a hammer-mill crushing mechanism capable of processing FRP waste with thicknesses between 3 mm and 15 mm. The major parts were designed using engineering standards and verified to ensure safe and reliable operation. Then a functional prototype was fabricated emphasizing cost-effectiveness and ease of maintenance. The simulation results show that stresses and deformations are within permissible limits, which indicate durability with operating conditions. Furthermore, sieve analysis showed that about 75% of the crushed output particles were less than or equal to 0.85 mm in size. Thus, making it suitable for reuse as fillers and reinforcement additives in construction materials, cementitious composites, asphalt mixtures, and composite products. These applications demonstrate clear pathways for converting fiberglass waste into revenue-generating material streams. The results shows that recycling via a dedicated crushing system offers a practical, scalable, and economically viable solution for FRP boat waste management. Beyond technical feasibility, the proposed project shows strong potential for integration into local boatyards and municipal waste-management facilities. This will support circular economy principles, reduce environmental harm, and enable value recovery from waste.

Keywords: Fiberglass Recycling; Hammer Mill; Mechanical Crushing; Sustainable Waste Management

ICSD26_255

INTERPLAY OF GREEN WORK BEHAVIOUR, ORGANIZATIONAL COMMITMENT IN NURTURING CORPORATE SOCIAL RESPONSIBILITY

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Abstract: As sustainability becomes a strategic priority for organizations, understanding how employees respond to CSR initiatives at the individual behavioural level is increasingly important. The current study examines the relationships between CSR (ECSR and CCSR), GWB, and OC. Drawing on social exchange theory, the study proposes that when employees perceive their organization as socially and environmentally responsible, they are more likely to engage in environmentally friendly behaviours at work. A quantitative study used primary data from 210 selected hotel employees, using a convenient sampling approach in Batticaloa District, measured with a five-point Likert scale. Data were analysed using the bivariate method via SPSS (Version 22). According to the analysis, there is a high significant positive relationship between ECSR and GWB ($r = 0.693$, $p < 0.05$) and ECSR and OC ($r = 0.598$, $p < 0.05$). Based on the results, the study concludes that ECSR plays a crucial role in shaping both GWB and OC. And there is a high significant positive relationship between CCSR and OC ($r = 0.958$, $p < 0.05$); this means, when employees perceive the organization genuinely acting responsibly toward customers, they are much more committed to the organization. Finally, where there is a weak significant positive relationship between CCSR and GWB ($r = 0.142$, $p < 0.05$) and OC and GWB ($r = 0.260$, $p < 0.05$), it indicates that engaging in CCSR slightly relates to GWB and OC also slightly relates to GWB.

Keywords: Corporate Social Responsibility; Green Work Behaviour; Organizational Commitment

ICSD26_261

SUSTAINABLE DEVELOPMENT AND CHARACTERIZATION OF A CHITOSAN-ALOE VERA WOUND DRESSING DERIVED FROM SHRIMP SHELL WASTE

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Abstract: The growing demand for sustainable biopolymers as alternatives to synthetic materials has led to increase research into environmentally friendly polymers. This study focuses on the extraction of chitosan from shrimp shell waste, a commonly discarded by product of the seafood industry in Sri Lanka, and developing a wound dressing enriched with Aloe vera. This study aimed to convert waste material into value added product, thereby supporting both sustainability and biomedical innovation. Chitosan was extracted through demineralization, deproteinization, and deacetylation process, and its formation was confirmed using Fourier Transform Infrared Spectroscopy (FTIR) and degree of deacetylation analysis. The membrane was prepared using the solution casting method, with glycerol added as a plasticizer and Aloe vera extract incorporated with different concentrations to enhanced healing performance due to its well-known soothing, antimicrobial, and anti-inflammatory properties. The developed membranes, with an average thickness 0.15 mm, were evaluated for key characteristics including micro-environmental pH ranging, swelling index, moisture content and water vapor permeability. The optimal results showed that the membrane maintained a stable pH in range of 5 - 7 which is close to that healthy skin. In addition, the membranes showed suitable moisture retention between 10% - 20%, allowed sufficient breathability and exhibited good swelling capacity (70% - 80%). Overall, this study demonstrated that shrimp shell waste can be successfully transformed into a sustainable and biocompatible chitosan-based wound dressing enhanced with Aloe vera. The findings highlight the potential of this low-cost and eco-friendly material for future wound dressing applications, with further studies recommended to evaluate its antibacterial activity and clinical performance.

Keywords: Aloe vera; Biomaterials; Biopolymers; Chitosan; Shrimp Shell Waste; Wound Dressing

ICSD26_264

DESIGN AND CALIBRATION OF A PRECISION DENSITY MEASUREMENT SYSTEM USING ELECTRICAL RESISTANCE VARIATION

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Abstract: Accurate measurement of fluid properties is vital across scientific and engineering fields, particularly in quality control for industries like dairy and rubber processing. However, traditional densometers and hydrometers often present significant limitations, including the requirement for large sample volumes, a narrow range of measurement, and difficulty to use easily. To address these challenges, this research introduces a compact, cost-effective liquid density sensor utilizing Archimedes' principle and a linear sliding potentiometer. The mechanism employs a submerged spherical float attached to the linear potentiometer wiper as fluid density varies, the resulting change in buoyant force causes vertical displacement, which alters the electrical resistance and produces a measurable output voltage signal. To optimize sensitivity and precision across varying liquid types, a dual-probe design featuring two different-sized spherical floats was implemented a larger probe optimized for low-density fluids and a smaller probe for high-density environments. This spherical geometry is specifically chosen to ensure that the buoyant force remains vertical, thereby minimizing lateral measurement errors. Comprehensive experimental testing revealed that the sensor achieves a high performance with an accuracy of 98.24 ± 0.05% and an average error margin of only 1.76 ± 0.05%. The device effectively detects fluid densities within a range of 0.53 g/cm^3 to 1.15 g/cm^3, maintaining a consistent standard deviation of 5% and a sensitivity of 0.079 g cm^{-3} V^{-1}. The sensor's compatibility with its own calibrated platforms ensures it is accessible and easy to deploy, requiring no specialized training. Furthermore, the inherent flexibility of the design allows for potential modifications to measure additional characteristics such as viscosity and flow rates. Ultimately, this sensor offers a versatile and smart solution for fluid characterization in dairy milk manufacturing and other industrial sensing applications.

Keywords: Linear Resistance; Upthrust Force; Density; Liquid; Viscosity

ICSD26_269

SPATIAL EVALUATION OF GROUNDWATER POTENTIAL IN TRINCOMALEE DISTRICT: A PATH TOWARD SUSTAINABLE WATER SECURITY

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Abstract: Water is the backbone of life and development, and ensuring its sustainable availability is essential for present and future generations. Growing water demand, climate variability, and uneven rainfall distribution have led to frequent surface water scarcity. This has increased reliance on groundwater, especially in dry-zone regions such as Trincomalee District, Sri Lanka. Since groundwater is generally a safe and reliable source of drinking water, improved groundwater resource planning is essential. Identifying and assessing groundwater potential and availability, and managing these resources carefully, is therefore critical. In this context, geospatial technologies offer a cost-effective and proven approach for groundwater assessment. Accordingly, this study develops a spatial decision-support framework to identify groundwater potential zones in Trincomalee District using Geographic Information Systems and multi-criteria decision analysis. Ten hydrogeologically relevant factors such as lithology, slope, drainage density, lineament density, land use, soil type, rainfall, geomorphology, topographic wetness index, and proximity to surface water, were integrated to model groundwater suitability. With the support of three experts, the Analytical Hierarchy Process was applied to assign relative weights to each factor, achieving an acceptable consistency ratio (6.2%) and ensuring methodological reliability. The resulting groundwater potential map classifies the district into five suitability categories, revealing that approximately 11% of the area falls within high groundwater potential zones. An estimated 29.3% of the study area is classified as non-potential zones. These findings provide spatially explicit evidence to guide groundwater exploration, borehole placement, and long-term water resource planning. Thus, this research offers a practical and scalable approach to support sustainable groundwater management in semi-arid environments. The framework can assist policymakers, water authorities, and local planners in prioritising groundwater development while minimising environmental risks and over-extraction. By strengthening data-driven decision-making, the study contributes to improved water security, climate resilience, and community well-being in Trincomalee District and other water-stressed regions.

Keywords: Decision Support Systems; Geographic Information Systems (GIS); Spatial Modelling; Sustainable Water Management Practices; Water Scarcity

ICSD26_283

CHARACTERIZATION OF NATURAL ILMENITE AND GYPSUMFROM SRI LANKA AS POTENTIAL OXYGEN CARRIERS IN CLC PROCESSES

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Abstract: Chemical looping combustion (CLC) has emerged as an innovative approach for achieving efficient fuel utilization with inherent carbon dioxide separation, positioning it as a viable solution for sustainable energy production. This research explores the potential of naturally occurring Sri Lankan ilmenite and gypsum as oxygen carrier materials in CLC systems operated with coal as the fuel. The influence of process parameters such as operating temperature and fuel-to-oxygen carrier ratios on combustion efficiency and oxygen transport performance was analyzed using a thermogravimetric analyzer (TGA). The instrument simulated cyclic oxidation and reduction conditions representative of CLC environments. The experimental findings revealed that both ilmenite and gypsum exhibit stable thermal behavior and effective oxygen transport properties. However, gypsum demonstrated enhanced CLC performance relative to ilmenite, primarily due to its superior oxygen transfer capacity and higher reactivity. The study indicates that locally sourced ilmenite and gypsum, particularly gypsum hold promise as economical and environmentally sustainable alternatives to synthetic oxygen carriers. Continued investigation is recommended to improve material performance and evaluate their potential for large-scale industrial deployment.

Keywords: Chemical Looping Combustion; CO_2 Capture; Gypsum; Oxidation; Oxygen Carrier; Ilmenite; Reduction

ICSD26_290

SEASONAL DECOUPLING OF WATER QUALITY AND BENTHIC MACROINVERTEBRATE RESPONSES IN A MONSOON-DRIVEN RIVER: EVIDENCE FROM THE YAN OYA BASIN, SRI LANKA

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Abstract: Understanding how benthic macroinvertebrate communities respond to changes in water quality during monsoon-driven hydrological patterns is still a challenge for assessing river health in tropical areas. While physiochemical indices are used, they do not always accurately reflect ecological health, especially with significant seasonal changes. This study addresses this gap by looking at the seasonal relationship between water quality and macroinvertebrate community responses in the Yan Oya River, Sri Lanka. Benthic macroinvertebrates were sampled at 12 locations during wet and dry seasons in 2025 using a D-frame net. Concurrently physicochemical parameters were measured to compute a water quality index (WQI). Macroinvertebrate responses were assessed using the percentage of Ephemeroptera, Plecoptera, and Trichoptera (%EPT), Shannon Diversity Index (H′), and species richness. Seasonal differences were analysed using the Wilcoxon test, while Spearman's correlation analysis were employed to evaluate relationships between biological metrics, WQI and salinity. Results show that %EPT was significantly higher during the dry season than wet season ($Z = -2.31$, $p < 0.05$). This reflects a greater persistence of sensitive taxa under stable low-flow conditions. In contrast, WQI values were significantly higher during the wet season at all sampling locations ($Z = -3.06$, $p < 0.05$). This indicates improved physicochemical conditions due to monsoonal dilution. During the wet season, a significant negative relationship between %EPT and WQI was found ($r_s = -0.614$, $p < 0.05$). This suggests that hydrological disturbance has a greater effect than chemical suitability during high-flow periods. No significant link between %EPT and WQI appeared during the dry season, and salinity showed no significant relationship with %EPT in either season. The findings show that hydrological regime and habitat stability have a greater effect on benthic macroinvertebrate community structure than short-term improvements in water quality. This study highlights the importance of integrating biological indicators with physicochemical assessments to improve river health in tropical rivers.

Keywords: Biological Indicators; Hydrological Disturbance; River Health; Seasonal Flow Regime

CLIMATE-SMART AGRICULTURE, SUSTAINABLE CROP PRODUCTION, AND BIO-INNOVATIONS

ICSD26_028

EFFECT OF SOUND FREQUENCIES ON THE GROWTH AND DEVELOPMENT OF TOMATO (*Solanum lycopersicum*) PLANTS

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Abstract: Sustainable agriculture is increasingly seeking non-chemical ways of driving plant growth and stress resistance with low environmental impact. Among these, acoustic stimulation has been proposed as a low-cost bio-stimulant, but there is little evidence of music genre-dependent effects in horticultural crops. This study evaluated the effect of three sound treatments, such as 100 – 200 Hz (Sri Lankan classical music), 1000 – 3000 Hz (heavy metal music), and 200 – 800 Hz (Buddhist chanting), on vegetative growth and developmental processes of tomato (*Solanum lycopersicum* L.) under controlled environmental conditions. The experiment was conducted using a Completely Randomized Design (CRD) with four treatments (one control [no music]) and 10 replications per treatment. Plants were exposed to respective sound treatments in soundproof cabins for six hours a day, daily throughout the growth period. Growth parameters (shoot height, leaf length, leaf width, and number of leaves), physiological traits (chlorophyll content), and yield components were quantified and compared using repeated measures ANOVA with Tukey–Kramer corrections at a 5% significance level. Results indicated 200 – 800 Hz (Buddhist Chanting) always produced the tallest shoot, biggest leaf, most leaves, and chlorophyll content during development, followed by 1000 - 3000 Hz (metal music), while 100 – 200 Hz (classical music) had irregular effects as the control. Yield response also generally was higher in 200 - 800 Hz (Buddhist Chanting) treatments. These findings suggest that acoustic stimulation, particularly 200 – 800 Hz, can increase tomato plant early vigor and productivity. The study highlights the potential of music-based interventions as long-term bio-stimulants and calls for intensified research into sound response bases and plant mechanistic and frequency-specific bases.

Keywords: Acoustic Stimulation; Music Genres; Plant Physiology; Sustainable Agriculture; Tomato (*Solanum lycopersicum* L.)

ICSD26_084

ADULTICIDAL AND REPELLENCE EFFECT OF TEN SELECTED PLANT EXTRACTS AGAINST RICE LEAF FOLDER (*Cnaphalocrocis medinalis*) WITH SPECTROSCOPIC INSIGHTS ON *Justicia adhatoda*

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Abstract: The increasing resistance of rice pests to synthetic insecticides has also shown that there is a pressing need to have safer and plant-based insecticides. This paper compared repellence and adulticidal activity of ten botanical extracts to the rice leaf folder (*Cnaphalocrocis medinalis*) and revealed the most effective active extract using chromatographic and spectroscopic characterization. Topical application and Y-shaped olfactometer were used as laboratory bioassay techniques at five different concentrations range from 1%, 3%, 5%, 10%, and 15% v/v in-controlled conditions. The analysis of data was performed by the two-way ANOVA and then by Tukey post hoc tests and Games-Howell tests. Welch and Brown-Forsythe robust tests were used when homogeneity assumptions were not met. Lethal concentration (LC_{10}, LC_{50} and LC_{90}) values at $p < 0.05$ were estimated by Probit regression analysis. According to the overall results, the proportion of repellence rose as -8% at 1% to 62 at 15% whereas the proportion of adult mortality was 21.5 to 75.6 which confirmed the presence of a specific dose-dependent effect. Probit analysis revealed that *Azadirachta indica* exhibited the highest toxicity (LC_{50} = 1.03% v/v), followed by, *Justicia adhatoda , Ricinus communis* (1.10% v/v), and *Pongamia pinnata* (1.11% v/v), whereas *Lawsonia inermis* showed comparatively lower efficacy (LC_{50} = 1.23% v/v).The column chromatography of *J. adhatoda* gave 15 fractions subsequently monitor by Thin Layer Chromatography (TLC) with the most active fractions being the mid-polar fractions. UV-Visible spectrometry showed significant absorption at 217 nm, 273 nm, and 324 nm that indicate $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transitions that are typical of alkaloids and flavonoids. The alkaloid and phenolic groups were confirmed in FTIR spectra as there were prominent bands at 3362 cm^{-1}(O-H stretch), 2924 cm^{-1} (C-H stretch), 1654 cm^{-1} (C=O amide), 1450 cm^{-1} (C=C aromatic), and 1050 cm^{-1} (C-O stretch). Comprehensively, *Azadirachta indica* had the greatest insecticidal effect whereas *Ricinus communis, Justicia adhatoda,* and *Pongamia pinnata* closely followed, which implies that these plant extracts have high potential as environmentally friendly biopesticide against *C. medinalis*.

Keywords: Adulticidal Activity; FTIR Spectra; Olfactometer Assay; Thin layer Chromatography; UV-Visible Spectrometry

ICSD26_244

INVESTIGATION OF THE CHEMICAL CONSTITUENTS IN SLUDGE FROM WATER TREATMENT PLANTS LOCATED IN ANURADHAPURA

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Abstract: Sludge is an inevitable by-product generated during the water treatment process and commonly accumulates in water treatment plants. Its chemical composition is influenced by the type of coagulants applied during treatment and by the concentration of suspended and dissolved solids present in the raw water. Hence, the objective of this research was to study the composition of sludge generated in different water treatment plants in Anuradhapura district. Twenty different sludge samples were collected from *Nuwara wewa*, *Kala wewa*, *Thuruwila*, *Eppawela*, and *Galnewa* sludge accumulating tanks in Anuradhapura. pH, electrical conductivity, organic matter content, total nitrogen, phosphorus, potassium, calcium, magnesium, trace elements, and heavy metals were determined using standard analytical procedures with three laboratory replicates for each sample. Data were analyzed using the ANOVA procedure and mean separation was performed by the LSD test using R-Studio. All the sludge samples had neutral pH while sludge samples had comparatively greater total Nitrogen, Phosphorus and organic matter contents. According to the results, pH, electrical conductivity, organic matter, total nitrogen, total potassium, magnesium, manganese, zinc, aluminium, and iron content of drinking water sludge samples were found to be significantly different ($p \leq 0.05$). However, the total phosphorus and calcium content of the sludge were not significantly different ($p \geq 0.05$) among the sludge samples from different water treatment plants. Heavy metals were not detected in any of the sludge samples studied. Sludge generated from water treatment plants may be used as a soil conditioner in agriculture for safe disposal considering the nutrient levels of sludge. Further research is required to study the effects of drinking water sludge for agricultural applications.

Keywords: Sediments; Sludge; Soil Amendments; Soil Nutrients; Water Purification

ICSD26_258

PHOSPHATE-SOLUBILIZING BACTERIA IN TEMPERATURE-ADAPTED SOIL MICROBIOMES: A SYSTEMATIC REVIEW ON THEIR POTENTIAL AS PLANT GROWTH-PROMOTING BIOFERTILIZERS

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Abstract: The effects of climate change make it tough for sustainable agriculture in certain regions and small farms in less developed countries are most impacted by insufficient phosphorus and changing temperatures. Temperature-adaptive phosphorous solubilizing bacteria (PSB) keep the soil's phosphorus available and also support a healthy balance in the ecosystem. It carefully checks if certain kinds of PSB help the soil and improve plant growth due to climate. A search of Google Scholar, ScienceDirect and ResearchGate was carried out every year from 2010 to 2025. The search was performed by combining the words "biofertilizers," "phosphate-solubilizing bacteria," "phosphorus bioavailability," "plant growth promotion," and "temperature tolerance." Articles were examined using standard methods. Psychrotolerant and thermotolerant phosphate-solubilizing bacteria have the ability to maintain the solubilization of phosphorus under temperature stress conditions by the coordinated cellular, enzymatic, and protective adaptations. All of the tested Himalayan Pseudomonas cultures at 15 °C and 25 °C broke down the phosphate material. PBII_PAC506 was the top strain in phytase activity (15.91 ± 0.35 U/mL at 15 °C) and GBPI_CDB143 had the highest ability to dissolve tricalcium phosphate (110.50 ± 3.44 µg/mL at 25 °C). The growth of *Arabidopsis thaliana* (as measured by rosette diameter, leaf area and biomass) was improved by every isolate except *Pseudomonas Palleroniana. Pantoea agglomerans* samples taken from Tabriz grew and survived when stored in tricalcium phosphate/rock phosphate media at a temperature of 55 °C. Using *P. agglomerans* in greenhouse tests on maize resulted in greater amounts of root and shoot materials and increased phosphorus intake and these positive effects were almost the same as those found using half the amount of triple superphosphate. Tough, heat-resistant PSB can help farming during extreme climate and environmental situations by requiring less synthetic fertilizer. Agriculture can use microorganisms to help reduce stress on the environment. More research is needed using genomics to modify strains, review energy-making processes and perform studies at numerous locations globally, making it more practical for wide use.

Keywords: Biofertilizers; Climate resilience; Phosphorus Solubilizing Bacteria; Plant Growth Promotion; Temperature Adaptation

ICSD26_259

OPTIMIZATION OF ACID HYDROLYSIS OF PANICUM MAXIMUM USING RESPONSE SURFACE METHODOLOGY FOR REDUCING SUGAR PRODUCTION

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Abstract: Lignocellulosic biomass valorization has gained significant global attention due to its potential as a sustainable alternative to fossil fuels. This study aimed to evaluate *Panicum maximum* as a potential feedstock for reducing sugar production. The modified Van Soest method was applied for biochemical composition analysis of the samples. Sulphuric acid (H_2SO_4) was used as the acid catalyst for hydrolysis. A Teflon-lined hydrothermal reactor was used for the acid hydrolysis process. Parameters considered were temperature (120-180 °C), H2SO4 concentration (2-10% v/v), and reaction time (10-60 min). The resulting reducing sugar yield was quantified with the 3,5-dinitrosalicylic acid (DNSA) method after the hydrolysis process. Response Surface Methodology (RSM) with Central Composite Design (CCD) was used for optimization of reducing sugar yield. The biochemical composition was cellulose (35.85 ± 2.88%), hemicellulose (22.25 ± 0.59%), lignin (6.47 ± 0.85%), ash (6.25 ± 0.33%), and soluble (29.17 ± 3.15%) (w/w). This higher holocellulose content (58.10% w/w) and low lignin were ideal for hydrolysis. ANOVA indicated that temperature ($P = 0.001$) and H_2SO_4 concentration ($P = 0.001$) significantly influence the hydrolysis process, while reaction time ($P = 0.612$) was less significant as a single factor, but their interaction effect had a significant influence. The optimized acid hydrolysis conditions were 179.99 °C, 2% v/v H_2SO_4, and 31.75 min, with a predicted reducing sugar yield of 21.43% (w/w). Experiment validation yielded 21.68 ± 0.05% (w/w), confirming the model accuracy. This study revealed the potential of Panicum maximum as a good lignocellulosic candidate for reducing sugar production, which can be used for bioethanol production.

Keywords: Hydrolysis; Lignocellulose; *Panicum maximum*; Reducing sugars; Response Surface Methodology (RSM)

ICSD26_265

SODIUM ALGINATE–MEDIATED FERTILIZER SEED COATING AS A STRATEGY TO IMPROVE GERMINATION AND SEEDLING VIGOUR IN *Capsicum annuum* L.

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Abstract: Seed coating technology is progressively recognized as an effective approach to improve seed germination, establishment of initial seedling vigour and nutrient use efficiency in modern agriculture. Biopolymers, sodium alginate can be used as the polymer matrix for coating process as it is biodegradable, non-toxic and controlled release properties which making it suitable for sustainable crop production. Therefore, the optimum application rate of the polymer is critical while coating the fertilizer with seeds. This study was conducted to optimize the rate of sodium alginate for producing fertilizer-coated capsicum seeds, a major cash crop in Sri Lanka. The experiment was carried out at Horticultural Crops Research and Development Institute, Gannoruwa using Gannoruwa Prarthana Hybrid Capsicum variety as planting material. Treatments consisted with six sodium alginate concentrations (0.5%, 1%, 1.5%, 2%, 2.5% and 3%) to produce fertilizer coated seeds and uncoated seeds used as control with four replicates for each. Fertilizer was coated to the seeds according to the Department fertilizer recommendation for capsicum. Parameters evaluated included germination percentage, seedling vigour index, pH variation and swelling ratio of the different concentrations of NaAlg, and plant growth performance after 21 days of nursery establishment. Results revealed significant differences ($P > 0.05$) were observed all the time for interaction effects between the treatments. The 1% sodium alginate-fertilizer coated seed treatment consistently showed greater performance for germination percentage and seedling vigour index (96%; 211.2), neutral pH range, 27.85 of swelling ratio across treatments. Nonetheless, higher concentrations ($\geq$ 2%) tended to reduce germination and growth owing excessive coating thickness. The highest early seedling growth performed by 1% sodium alginate-fertilizer coated seed treatment. Thus, the study provides valuable perceptions to improve the fertilizer-coated seed technology and presents a novel sustainable method to maximize nutrient use efficiency in capsicum production.

Keywords: Biopolymer Coating; *Capsicum annuum* L.; Fertilizer-Coated Seeds; Nursery Performance; Sodium Alginate

ICSD26_276

EVALUATION OF WATER STRESS TOLERANCE IN TOMATO (*Solanum lycopersicum* L.) GENOTYPES FROM SRI LANKA

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Abstract: This experiment was conducted to evaluate the resilience of seventeen Sri Lankan tomato genotypes under water stress conditions. The selected genotypes were collected from the Plant Genetic Resource Centre (PGRC), Horticultural Research Institute (HORDI) and farmers' fields of Sri Lanka. The experiments were conducted as a pot experiment under control and water-stress conditions in a randomized complete block design with three replicates. Morphological assessment revealed that varieties such as Batu (branches: 14.67 ± 2.19 vs. 9.00 ± 2.52, $p = 0.16$; leaf area: 49.84 ± 5.09 vs. 14.83 ± 2.33, $p = 0.06$), Cherry (leaf area: 45.37 ± 3.55 vs. 22.91 ± 2.39, $p = 0.60$), and Bathiya (leaf area: 28.27 ± 3.87 vs. 26.63 ± 3.49, $p = 0.763$) maintained branch number and leaf area under drought with non-significant reductions compared to the control. Chlorophyll content was similarly retained in drought-tolerant lines (Bathiya: 30.39±0.11 vs. 20.97 ± 0.12, $p = 0.065$; L. sour: 20.85 ± 0.16 vs. 20.41 ± 8.13, $p = 0.110$) compared to the control. L.sour and Cherry demonstrated stability by showing no significant reduction in stem diameter under drought stress ($p > 0.05$). Bathiya (root area: 127.69 ± 3.81 vs. 146.52 ± 1.01, $p = 0.32$; root length: 13.23 ± 0.18 cm vs. 13.73 ± 0.36 cm, $p = 0.284$) maintained roots under stress showing roots architecture was not affected in some genotypes. Drought delayed flowering (Wal: 62.6 ± 1.4 days), while Biththara flowered earliest (38.7 ± 0.1 days). Across the tested genotypes, Cherry and Biththara demonstrated the highest resilience with the lowest yield drops, maintaining average yield per plant of 749.1 ± 18.2 g and 657.4 ± 26.3 g under drought respectively. Cherry, Field - 02, Biththara, and L-sour emerged as highly drought-tolerant varieties by maintaining minimal leaf rolling scores. Molecular analysis using the AS2 drought-tolerance marker confirmed the presence of tolerant alleles in Biththara, Bathiya, Field - 02, L. sour, Cherry, Rajitha, and KC - 1. In conclusion, Biththara, L. sour, Cherry, and Bathiya consistently exhibited superior tolerance maintaining yield, growth, and root development under water stress.

Keywords: Crop Improvement; Genotypes; *Solanum lycopersicum* L.; Water Stress; Yield Parameters

ICSD26_358

DECARBONIZING THE TEA INDUSTRY: COMPREHENSIVE SCOPE 1, 2, AND 3 CARBON FOOTPRINT ASSESSMENT OF A MEDIUM-SCALE SRI LANKAN TEA FACTORY

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Abstract: Tea production is a key economic contributor in Sri Lanka, generating significant foreign exchange earnings and providing employment for local communities. Despite its economic importance, the environmental impacts of medium-scale tea factories, particularly Greenhouse Gas (GHG) emissions, remain underexplored. Accurate quantification of these emissions is essential for identifying mitigation pathways and promoting sustainable tea production. This study estimated GHG emissions of a medium-scale tea factory in the low country, covering direct sources (biomass combustion, company-owned tea leaf transportation, wastewater management, purchased electricity) and indirect sources (staff commuting, outsourced tea leaf transport, solid waste management, and packaging transport) in accordance with the GHG Protocol and ISO 14064. Primary operational data, including fuel and electricity consumption, production logs, and commuting surveys, were combined with secondary emission factors. Total annual emissions were 57,612.79 tCO_2e, predominantly from purchased electricity (56,317.82 tCO_2e; 97.77%), while Scope 1 and Scope 3 contributed 1.27% and 0.96%, respectively. Within Scope 1, the biomass boiler accounted for 53.11% of emissions. Mitigation strategies include adopting high-efficiency fuels, such as torrefied biomass pellets, coconut shell briquettes, or pelletized tea waste, which provide a higher calorific value and lower emission intensity than conventional wood chips and rice husk. Scope 2 emissions can be partially reduced through renewable energy integration, including rooftop solar photovoltaics and biogas-based power from tea residues, alongside energy efficiency interventions such as variable frequency drives, LED lighting, process automation, and systematic energy audits. For Scope 3, staff transportation was the primary contributor (56.5%), and mitigation measures include providing shuttle services, promoting carpooling among workers from the same area, and hiring staff from nearby locations. Implementing these targeted strategies can substantially reduce the carbon footprint of tea factory operations while supporting sustainable tea production and operational efficiency, offering a replicable framework for the broader tea industry.

Keywords: Carbon Footprint; Energy Efficiency; Greenhouse Gas Emissions; Mitigation Strategies; Sustainable Tea Production

STRENGTHENING UNIVERSITY-INDUSTRY COLLABORATIONS FOR SUSTAINABLE DEVELOPMENT

ICSD26_075

IMPROVING SUSTAINABILITY IN SUPPLY CHAIN INNOVATION THROUGH UNIVERSITY-INDUSTRY COLLABORATIONS: A SYSTEMATIC LITERATURE REVIEW

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Abstract: Sustainability is a critical priority in Supply Chain Innovation (SCI), making collaboration essential to harness a full range of knowledge and resources. For instance, by collaborating with external organisations such as universities, companies can access new technologies and gain expert knowledge. Despite this importance, a research gap exists in understanding the engagement between universities and industry in SCI, which hinders the exploration of new insights into SCI and limits comprehension of its potential environmental and societal sustainability impacts. A systematic literature review to address this gap is justified due to the fragmented nature of existing research, which limits a cohesive understanding of how different forms of University-Industry Collaborations (UICs) contribute to sustainability in SCI. Hence, this study aims to explore the role of UICs in SCIs for improving sustainability. Forty-one peer-reviewed journal articles were content analysed based on constructs deductively derived from four frameworks: SCI encompassing product/service, process, and organisational innovations; sustainability performance addressing environmental, economic, and social aspects; UICs including educational collaborations, academic entrepreneurship, and research-related collaborations; and supply chain collaboration practices such as joint knowledge sharing, information sharing, and goal congruence. A conceptual framework was developed based on contingency analysis, emphasising how educational collaborations between universities and industries lead to innovative product designs that improve environmental sustainability. Collaborations promoting academic entrepreneurship can develop business models with socially and economically sustainable practices. The conceptualisation also indicates that research related to UICs supports open innovation, enhancing overall sustainability. The emphasis is also on the practitioner's role in promoting sustainability by fostering joint research projects, organising innovation workshops, and co-developing curricula. Policymakers can support these initiatives by creating incentives for UICs, such as sustainability-focused research grants or tax benefits. Additionally, this study highlights the need for supply chain professionals to be more open-minded when collaborating with universities for improved sustainability outcomes.

Keywords: Supply Chain Innovation; Sustainability; University-Industry Collaboration

ICSD26_098

A UNIVERSITY-INDUSTRY PARTNERSHIP FOR SUSTAINABLE HEALTH: DEVELOPING AND VALIDATING A NOVEL HERBAL CANDY FOR LIVER PROTECTION IN AT-RISK ADULTS

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Abstract: The increasing prevalence of Non-alcoholic Fatty Liver Disease (NAFLD) among overweight and obese individuals necessitates accessible interventions. Through a partnership between the University and industry, a novel functional food product, LivosBEE^{TM} herbal candy, was developed, and its hepatoprotective efficacy was evaluated. A randomised, single-blind, placebo-controlled trial was conducted over ten weeks with 30 overweight and obese (BMI ≥25 kg/m^2) adults aged 20 - 55 years. Participants were assigned to receive either 5g/day of LivosBEE^{TM} or a placebo. Liver function markers, lipid profile, and glycemic markers were measured at baseline, week two, and week eight. Phytochemical analysis revealed substantial antioxidant properties, with total phenolic content of 28.565 ± 1.350 mg GAE/g, total flavonoid content 8.446 ± 0.504 mg RE/g and DPPH radical scavenging activity of 64.54 ± 1.38%. The treatment group exhibited a statistically significant reduction in Alanine Aminotransferase (ALT) from baseline to week two ($p = 0.034$) and week eight ($p = 0.002$), with a significant between group difference at the endpoint ($p = 0.022$). Although there were no statistically significant differences between the groups, aspartate aminotransferase (AST) levels also significantly decreased within the treatment group ($p = 0.003$ and $p = 0.007$, respectively). Gamma-Glutamyl Transferase (GGT) levels remained stable in the treatment group, showing a significant difference compared to the control at the end point ($p = 0.028$). Although there was no statistically significant difference between the groups, bilirubin significantly decreased within the treatment group ($p = 0.04$). No significant changes were observed in Alkaline Phosphatase (ALP), lipid profile, or glycemic parameters. These findings demonstrate that LivosBEE^{TM} effectively improves specific liver health markers, presenting a promising nutraceutical strategy for hepatoprotection in at-risk populations.

Keywords: Antioxidant; Hepatoprotective; Herbal candy; Liver function markers; Non-alcoholic fatty liver disease

ICSD26_120

HYBRID APPROACH FOR AUTOMATED UNIVERSITY TIMETABLING USING GRAPH COLORING AND LINEAR PROGRAMMING MATHEMATICAL MODEL BASED RESOURCE OPTIMIZATION

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Abstract: Efficient University course timetabling is widely recognized as a complex optimization problem that must satisfy hard and soft constraints such as avoiding course and lecturer conflicts, managing limited class room and practical labs, and optimizing room utilization. Traditional scheduling methods continuously leads to inefficiencies, time consumption, and conflicts that affect academic operations. To overcome these problems, an automated course timetabling system was developed to generate institutional timetables applicable across diverse academic settings. The proposed system integrates graph coloring theory with linear programming mathematical models to solve the timetabling optimization problems. The proposed approach was validated through its implementation at the Faculty of Computing at Sabaragamuwa University of Sri Lanka. All necessary institutional data were systematically collected and processed using MATLAB and the implementation consists of two integrated phases. Initially, a graph model representing course modules was conducted, where vertices represent course modules and edges represent scheduling conflicts between them. An adjacency matrix was conducted to represent the relationships and a greedy graph coloring algorithm was applied to assign the timeslots and ensure conflict free scheduling. In the next phase, a linear programming mathematical model was developed to optimize room allocation and improve the utilization of available rooms across all departments. The results indicate that the system successfully generated a conflict free timetable with improving classroom utilization. Additionally, a wastage analysis was performed to evaluate the number of unused seats within each course. Future work will focus on enhancing automation by integrate a user friendly interface and incorporating dynamic timetable adjustments capabilities in response to real time changes and implementing an artificial intelligence framework to minimize the revisions made on publications after the schedule. This study provides a practical and systematic solution to the university timetabling problem, helps to improve administrative efficiency and optimal resource utilization.

Keywords: Adjacency matrix; Graph Coloring; Greedy Graph Coloring Algorithm; Hybrid Approach; Resource Optimization; Scheduling Algorithm.

ICSD26_148

AWARENESS AND SUSTAINABLE BEHAVIOR ON MICROPLASTIC POLLUTION AMONG UNDERGRADUATES IN COLOMBO DISTRICT, SRI LANKA.

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Abstract: Plastics and Microplastics are pervasive in natural and built environments, posing significant risks to ecosystems and human health. Young adults play a critical role in adopting sustainable practices and promoting environmental stewardship. This study examined the awareness, perceptions, and behaviors of undergraduates aged 18–25 in Colombo District, Sri Lanka regarding microplastic contamination, emphasizing sustainable development and biotechnological monitoring. A mixed-methods, cross-sectional design guided by Saunders' Research Onion was employed, integrating quantitative survey data (n = 374) with secondary literature on microplastic sources, environmental impacts, and mitigation strategies. Results demonstrated high environmental responsibility. Approximately 90% (336) recognized microplastics as an environmental threat and emphasized reducing plastic consumption ($p < 0.001$). Elevated concern about microplastics was significantly associated with proactive behaviors, including recycling and adopting sustainable alternatives. Students who recycled frequently were more likely to implement broader waste-management practices ($p < 0.001$), including reduced use of single-use plastic bags 58.7% (220) and adoption of reusable items. Willingness to reduce plastic use was significantly linked to specific actions such as using reusable bags ($p < 0.05$), and 54.4% (202) actively minimized plastic waste ($p < 0.01$). Awareness of national initiatives to curb plastic pollution was reported by 54.4% (204) while 45.6% (374) were unaware, highlighting the need for enhanced policy engagement. Availability and accessibility of sustainable alternatives emerged as the leading motivational factor 39.2% (374), underscoring the importance of practical solutions in driving behavior change. These findings underscore the critical role of undergraduates in advancing sustainable development and responsible consumption. The study highlights opportunities for university–industry collaboration to develop targeted educational programs, innovative interventions, and community initiatives that strengthen youth engagement, foster sustainable behaviors, and support long-term strategies for mitigating microplastic pollution in Sri Lanka.

Keywords: Environment; Human Health; Microplastics; Sri Lanka; Youth Awareness

ICSD26_183

DEVELOPING A SUSTAINABLE FRAMEWORK FOR UNIVERSITY–INDUSTRY TECHNOPRENEURIAL COLLABORATION: EVIDENCE FROM SRI LANKAN UNIVERSITIES

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Abstract: Technoprenreial UIC is essential for driving innovation and economic growth, yet differing priorities between universities and industries create barriers that limit effective collaboration. Although technopreneurship is essential national development, many students still lack the practical skills required by today's technology-driven economy, widening the gap between academics and industry needs. In Sri Lanka, limited R&D activity, inadequate support structures, policy gaps, and misaligned objectives further weaken technoprenreial UIC, and no locally tailored framework currently exists to guide these partnerships. The research aimed to assess the current state of university industry collaboration in technopreneurship, identify best practices, and develop a sustainable framework for collaboration within the university and industry. Literature research, a questionnaire survey for university students, university staff and industrial person were conducted to propose a sustainable UI Technoprenreial model. A survey of 307 university students from 12 Sri Lankan state universities, 52 university staff from 10 universities, and 110 industry representatives from various industries in Sri Lanka, was conducted using a questionnaire survey. The study used three questionnaires to gather primary data, and the Wilcoxon signed rank test and descriptive statistical techniques were used to analyze the data. Results showed 65% of students, 55% of industrial perspectives did not participate in collaborative activities in Technoprenurship, while 85% of staff participated. Industry representatives reported policies supporting technopreneurial UIC are inadequate, reflected in low mean scores for national policies (2.32), U–I link policies (2.85), and university-level policies (2.59). Staff noted sufficient human resources (3.50) but weak infrastructure (2.81) and inadequate labs (2.35), showing major resource gaps. Students highlighted the importance of sustainability in UIC, with high means for environmental (3.85), SDG (3.96), and economic sustainability (4.00). IP collaboration remains low at 26 – 29%, show need for stronger innovation. Based on these findings, a sustainable technopreneurial UIC framework was developed.

Keywords: Innovation Ecosystems; Knowledge Partnerships; Technology Transfer; Technopreneurship; University–Industry Collaboration

ICSD26_233

BLOCKCHAIN-ENABLED UNIVERSITY-INDUSTRY COLLABORATION FOR SUSTAINABLE FOOD WASTE MANAGEMENT IN DEVELOPING REGIONS: A SMART PLATFORM FRAMEWORK AND IMPLEMENTATION MODEL FOR SAARC UNIVERSITY CAFETERIAS

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Abstract: Food waste represents a critical sustainability challenge in developing regions, with SAARC countries facing substantial barriers in achieving Sustainable Development Goals. University campuses, characterized by extensive cafeteria operations and fluctuating student populations, emerge as significant contributors requiring innovative solutions. This study proposes a novel blockchain-enabled framework for university-industry collaboration specifically designed for food waste management in SAARC region universities. The framework integrates authenticated data collection mechanisms, smart contract automation, and comprehensive stakeholder ecosystem design to address persistent transparency, traceability, and accountability challenges in institutional waste management systems. Proof-of-concept validation at NSBM Green University, Sri Lanka, demonstrates robust technical feasibility with sub-50 ms transaction processing, 100% security validation, and successful multi-location tracking capabilities. The platform utilizes Ethereum blockchain's immutability combined with Solidity smart contracts to capture real-time waste data through authenticated manual inputs, creating tamper-proof records specifically suited for resource-constrained developing region contexts. Comparative analysis reveals quantified improvements over traditional methods including 100% data integrity enhancement, 75-85% faster data processing speeds, and over 95% improvement in reporting efficiency. The proposed stakeholder ecosystem encompasses universities, industry partners, government agencies, and student entrepreneurs, creating structured pathways for effective technology transfer, collaborative knowledge co-creation, and substantial employability enhancement opportunities. Conservative projections suggest 10-15% waste reduction potential through systematic data-driven interventions. This study presents a comprehensive conceptual framework validated through rigorous proof-of-concept testing at a single institution, with the proposed regional scalability model strategically designed for future multi-university implementation across SAARC countries. The framework establishes a practically replicable model for developing region universities, advancing institutional sustainability through transparent and verifiable waste management while simultaneously creating meaningful opportunities for university-industry collaboration and student entrepreneurship development. The research contributes significantly to emerging academic literature on blockchain applications in resource-constrained educational environments while providing actionable implementation strategies and practical deployment guidelines for sustainable development initiatives in developing regions.

Keywords: Blockchain Technology; Developing Economies; Food Waste Management; SAARC Region; Smart Contracts; Sustainable Development; University-Industry Partnerships

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MACHINE LEARNING–DRIVEN BEHAVIOURAL SIGNAL ANALYSIS FOR UNDERSTANDING LEARNER INTERACTION IN EDUCATION SYSTEMS.

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Abstract: Monitoring student engagement in physical classrooms is difficult due to manual observation limits, large class sizes, and low-quality video that reduces the accuracy of existing AI systems. This research proposes an AI-based Student Engagement Optimization System that integrates facial recognition and eye-gaze tracking to automate attendance marking, emotion and behavior detection for measure concentration level and ESRGAN-based video enhancement into a single framework. OpenCV and dlib were used for face recognition and gaze estimation, while DeepFace and MediaPipe enabled emotion and landmark analysis. Furthermore, ESRGAN was integrated to restore details related to facial features from low-resolution footage and allow for improved accuracy in the recognition of faraway or compressed videos captured in classrooms. This encompasses four modules: automated attendance marking, emotion and behaviour detection, CNN-based concentration assessment, and super-resolution enhancement. Validated on classroom video data, the system achieved 98% face-detection accuracy and 92% emotion-classification accuracy, showing significant improvements after ESRGAN enhancement. A unified and scalable approach for real-time monitoring of student engagement is supported by the proposed model, while it further presents support for data-driven teaching practices.

Keywords: Emotion Analysis; ESRGAN; Eye-gaze Tracking; Facial Recognition; Student Engagement; Video Super-resolution

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THE RISE AND FALL OF THE RUHUNA BUSINESS INCUBATOR: POLICY LESSONS FOR FUTURE UNIVERSITY INCUBATORS

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Abstract: The Ruhuna Business Incubator (RBI) was established in 2001 at the "GamUdawa" site in Kamburupitiya by the Faculty of Agriculture, University of Ruhuna, in partnership with the Southern Development Authority (SDA), the Matara District Chamber of Commerce & Industry, and the Japan–Lanka Industrial D *Sri Lanka* evelopment Center, with support from UNIDO. Conceived as a regional institutional innovation, RBI aimed to stimulate entrepreneurship through shared infrastructure, technical advisory services, and structured training for start-ups, thereby operationalizing university–industry collaboration within a peripheral regional economy. While the incubator initially demonstrated the potential of multi-stakeholder collaboration, its subsequent decline reveals critical governance and policy failures. The dissolution of the SDA and the withdrawal of the Japan–Lanka Industrial Development Center created an institutional vacuum, exposing the incubator's dependence on external agencies and project-based partnerships. Efforts to revitalize RBI—including a successfully secured Human Capital Building and Training (HCBT) project, a sector-specific cinnamon incubator proposal submitted to Bhumi Puthra Bank, and post-tsunami community recovery initiatives such as the establishment of a school library in Elpitiya—were ultimately stalled. These setbacks were not merely operational but systemic, stemming from the absence of institutionalized leadership succession, restrictive administrative controls, and a compliance-oriented audit culture that discouraged adaptive management and entrepreneurial risk-taking within the university system. The RBI experience illustrates deeper structural constraints in Sri Lanka's innovation ecosystem. Universities lack clear statutory authority and governance frameworks to manage business incubators as semi-autonomous development entities. Financial sustainability mechanisms are weak, resulting in excessive reliance on donor funding and ad hoc projects. Moreover, fragmented inter-agency coordination and limited integration of university incubators into national innovation and industrial policy have constrained their strategic positioning. This case underscores that institutional design rather than project performance alone determines the sustainability of university-based incubators. For future initiatives, policy reform must prioritize legally defined mandates, hybrid governance models that balance autonomy with accountability, diversified financing structures, and explicit alignment with national and regional development strategies. Without such systemic reforms, university incubators risk remaining donor-dependent experiments rather than enduring instruments of regional economic transformation.

Keywords: Business Incubator; Entrepreneurship; Governance; Policy Gaps; Sri Lanka

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Sri Lanka

University of Ruhuna
Sri Lanka

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Thailand

Rajarata University of
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Sri Lanka

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