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November 21-22, 2024

Faculty of Technology
University of Sri Jayewardenepura
Sri Lanka

"Future-Ready Solutions through Advanced Technologies"

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Message from the Vice-Chancellor

It is with immense pleasure that I write this congratulatory message for the fourth International Conference on Innovation and Emerging Technologies (ICIET) 2024, organized by the Faculty of Technology, University of Sri Jayewardenepura.

ICIET 2024, much like its previous editions, represents a vital step forward in Sri Lanka's technological and innovative journey. As the leading Technology Faculty in the country, the Faculty of Technology, University of Sri Jayewardenepura has once again demonstrated its critical role in advancing the nation's technological capabilities. I would like to express my sincere appreciation to the dedicated academic and non-academic staff of the faculty for their exceptional efforts in organizing this prestigious event, setting a standard of excellence year after year.

This year's conference theme, *'Future-Ready Solutions through Advanced Technologies'*, highlights the urgent need for innovative solutions as we navigate the rapid advancements in technology and their potential to drive sustainable development. The University of Sri Jayewardenepura has a proud tradition of supporting research, innovation, and technological growth, and the Faculty of Technology has been instrumental in fostering a culture of knowledge, creation, and dissemination. Through ICIET 2024, I am pleased to see the faculty continuing to extend its support to a broader community of researchers and professionals committed to harnessing cutting-edge technologies for the betterment of the society.

It is indeed gratifying to witness the continuous growth of ICIET, which this year has introduced 15 specialized tracks and attracted both local and international participation. As the Vice-Chancellor, I am immensely proud of the accomplishments of the Faculty of Technology and encourage them to persist in their remarkable efforts while further expanding their scope in the years to come.

I would like to extend my sincere gratitude to the General Chair of ICIET 2024, Dean of the Faculty of Technology, Prof. Renuka Nilmini Liyanage, and the members of the conference organizing committee for their unwavering commitment to bringing this event to fruition. My best wishes to all participants and presenters, and I hope that ICIET 2024 proves to be a rewarding and insightful experience for everyone involved.

Senior Professor M. M. Pathmalal
Vice-Chancellor
University of Sri Jayewardenepura

Message from the General Chair

As the International Conference on Innovation and Emerging Technologies (ICIET) 2024 unfolds, I am pleased to extend this warm welcome. Building on the remarkable success of previous years, this conference has grown into a dynamic platform for fostering invention, innovation, and the exploration of cutting-edge knowledge, with the far-reaching aim of benefiting the society and shaping the future.

The theme of ICIET 2024, *'Future-Ready Solutions through Advanced Technologies'*, is particularly timely as the world seeks innovative solutions to address current and future challenges. With 15 tracks covering a broad spectrum of technological advancements, including Science, Engineering, and Technology, the conference offers a unique opportunity for scholars, emerging researchers, industry professionals, and technology enthusiasts to engage in groundbreaking ideas and research.

I am excited that this year's conference will occur in person over both days. This format provides participants with an invaluable opportunity to engage directly, build networks, and foster collaborations that may lead to future innovations. Additionally, we have organized an inspiring series of keynote addresses featuring leading experts from academia and industry, who will share valuable insights into the future of technology and its global impact.

ICIET 2024 is the result of the tireless dedication and hard work of many individuals. I would like to express my sincere gratitude to the members of the conference organizing committee and the academic and non-academic staff of the Faculty of Technology, whose efforts have brought this event to life. The continued guidance and support of the Vice-Chancellor, Senior Professor M.M. Pathmalal, have also been instrumental in making ICIET 2024 a reality. I extend my heartfelt thanks to our sponsors for their invaluable contributions in making this event possible.

With great excitement, I congratulate all the presenters and participants, and I welcome you to ICIET 2024. May it be a truly enriching and inspiring experience for all.

Professor Renuka Nilmini Liyanage
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Dean/General Chair - ICIET 2024
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University of Sri Jayewardenepura

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BSc (Colombo, Sri Lanka), MSc (Cardiff University, UK), PhD (Cardiff University, UK)

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Conference Tracks

Agricultural Technologies for Sustainability

Artificial Intelligence and Data Science

Automotive Engineering

Biotechnology, Bioengineering, and Industrial Bioprocessing

Building Construction and Infrastructure Technology

Communication and Networking Technologies

Electrical, Electronics, and Embedded Systems

Energy, Environment, and Sustainability

Food Security, Nutrition, and Processing Technology

Geo Resources, Geo Environment, and Geotechnics

Information Systems/Applications and IS Strategies

Materials Engineering and Process Technology

Mechatronics, Robotics, and Automation

Technology Education and Management

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D.M.N.T. Dissanayaka[a], S.A.M.B.C. Samarasekara[b], S.D.T. Maduwanthi[b,*], and N.K.M.C. Nagahawaththa[c]

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Abstract

One of the most popular beverages in the world along with a bundle of nutritional and health benefits is tea. The harvesting practices have a significant impact on the cost of production, the quality of the final product and the growth of the bush crucial to the sustainability of tea lands. As a result, implementing appropriate harvesting policies has become essential to the production of tea. The purpose of this study is to evaluate the level of practicing tea leaf plucking policies and to assess the knowledge and attitudes of tea land owners in Sri Lanka regarding correct leaf plucking policies. A structured questionnaire was distributed among randomly selected 150 tea land owners. The knowledge of the tea land owners on policies of tea leaf plucking was assessed by asking for their agreement with several statements using a 5-point Likert scale. Responses were coded accordingly and analyzed using Minitab 17. According to the results obtained majority of the respondents own less than 1 acre of land and mostly practice hand plucking in 7-day intervals. Moreover, 35% of the respondents use fertilizer bags and 25% use polysacks which are not recommended as appropriate green leaf containers. Furthermore, the Chi-square test confirms that ($p=0.013$) there is a lack of knowledge on the effect of leaf collecting container and leaf quality. The knowledge index was 69.66% of tea land owners which is a satisfactory level. Based on the results, it is evident that nearly 75% use level stick during leaf plucking. In conclusion, the survey results suggest a potential gap in knowledge and practices among tea farmers. By prioritizing and implementing training programs, there is an opportunity to enhance the overall quality of tea production.

Keywords: tea, leaf plucking, policies, knowledge of tea land owners

Advancing Agricultural Engineering: The Role of Emerging Technologies in Precision Agriculture and Sustainable Development in Asia

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Abstract

The integration of emerging technologies into agricultural research is transforming the landscape of modern farming, driving unprecedented advancements in productivity, sustainability, and precision. This review explores the pivotal role of cutting-edge innovations in agricultural engineering that are revolutionizing farming practices and shaping the future of agriculture. Key technologies include advanced sensor systems, autonomous machinery, and artificial intelligence (AI)-driven analytics. Given then importance, this systematic review was carried out in order to provide a comprehensive understanding of its methodologies, benefits, challenges, and future prospects, and to screen main solutions that may be implemented through emerging agriculture engineering technologies in sustainable agriculture. Peer-reviewed articles from 2016 to 2024 were screened using the "Google Scholar" database. Inclusive keywords such as "precision agriculture", "emerging technologies", "future sustainability", "sensor systems", "autonomous machinery", and "Asia" were used during the article screening process. The analysis identified 75 research articles, distributed evenly across three key technological areas; big data (n=25), autonomous machinery (n=25), and sensor systems (n=25). The integration of data analytics and predictive modeling in precision agriculture allows for the optimization of inputs such as water, fertilizers, and pesticides. The review also highlights that integrating precision agriculture with sustainable farming practices not only significantly contributes to global food security but also helps minimize environmental impact. By harnessing these advancements, farmers can achieve more sustainable, efficient, and resilient agricultural practices, paving the way for a future where global food security and environmental stewardship are seamlessly integrated. Therefore, we advocate for broad stakeholder involvement in the agricultural sector to facilitate the systematic integration of emerging technologies like AI, Geographic Information Systems, robotics, autonomous machinery, block chain, and sensors in precision agriculture. Such engagement could substantially boost food productivity and help alleviate poverty and malnutrition, especially in developing regions like Asia.

Keywords: Asia, emerging technologies, precision agriculture, sustainable agriculture

Revolutionizing Small-Scale Poultry Farming in Sri Lanka with Affordable Automation for Quality Checking, Sorting, and Counting of Eggs

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Abstract

The poultry industry is a vital component of global agriculture, meeting the constantly growing demand for poultry products. In Sri Lanka, the egg industry holds a particular significance, with contributions from both small-scale and large-scale farms. In particular, the small-scale egg farmers, who play a vital role in local economy development, often rely on manual methods for their essential routine tasks, such as egg sorting, quality testing, and counting. These routine tasks are not only time consuming but also prone to human error, resulting in inefficiencies that drive up labour costs and reduce overall productivity. We identified this gap and proposed an automation-driven workflow to elevate the efficiency, accuracy, and reduce labour costs of their egg sorting operations. An automated egg sorting prototype was designed accordingly to sift different sizes of eggs based on the weight. The prototype also incorporated a lighting mechanism to determine the quality of eggs. This mechanism entailed several LED strips on which the eggs are placed (before the sorting operation). Under this illumination, a red or colourless egg was determined “foul”, and a yellow colour egg was identified as “good”. Consequently, the eggs were allowed to roll through an inclined surface and onto a load-cell supported base one-by-one. The load cell was accurately calibrated to report the weight of the egg and an actuator (*i.e.*, servo motor) is triggered to assign the egg to another channel according to a three way classification (*i.e.*, small <45 g, medium >45 g and <50 g, and large >50 g). This control workflow was facilitated by a versatile microcontroller: an ESP32 board. Preliminary results indicated ~90% accuracy while processing up to 1,800 eggs per hour (typically, 500 eggs per hour sorted manually), which is a marked improvement. Further studies are conducted to ascertain the cost-effectiveness and scalability of the proposed technology, while alleviating the practical difficulties faced by the local poultry industry.

Keywords: automation, cost-effective, egg counting, egg sorting, egg quality checking

Iron Biofortification of *Alternanthera sessilis* as a Solution to Alleviate Iron Deficiency in Sri Lanka: A Comparative Study of Hydroponics Techniques

H.R. Mohomed, H.U. Abhayarathne, K.D.C. Pamalka, G.G.L.L. Gunarathne, and G.S.G. Liyanage*

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Abstract

Iron deficiency remains a significant global health issue contributing to increased anaemia rates and impaired health, particularly in developing countries such as Sri Lanka. Despite its significance, only a few studies have explored hydroponic techniques for iron biofortification of leafy greens, highlighting an important research gap. This study evaluated the efficacy of two hydroponic techniques; the nutrient film technique (NFT) and the coconut-coir cultivation technique (CCT), for enhancing iron content in *mukunuwenna* (*Alternanthera sessilis*). Plants (n=6) were treated with nutrient solutions containing iron in concentrations of 162.5 (control), 200, and 250 ppm. Changes in the number of leaves and the heights were recorded weekly. Plants were harvested in the fifth week and aqueous extracts were prepared using the maceration method. Iron content, antioxidant activity, total phenolic, flavonoid, carbohydrates, and protein contents were analysed using various spectrophotometric techniques. The iron content absorbed by the plants increased with increasing iron concentrations in the nutrient solution in CCT, while NFT displayed a decreasing trend. NFT exhibited the highest final harvest weight, height and number of leaves. In contrast, the highest absorbed iron content (20.3 ppm), total proteins (2.84 g/100 g), and total phenols (105.16 mg GAE/g) were recorded in the CCT-250 group, while the highest carbohydrate content (25.11 g/100 g) and the highest flavonoid content (100.21 mg QE/g) were recorded in the CCT-control group. Antioxidant activity was highest in the NFT-control group (61.52%). Pearson correlation analysis revealed a positive correlation between total phenolic content and the absorbed iron concentration (r=0.565) in CCT plants. These findings suggest that CCT holds promising potential for iron biofortification. Further research is required to understand plant metabolite responses to elevated iron levels and to optimize cultivation conditions to maximize yield.

Keywords: *mukunuwenna*, nutrient film technique, coconut-coir cultivation, iron biofortification

Development of Biodegradable Nursery Containers Using Corn Waste: An Eco-Friendly Solution for Agriculture Industry

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Abstract

The global environmental crisis necessitates sustainable alternatives in agriculture and horticulture. This study aimed to develop biodegradable nursery containers using agricultural waste materials; corn husk, cob, wasted corn seeds, coir peat, and cow manure. Three formulations (M1, M2, and M3) that prepared to amount in same ratio only changing the ingredients were evaluated for water absorption and holding capacity, seed germination, plant growth (plant height, leaf length, and width), nutrient composition, biodegradability, and moisture content of the final product. M2, containing coir peat, exhibited the highest water holding and absorption capacity. Seed germination was highest in M1 (100%), containing cow manure and corn wastes, compared to M2 (80%) and M3 (90%). Plant growth was superior in M1 (61 mm), followed by M3 (59 mm) and M2 (57 mm). Leaf measurements showed M1 with the highest length (21 mm) and width (5 mm), while M2 and M3 exhibited lengths of 19 mm and widths of 3 and 4 mm, respectively. Nutrient composition analysis of M1 revealed, 0.12±0.06% fat, 0.13±0.41% nitrogen, 34.98±0.06% ash, and a pH of 4.61±0.01, indicating appropriate nutrient levels for plant growth. Moisture content of the final product is shown as 3.07±0.02%. Soil burial tests demonstrated a 40% weight loss, confirming biodegradability. M1, composed of corn husk, corn cob, corn starch, and cow manure in a 1 : 1 : 1 : 1 ratio, consistently outperformed other formulations across all parameters. This study presents an innovative, eco-friendly solution for sustainable agriculture, utilizing agricultural waste to create biodegradable nursery containers with favorable characteristics for plant growth and environmental compatibility.

Keywords: agricultural waste, biodegradable nursery containers, eco-friendly materials, plant growth performance, sustainability

Evaluation of the Potential Utilization of *Pseudomonas* Isolates as Bio Control Agents to Manage Pre- and Post-Harvest Diseases in Selected Up-Country Vegetable and Fruit Crops

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Abstract

Plant pathogens, including bacteria, fungi, viruses, and nematodes, cause major damage and defects in crop plants, resulting in a 27 - 42% global food production loss. When disease management strategies are applied, food production can potentially double. *Botrytis cinerea*, *Alternaria spp*., *Fusarium spp.*, *Xanthomonas campestris* pv. *campestris*, *Erwinia carotovora*, and *Ralstonia solanacearum* are the most significant phytopathogens responsible for the *Botrytis* rot in strawberry, *Alternaria* leaf spot in cabbage, damping off in cabbage nursery, black rot in cabbage, bacterial soft rot in carrot, and bacterial wilt in potato disease, respectively. The inhibitory effect of seven isolates of *Pseudomonas* species were tested under *in vitro* conditions. The dual plate assay method was used to evaluate the antagonistic effect of *Pseudomonas* isolates against the above-mentioned plant pathogens. This assay allowed for the observation of inhibition zones. *Pseudomonas fluorescens* significantly inhibited the growth of *Botrytis cinerea* (40%), *Alternaria spp.* (80%), *Fusarium spp.* (66%), and *Xanthomonas campestris* pv. *campestris* (79%). *Pseudomonas protegens* strain able to control *Botrytis cinerea*, *Fusarium spp.*, and *Xanthomonas campestris* pv. *campestris* significantly. The level of significance was 69, 66, and 70%, respectively. *Pseudomonas cichorif* strain was able to control *Botrytis cinerea* at level of 84%. *Pseudomonas alkanivorans* strain able to significantly control *Xanthomonas campestris* pv *campestris*. The level of significance was 83%. The findings suggest that *P. fluorescens* and other *Pseudomonas* strains could be developed into effective biocontrol agents to reduce crop losses, thus, enhancing agricultural sustainability and productivity.

Keywords: biological control, dual plate assay, phytopathogens, *Pseudomonas* isolates, agriculture and horticultural importance

Application of Light Emitting Diodes (LED) on Water Spinach (*Ipomoea aquatica* Forsk)

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Abstract

Water spinach (*Ipomoea aquatica* Forsk) is a widely consumed leafy vegetable in many parts of the world. The LED technology is explored as a potential solution to extend the shelf life and maintain the quality of leafy vegetables. The objective of the study is to analyze the postharvest storage of the water spinach under different LED wavelengths. Accordingly, the intensity range of 1.69 to 2.83 W/m^2 was selected. The selected storage condition was 15 °C and 80% relative humidity, and the weight reduction, chlorophyll content, and leaf color of the water spinach were recorded for four days. The weight reduction of the leaves was 83.03±0.11, 76.05±2.08, and 80.28±0.86%, for red (1.69±0.07 W/m^2), blue (2.83±0.05 W/m^2), and green (2.02±0.09 W/m^2) LED, respectively. The corresponding chlorophyll change percentages were 33.52±0.72, 51.79±3.84, and 32.84±5.89%. The corresponding color changes (ΔE) values were 10.65±1.65, 08.49±1.71, and 10.98±1.07. According to the results, irradiation with blue LED significantly decreases the weight reduction compared to other methods. Also, blue LED significantly increased the chlorophyll content of the leaves and influenced color changes. In conclusion, continuous exposure to blue LED light effectively delays the senescence and yellowing of water spinach, making LED lighting beneficial for maintaining its postharvest storage quality.

Keywords: chlorophyll content, fresh weight, illumination, *Ipomoea aquatica*, LED

Utilization of Distillery Waste as an Ingredient in Cattle Feed

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Abstract

Distillery spent wash (DSW) are considered as by-products generated during the distillation of alcohol. Beer pulp (BP), toddy spent wash (TSW), and palmyra spent wash (PSW) are examples of DSW. These effluents could be hazardous to the environment and health when dumped into waterways without proper treatment as it contains higher level of organic and inorganic matter. The most effective way to overcome this issue is to use these by-products as an animal feed. BP is already utilized as a cattle feed ingredient in many countries as it is a rich source of nutrients. The nutrient composition of TSW and PSW is not known and the commercial applications also have not been established yet. Thus, a preliminary study was conducted to evaluate the nutrient composition of TSW and tested as a cattle feed ingredient by incorporating TSW in a total mixed ration (TMRt) and undertaking a feeding trial against a TMR prepared incorporating beer pulp (TMRb). Although the nutrient content in TSW is comparable, ether extract, acid detergent fibre, and neutral detergent fibre contents were significantly higher (p<0.05) in BP than that of the TSW. Further, crude protein content (CP) was significantly higher (p<0.05) in the BP (50.0±0.71%) than the TSW (29.3±0.71%). When considering both TMRs, CP content of TMRb (15.6±0.11%) was significantly higher (p<0.05) than TMRt (11.7±0.11%). There was no significant difference in TMRb and TMRt in milk yield, feed intake and milk composition data. However, the milk fat content in TMRt-fed cows (3.92±0.15%) was significantly higher (p<0.05) than TMRb-fed cows (3.06±0.15%). Overall, results indicated that the toddy spent wash can be effectively incorporated into a TMR for cattle feeding, instead of dumped into waterways. Hence, further studies are required before using it at the commercial level.

Keywords: beer pulp, cattle feed, toddy spent wash, total mixed ration

Development of a Rating System to Assess the Sustainability of Farms in Sri Lanka

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Abstract

Agricultural sustainability evaluation is crucial for optimizing resource usage and safeguarding them for future generations. Globally, several rating tools exist to evaluate sustainable agricultural processes. However, Sri Lanka's unique environmental, economic, and social aspects are not addressed by these existing frameworks. While Good Agricultural Practices are established within the Sri Lankan framework, focus mainly on the environment, lacking integration of social and economic aspects. This study aimed to bridge this gap by developing a rating system to assess the sustainability of local farms, including horticulture, plantation, and organic sectors. Literature review and stakeholder perspectives were conducted as primary criteria for the framework. These criteria were then validated for their suitability in the Sri Lankan context through a survey of 34 farm management individuals using purposive and homogeneous sampling. Sub-criteria included national and international industry standards, government legislation, and benchmarks applicable to Sri Lanka. The framework has been validated further through technical committees and the points for each criterion were determined using the Analytical Hierarchy Process (AHP) decision-making method. The practicability of the study was tested by a pilot study. The final rating system contains six criteria with relevant sub-criteria; management, integrated cultivation management, water efficiency, energy efficiency, waste management, and social responsibilities and awareness. According to the AHP results, the weightage of the criteria is as follows: integrated cultivation management (23%), water efficiency (19%), management (17%), waste management (16%), energy efficiency (15%), and social responsibilities and awareness (10%). The pilot study, conducted on an organic farm in Piliyandala, Sri Lanka achieved 65 points out of possible 100. The application of this tool might contribute to better reflecting the sustainable agriculture practices in the sustainability assessments. Multiple pilot studies and regular updates based on new research and industry practices, along with continuous user feedback, will help refine the rating tool over time.

Keywords: sustainable agriculture framework, rating tool, green farm, pilot study

Discovery of a Plant Growth-Promoting *Bacillus subtilis* Strain from the Rhizosphere of the Sri Lankan Traditional Rice Variety *Kuruluthuda* for the use in Sustainable Rice Cultivation

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Abstract

The application of chemical fertilizers to meet the increasing demand of rice (*Oryza sativa* L.) imposes significant negative environmental and health impacts. Biofertilizers containing plant growth-promoting rhizobacteria (PGPR) are a sustainable alternative to chemical fertilizers. Sri Lankan traditional rice varieties are considered to be successful under organic farming conditions. In this research, the bacteria associated with the rhizosphere of Sri Lankan traditional rice were isolated, hypothesizing that these bacteria possess potential plant growth-promoting (PGP) traits to promote rice growth under organic farming. The rhizosphere bacteria were isolated from the Sri Lankan traditional rice variety *kuruluthuda* cultivated without chemical fertilizers for two consecutive cropping seasons. Potential PGPR candidates were identified by *in vitro* and *in vivo* analysis. This study discovers a potential PGPR strain identified as *Bacillus subtilis* using 16S rRNA partial sequence analysis with the aid of phylogeny. *In vitro* screenings proved that this bacterium demonstrates PGP traits, including phosphate solubilization ability (55.092±0.318 mg/L), and the production of indole acetic acid (11.973±0.140 mg/L), and ammonia (9.216±0.587 mg/L). Moreover, the isolated strain exhibited antagonism against the common rice pathogen *Bipolaris oryzae*. *In vivo* screenings using both *kuruluthuda* and commercial BG-352 rice plants further confirmed that the *Bacillus subtilis* strain significantly enhances rice growth ($p<0.05$), as evidenced by increased shoot and root lengths, fresh and dry weights compared to control plants, over a one-month greenhouse trial. These findings indicate that the isolated *Bacillus subtilis* strain holds promise as a biofertilizer, offering eco-friendly alternative to chemical fertilizers for sustainable rice cultivation.

Keywords: traditional rice, plant growth promotion, *Bacillus subtilis*, *kuruluthuda*, biofertilizer

Morphological and Molecular Characterization of C*urvularia*-Associated with *Oryza sativa* (Rice) Seeds from Selected Districts in Sri Lanka

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Abstract

The genus *Curvularia* comprises of phytopathogenic, saprobic, and endophytic fungi associated with poaceous hosts. This study aimed to isolate, characterize, and identify the rice seeds-associated fungi in Sri Lanka based on their molecular and morphological characteristics. Symptomatic rice seed samples were collected from selected locations in Sri Lanka and associated fungal species were isolated. Thirty-one fungi were initially isolated from rice seeds and based on spore morphology, five isolates were initially identified as *Curvularia*. Since *Curvularia* is considered as an emerging pathogen on rice further studies were focused on those isolates. *Curvularia* isolates were initially grouped into two according to their morphological characters. Then isolates were subjected to DNA extraction using sodium dodecyl sulphate protocol and PCR amplification of nuclear ribosomal internal transcribed spacers (ITS) 1 and 2, with 5.8S region followed by purification and bidirectional sanger sequencing. Phylogenetic tree was created to accurately identify the species according to Genealogical Concordance Phylogenetic Species Recognition. The ITS sequence data were used to construct the maximum likelihood phylogeny of *Curvularia* isolates in this study with available ex-type sequence data. According to the constructed phylogenetic tree one isolate (WC1.01) clustered closely to the ex-type of *Curvularia alcornii*, and all other isolates (WG1.01, WG1.02, DA2.02, and ID1.01) were grouped in the *Curvularia geniculata* clade. Both of these species have previously been reported as pathogens on rice. This study highlights the need for routine collection and molecular reassessments of seed-borne fungi in *Oryza sativa* to identify the emerging fungal threats to national food security.

Keywords: *Curvularia*, morphology, phylogeny, phytopathogenic, poaceous hosts

Designing an Automated Siphon System for Ornamental Fish Tanks that Enhances Water Quality and Maintenance by Siphoning Based on pH Levels

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Abstract

Aquaculture is a fast-growing industry as it provides relatively cheap protein sources and attractive fish and plant species for the ornamental fish industry. Intensive indoor aquaculture systems are practiced to fulfil high demand and maximize the use of water and land spaces as well. Considerable amount of expenditure in the industry is used on labors for feeding, tank cleaning, water replenishment, water quality checking etc. Further, aquaculture production is considerably decreased due to poor water quality. Therefore, a smart aquaculture system to clean fish tanks (siphon) and replenish water according to pH level has been proposed in this study. The system employed an Arduino Mega 2560 board as the core unit and integrated digital sensors for monitoring water quality parameters, including pH, temperature, and dissolved oxygen. The experimental setup consisted of two tanks; the experimental tank and the rest tank, serving as a control. Both tanks have the same dimensions (75 cm × 30 cm × 30 cm). Five pairs of platy (*Xiphophorus maculatus*) fish were used for each tank. Their preferred pH range 6.8 to 8.5 was set as the optimum pH range. The system was tested for two- and three-days siphon intervals. pH, temperature, and dissolved oxygen was recorded at every 6 hours of the day for ten days. The sonar sensor monitored water levels, while a digital pH sensor provided real time pH data from the tank. The system incorporates a siphon arm along the tank's length, removing sediments below the water surface up to 30%. Following sediment removal, the replenishment process commences. Results indicated that the experimental tank maintains water quality at optimal levels (pH: 6.8 - 8.5, dissolved oxygen: 6 - 8 mg/l, and temperature: 30±3 °C) compared to the rest tank in various occasions. Therefore, the system can be considered as a good replacement for manual siphoning. Overall, the developed smart aquaculture system exhibits its effectiveness in achieving efficient and sustainable aquaculture practices.

Keywords: aquaculture, Arduino technology, ornamental fish, smart aquaculture, water quality

Optimization of Surface Sterilization and Shoot Induction Protocol for *in vitro* Propagation of Bamboo (*Bambusa textilis* var. *Gracilis*)

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Abstract

Bamboo plants are considered the 'green gold' of plants, due to their numerous benefits, making them highly valuable. Therefore, tissue culture is viable for mass production to meet market demands and conserve bamboo resources. Bamboo tissue culture techniques face significant challenges such as contamination and browning of cultures. Thus, this study was conducted to develop an effective surface sterilization protocol and to enhance the shoot induction of *Bambusa textilis* var. *gracilis*. Nodal segments were collected and sterilized using three surface sterilization protocols; surface sterilants alone (T_1), surface sterilants with 500 mg/L sodium dichloroisocyanurate (T_2), and surface sterilants + vacuuming with 0.1% $HgCl_2$ (T_3). The contamination rate and survival rates were calculated. Further, growth performances of nodal segments were observed under four treatments; T_1 - MS medium without hormones (control group), T_2 - MS medium + 2 mg/L BAP, T_3 - MS medium without hormones + 550 mg/L NH_4NO_3, and T_4 - MS medium + 2 mg/L BAP + 550 mg/L NH_4NO_3, with five replicates. Growth performances were measured at weekly intervals over four months. According to the results, the lowest contamination rate (20%) and the highest survival rate (80%) were observed in surface sterilants combined with 0.1% $HgCl_2$ vacuuming. Regarding growth performances, the nodal segments in T_4 produced the highest number of shoots (16) and plantlet height (5.5±0.4 cm). In contrast, the lowest number of shoots (3) and plantlet height (3.1±0.2 cm) were observed in the control group (T_1) four months after establishment. Therefore, this study concluded that surface sterilants combined with vacuuming with 0.1% $HgCl_2$ effectively reduce contamination in bamboo tissue cultures. The shoot induction is significantly accelerated by supplementing the MS medium with 2 mg/L BAP and 550 mg/L NH_4NO_3, compared to the other tested treatments.

Keywords: *Bambusa textilis* var. *gracilis*, micropropagation of bamboo, surface sterilization, shoot induction

Comparative Analysis of Two Promising Accessions of *Phaseolus vulgaris* (Common Bean): Morphological, Growth, Nutritional, and Postharvest Quality Characteristics

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Abstract

Two common bean accessions, CP-3 and CP-4 were recently introduced by the Horticultural Crop Research and Development Institute at Gannoruwa, Sri Lanka. This study compared morphological characters, postharvest quality, and easily accessible nutritional properties of these bean accessions, harvested at three maturity stages; 10, 11, and 12 days from medium flower bud stage. Morphological characters in flowers, leaves, and seeds were similar in both accessions while, CP-3 pods exhibited significantly greater ($P \leq 0.05$) length (16.3 cm) and perimeter (31.9 mm) compared to those in CP-4 (15.6 and 30.5 mm, respectively). The effects of harvesting maturity on total soluble solids (TSS), titratable acidity (TA), and pod snapping quality were analyzed. A significant increase in TSS, TA, and a reduction in snapping quality was observed with advancing pod maturity in both accessions. Pod fresh weight was measured daily to calculate the percentage weight loss. Shelf life was determined by considering days taken to change the pod color from green to yellow, the percentage freshness reduction from 100 to 85%, and the percentage disease development from 0 to 10% of area. Pod color change was the key shelf life-determining factor for both accessions, with shelf life and percentage weight loss significantly decreasing as maturity increased. The longest shelf life for both accessions were recorded at maturity stage 10. Shelf life was similar for both accessions. Higher crude protein contents were recorded in maturity stage 10 and the crude fiber contents were recorded in maturity stage 12, for both accessions. CP-4 had a considerably greater crude fiber content at all three maturity stages while a greater crude protein level was recorded in the maturity stage 10 of CP-4. CP-3 accession showed significantly higher pod size. This information is important in the variety releasing protocol.

Keywords: crude protein, crude fiber, pod color, shelf life, variety releasing

Use of Electric Fence to Protect Coconut Plantations from Terrestrial Animals

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Abstract

Coconut plantations face significant threats and losses from various animals, including wild boar, porcupines, monkeys, and squirrels. Traditional mitigation methods such as traps, snares, chemical deterrents, and physical barriers have limited effectiveness while electric fencing has shown some effectiveness. A telephone-based questionnaire survey was conducted among 27 conveniently selected coconut farmers who use such electric fences. These respondents were from Polonnaruwa (n=11), Anuradhapura (n=6), Colombo (n=3), Kurunegala (n=3), Gampaha (n=1), Kaluthara (n=1), Rathnapura (n=1), and Badulla (n=1) districts , each owned 0.5 to 10 acres who had installed electric fences around their entire properties between 2009 and 2024, which also included fruits (bananas, pomegranate, papaya pineapple, mangoes, and guavas) cashew, vegetable, pepper, and lime. Prior to electric fence installation, they reported animal damage, occurring almost daily which was absent afterwards although some modified their fences to deter smaller animals like porcupines and wild boar. All respondents reported reduced crop damage caused by wild boar, porcupine, cattle, and deer due to these modifications. Additionally, the electric fence decreased incidences of theft. Eighteen respondents (66.7%) operated their fences 24 hours a day, while the remainder functioned only at night. The average initial cost for installation per acre was Rs. 72,768.75. Fence malfunctions were quickly addressed either by the installation company or by the landowners themselves. Despite the high initial investment cost, electric fence has low-maintenance cost and is a highly effective solution especially during the initial growing face of the plantation. During this time, there is no income, but any damage to young plants could potentially impact the prospective production. Therefore, the electric fence provides is a sustainable, less labor-intensive approach compared to traditional methods at times with added extra wires at ground level to enhance its effectiveness.

Keywords: coconut, electric fence, terrestrial, animals

Development of Eco-Friendly Growing Media Pellets for Urban Gardening Using Recycled Drinking Water Treatment Sludge

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Abstract

Drinking water treatment sludge (DWTP) is the solid or semisolid-like by-product produced mainly during the sedimentation process in the water purification process. The sludge is commonly content with nutrients and organic matter and it has the potential to be used as a growing media. This study aims to introduce the growing media (pellets) from the DWTP for urban gardens. The present study was conducted with, 7 types of pellets used with commercial pellet (T0) as a control treatment, and the rest were prepared using a mixture of water treatment sludge, coir dust, coir fiber, and active charcoal (T1-coir dust and water treatment sludge, T2-coir fiber and water treatment sludge, T3 and T4-active charcoal and water treatment sludge, T5-coir dust, active charcoal, and water treatment sludge, T6-coir dust, coir fiber, active charcoal, and water treatment sludge) with different ratio based on the weight, then mixed with water properly and compress it and made as a pellet. The most preferable pellet was identified by using the plant growth performance of the chili (*Capsicum annum* MI-2) and the best mean results were recorded in the T5 pellet as plant height of 7.2 cm, number of leaves of 7, length of the leaves of 3.9 cm, and length of the root 6.8 cm at the 28 days after sowing. Meanwhile, other tested pellets also showed good performance and among them, the T1 pellet showed the same performance as the commercial product. Based on the results of this study, the T1 pellet shows the same characteristics as the commercial product and the T5 pellet shows better performance than the commercial product with cost effectiveness than the commercial product. The chemical and physical characteristics recorded were below the recommended level in the soil, therefore, it can be used for agricultural purposes. Thus, those pellets have to be used as a sustainable sludge management strategy.

Keywords: alum sludge, growing media, growing pellets, sustainable sludge management, water treatment sludge

Development of a Cost Effective Boar Semen Extender Using Egg Yolk

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Abstract

A semen extender also known as semen diluent, is a substrate used to preserve and extend the viability of spermatozoa outside the female reproductive system. In the swine breeding industry of Sri Lanka, one of the main constraints is the high cost of the imported semen extenders. The objective of the study was to develop a cost effective boar extender using egg yolk for chilled semen production while maintaining a high motility rate of sperms in order to support the livestock farmers with a Sri Lankan manufactured extender. The experiment was conducted using six groups; one control (commercial extender) and five treatments that contained different ratios of buffer and egg yolk (T1: 70 : 30, T2: 75 : 25, T3: 80 : 20, T4: 85 : 15, and T5: 90 : 10). The key parameters measured were motility rate, pH, electrical conductivity (EC), and mortality rate. Sperm cells were counted at three different time periods; 6, 24, and 48 hours, using the hemocytometer. The T3 exhibited ($P<0.05$) a higher motility rate (77.25±2.59% for 6 hour chilled semen) compared among all experimental groups and was comparable to the 24 hour control values. The pH level of T3 remained similar to the control even at 48 hours ($P>0.05$), indicating its eligibility for insemination. However, all treatments showed a reduced EC throughout the 48 hour time period, while the control had the highest values. The overall cost for the egg yolk-based extender was Rs. 1,160.85, while the commercial product was sold for Rs. 2,000.00 per 100 mL sachet. The egg yolk-based extender is an affordable choice than the commercial (Duragen) extender, however with a limited active period of the sperms. Thus, the study suggests use of egg yolk-based extender with buffer to egg yolk ratio of 80 : 20 in field trials in order to elucidate its actual potential of usage in swine farm-based communities to enhance usage of an affordable local boar extender.

Keywords: artificial insemination, egg yolk-based extender, motility rates, boar semen, livestock farm

A Study to Determine Usage of Waste Whey in Making CO-3-Whey Silage in Sri Lanka

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Abstract

Whey silage is an innovative product that produces silage using whey, a by-product of cheese production. Most milk processing plants discharge liquid cheese whey as an untreated waste after cheese production, a waste rich in lactose, protein, fat, vitamin, and minerals. The present study investigates the potential of incorporating waste liquid cheese whey as an additive in producing CO-3-whey silage and evaluating different whey percentages in making CO-3-whey silage. Forage samples were collected from a single paddock during the early bloom stage, while untreated waste whey was obtained from a milk processing plant at Animal Husbandry Training Center, Kotadeniyawa, Sri Lanka. The experiment was conducted using four silage samples with three different treatments as 2, 5, and 10% whey, and control (without whey inclusion) with five replicates per treatment. Physical parameters such as color, texture, and odor, along with chemical composition including percentage of dry matter, ash, crude protein, and fiber content, were assessed. Palatability was measured by the feed intake/head/day/treatment by using randomized complete block design. The addition of liquid cheese whey up to 100 g/kg to shade-dried forage (10% whey treatment) had positive effects on silage quality, by increased crude protein and ash content and decreased pH level. Further, 10% whey silage exhibited the highest palatability. It boosted a fruity-pleasant aroma, an olive-green color, and a mold-free, firm texture. These findings suggest that liquid cheese whey can be effectively utilized as an additive in CO-3-whey silage production and the 10% whey-treated sample emerged as particularly promising and offering benefits such as improved nutrient composition and palatability.

Keywords: CO-3 silage**,** liquid cheese, sustainable waste, whey, whey silage

Advances in Hyperspectral and Multispectral Imaging for Rice Disease Identification: A Systematic Review

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Abstract

Rice diseases are one of the biggest threats to rice farming across the world since they affect the yield and productivity of the crops. The conventional techniques used in identifying diseases include the visual inspection or laboratory testing and these are usually cumbersome, time-intensive and personnel sensitive. In contrast, multispectral and hyperspectral imaging techniques could be more effective and practicable for the identification of rice diseases. The focus of this review is to evaluate the literature on the use of these new imaging techniques in diagnosing diseases that affect rice paddies. A systematic literature review was carried out on Google Scholar, PubMed, and Web of Science to find articles published between 2014 and 2024. From the literature search, 21 relevant papers were identified that aimed at the use of hyperspectral and multispectral imaging for the detection of rice diseases. These studies were systematically reviewed to assess the effectiveness of the various imaging technologies in the identification of the common rice diseases such as blast disease, sheath blight, and bacterial leaf blight. The review also showed that hyperspectral imaging gives better accuracy and sensitivity in identifying rice diseases compared to multispectral imaging. The advancements in machine learning, particularly deep learning, have further propelled the capabilities of hyperspectral imaging in agricultural applications. Nevertheless, this study also reveals that multispectral imaging holds great promise for fast diagnosis and tracking of diseases with non-invasive methods. A limitation of this study is reliance on published literature. Additionally, the reviewed studies may not fully represent variability and challenges in real-world application. Further studies should aim to improve the reliability and applicability of these imaging methods for application in actual farming conditions. Also should focus on optimizing these technologies for real time applications in the field. Further developments in hyperspectral and multispectral imaging could potentially enhance disease identification and control for rice crops; however, more research is needed for these methods to be incorporated into practical agriculture.

Keywords: disease detection, hyperspectral imaging, multispectral imaging, precision agriculture, remote sensing, rice diseases

Analysis of Live Weight Gain in Red Madras Crossbred Sheep by Feeding a Total Mixed Ration as a Night Feed

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Abstract

Rearing Red Madras crossbred sheep has become a major challenge for the Fodder Resource and Investigation Center presently as the animals do not gain the expected weight for their age. The center's overall productivity and profitability are negatively impacted by this problem. Improving the financial status and sustainability of their sheep rearing operations depend on unveiling a solution to this issue. Over a period of eight weeks, this study examined the effects of feeding Red Madras crossbred sheep a total mixed ration (TMR) as a night feed on their live weight gain and physical characteristics. The study, which took place at the Fodder Resource and Investigation Center in Dombawinna, Kotadeniyawa, Sri Lanka involved eight weaned male lambs which were randomized into two groups: the control group (T1) and the treatment group (T2), with four animals in each group. While the control group was exposed only for grazing, the treatment group received the TMR supplementation. Each animal was fed with 750 g of CO-3 grass and 250 g of concentrate under the TMR supplementation. The testicular measurements were taken at the end of the study, whilst weekly measurements of body weight, height, length, girth, and abdomen circumference were also recorded. Compared to the control group, 2-fold increase in live weight gain ($P<0.05$) was observed in the treatment group in the sixth week compared to the first week of the control. In addition, there were significant improvements in the physical characteristics of the treatment group, including height ($P<0.05$), girth circumference ($P<0.05$), and abdomen circumference ($P<0.05$). However, there were no significant differences between the testicle or body lengths between the two groups at the end of the eighth week. These results highlighted the effectiveness of TMR night feeding in promoting live weight gain and improving specific physical traits in Red Madras crossbred sheep, thus providing valuable insights for animal husbandry practices aimed at improving sheep growth and early attainment of puberty.

Keywords: total mixed ration, night feeding, Red Madras crossbred sheep, weight gain, physical traits, livestock management

The Mitigation Strategies for Adverse Weather Conditions on Tea Cultivation in Sri Lanka

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Abstract

Tea (*Camellia sinensis* (L.) Kuntze), one of Sri Lanka's most economically important crops, faces frequent challenges due to adverse weather. In the present study, the mitigation strategies for adverse weather conditions on tea cultivation, which belongs to the low country wet zone, were evaluated to identify the particular adverse weather conditions' effects and to determine the mitigation strategies employing a mixed method. Quantitative data about soil parameters, climate data, tea harvest, and fertilizer application information were collected over 6 months. Qualitative data gathered for mitigation methods were analyzed through 823 interviews with tea industry stakeholders. Correlation analyses were performed on relationships among soil parameters, climate variables, and tea harvest. Warmer temperatures (around 27.2 to 29.4 °C) have led to a higher tea yield of 149 kg per week per acre. Extremely high temperatures (above 29.6 up to 34 °C) negatively impact harvest, indicating a weak, negative linear relationship between the average temperature and tea harvest. Excessive rainfall (above 71.8 mm) and low rainfall (below 39 mm) negatively impact tea production. During low rainfall, soil moisture deficits occur, affecting the tea bushes, which thrive in high-humidity conditions. A moderate humidity range (around 70 - 85%) is associated with a wide range of tea harvests while humidity plays a role, but it is not the sole determinant of harvest, even at lower humidity levels, plants produce a moderate harvest. Prolonged dry season leads to reduced phosphorus uptake, impacting tea harvest. Higher soil phosphate levels retained during one month resulted in the mitigation of the low crop yield. Even if temperature increases and relatively low rainfall with higher soil phosphate levels, it does not have adverse effects on tea harvest for a limited period. Shade trees for seasonal drought and organic matter uses or mulching for excessively high rainy seasons are essential to maximize tea harvest.

Keywords: tea cultivation, adverse weather, phosphate level, harvest

Hydration Stability of Urea Nanococrystals as a Sustained Nitrogen Source in Agriculture

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Abstract

Knowledge of the stability of novel fertilizer formulations against relative humidity (RH) is essential for their successful adoption as agrochemical products. The growing demand for sustainable agriculture has driven the development of innovative fertilizer systems such as urea-based nanococrystals, engineered for controlled nitrogen release. This study investigates the hydration stability of urea-based nanococrystals under different RH to assess their potential as a sustainable nitrogen source. Urea-based nanococrystals were synthesized via mechanochemical grinding using vibratory mixer mill and liquid assisted grinding method and confirmed their formation using powder X-ray diffraction and differential scanning calorimetry. The hydration stability was tested across varying RH conditions (30, 72, 84, and 97%) over time intervals ranging from 3 hours to 2 months. Their structural stability at above RHs were assessed by characterization using Fourier transform infrared spectroscopy (FTIR) with particular focus on the O-H and C=O stretching vibrations to detect molecular interactions and structural changes. Results showed that at low humidity (RH 30%), the nanococrystals maintained structural integrity with minimal changes in FTIR spectra, indicating high resilience to moisture. At high humidity levels (RH 72, 84, and 97%) significant changes in peak intensities and shifts in regions associated with O-H and C=O stretching vibrations suggested molecular interactions and potential structural alterations. These findings showed urea-based nanococrystals exhibit long term efficacy in releasing nitrogen in controlled agricultural environments, but extended exposure to high humidity may cause structural alterations.

Keywords: hydration stability, nanococrystals, solubility, sustained release, urea

Evaluation of Seed Germination Performance in Robusta Coffee (*Coffea canephora*) with Different Seed Treatments

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Abstract

Robusta coffee (*Coffea canephora*) is a high value cash crop largely cultivated in tropical regions throughout the world. In commercial scale, new plant production is mainly done by seed germination. A nursery experiment using Robusta coffee mature berries was conducted to observe the effect of different seed treatments for shortening the germination time period. Coffee seeds/berries harvested from a single Robusta plant were planted in three replications in sand nurseries inside a 60% shade net house according to the experimental design of complete randomized design. Each replicate was consisted of 30 seeds/berries. Treatments were planting of the whole coffee berry, seeds with parchment, seeds without parchment, seeds with parchment soaked for 24 and 48 hours in water and seeds without parchment soaked for 24 and 48 hours in water. Coffee seeds planted without parchment has a significant effect to reduce the germination period. Seeds planted without parchment have initiated germination within 18 days and 80% of seeds were germinated within 40 days. The longest time period to initiate germination was observed in planting of the whole coffee berry. It took 92 days to reach 80% germination. Soaking the seeds in water also has shown significant differences compared to planting the whole berry and planting of seeds with parchment which is the most common practice of farmers. The study revealed that removing of the parchment significantly reduces the germination time in Robusta coffee seed nurseries. Since removing of the parchment is time and labour consuming, soaking of seeds for 24 hours in water is suitable for large scale plantings. Based on the result revealed by the study farmers can schedule the field preparation and field planting.

Keywords: *Coffea canephora*, mature berries, seed germination, seed treatments

Evaluating Different Trellising Designs for Heavy Fruit Bearing Cucurbits

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Abstract

Developments of vertical living structures have progressed creatively according to the requirements of the users. In urban agricultural areas, heavy fruit bearing, creeping-type cucurbit cultivation is difficult due to space limitations. Hence, this study was conducted with the objective of identifying proper trellises for cucumber, watermelon and pumpkin that can be utilized in urban settings. This experiment was conducted at Center for Sustainable Agriculture Research and Development, Makandura, Gonawila, Sri Lanka, which belongs to the low country intermediate zone (IL1a). Three trellising methods were subjected to the experiment, namely the net weaving method, the column planting cubical method, and the normal trellising method, while the conventional ground planting method was used as the control. Pumpkin, watermelon, and cucumber, were used to evaluate the impact of treatments. Crops were established, and all the agronomic practices were carried out according to the recommendations of the Department of Agriculture. Number of leaves, number of tendrils, length of tendrils, and chlorophyll contents were recorded as vegetative data, while the weight of fruits (kg) was measured as a quantitative yield parameter at harvesting. The collected data were subjected to analysis of variance. The results denoted no significant difference ($P<0.05$) for number of leaves, number of tendrils, length of tendrils, and chlorophyll content. Regarding the yield data, it denoted no significant difference ($P<0.05$) for the yield parameter as well, while the net viewing method denoted the highest mean value for yield for cucumber (27 kg/trellis) and watermelon (9 kg/trellis) while cubical methods denoted the highest yield data for pumpkin (8.7 kg/trellis). However, for all the recorded parameters, the lowest mean values were observed in the control treatment. The results suggested that all three trellising techniques tested in this experiment can be successfully used in urban agriculture to obtain a good yield by effectively utilizing natural resources such as water and light while overcoming space limitations.

Keywords: cucumber, pumpkin, trellis, urban agriculture, watermelon

Evaluation of Alternative Potting Mixture for Black Pepper (*Piper nigrum* L.)

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Abstract

The cultivation of black pepper (*Piper nigrum* L.) requires optimal potting mixtures for the healthy growth and maximized yield. Conventional propagation practice of black pepper (*Dingirala*); the planting of nodal cuttings on a medium containing equal parts of top soil, well-decomposed cow dung, river sand, and coir dust has become problematic due to the scarcity and high cost of cow dung. Therefore, this study was carried out to evaluate the inorganic fertilizer as an alternative to cow dung on the growth of black pepper at the nursery stage. The experiment was laid out in a randomized complete block design with 3 treatments and 3 replicates (40 cuttings per replicate). The tested potting mixtures were T1 (control) - top soil : sand : coir dust : cow dung = 1 : 1 : 1 : 1, T2 - top soil : sand : coir dust = 2 : 1 : 1 which was treated with a rate of 1 g/pot of nitrogen (N) fertilizer (urea), and T3 - top soil : sand : coir dust = 2 : 1 : 1 which was treated with a rate of 1 g/pot of compound fertilizer (NPK 21 : 7 : 14). All treatments were replicated thrice. Shoot length, number of leaves, number of nodes, root volume, and fresh weights of shoots and roots from cut ends were measured 3 months later. The results showed that while T1 (with cow dung) promoted superior ($p<0.05$) shoot growth, as indicated by higher shoot length (54.29 cm) and shoot weight (15.35 g), there was no significant difference in the number of leaves or nodes across treatments. Notably, T2 (with nitrogen fertilizer) and T3 (with NPK) demonstrated comparable results for root weight and volume, with T3 exhibiting slightly better root development. These findings suggest that nitrogen fertilizer, when used in combination with other soil components, can substitute cow dung without significantly impairing plant growth. This study provides evidence that using nitrogen fertilizer as a cost-effective alternative to cow dung can sustain the early growth of black pepper cuttings, contributing to more efficient and economically viable nursery practices.

Keywords: black pepper, potting mixture, nitrogen fertilizer, compound fertilizer

Optimization of *Azolla* Cultivation for Biofertilizer Formulation

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Abstract

The growing population's demand for higher crop yields has led to increased chemical fertilizer use, resulting in soil nutrient depletion and nitrogen pollution. This study explores *Azolla*, a small aquatic fern, as a potential liquid biofertilizer. It forms a symbiotic relationship with the nitrogen-fixing cyanobacterium *Anabaena azollae*, enabling significant increase in the occurrence of nitrogen fixation. *Azolla* can double its biomass in 3 to 5 days, enhancing soil fertility and boosting crop yields. *Azolla* was cultivated in plastic containers (707 cm^2 area) with plant density of 20 g/cm^2. Water depths for cultivation varied at depths of 4, 6, 8, and 10 cm. Four different light intensities that affect cultivation were measured by covering the containers with 30, 50, and 70% shading nets. Exposure to 100% sunlight intensity was given by without covering the containers. The pH of the medium varied at 5, 6, 7, 8, and 9. Growth was measured in terms of fresh mass, dry mass, relative growth rate, doubling time, and nitrogen concentration to find out the best growth conditions for *Azolla*. A 7-day optimization period was followed by a 15-day growth analysis under optimum conditions. Nitrogen content was determined by Biuret analysis and data obtained were statistically analyzed. Optimal water depth, sunlight intensity, and pH for *Azolla* cultivation were 4 cm, 100%, and 6, respectively. Nitrogen content had linear increment with fresh weight, while relative growth rate was negatively correlated with doubling time. These results support the use of *Azolla* as a biofertilizer in the tropical environment through efficient nitrogen fixation and rapid biomass accumulation. Optimization of environmental factors is recommended for the maximum production of *Azolla* biomass. In conclusion, this study has confirmed the potentiality of *Azolla* as a sustainable biofertilizer to enhance agricultural productivity.

Keywords: *Azolla* cultivation, biofertilizer formulation, nitrogen fixation, optimization, agricultural productivity

Evaluation of Local Ginger (*Zingiber officinale* Roscoe) Accessions under Coconut Cultivation in Low Country Intermediate Zone of Sri Lanka

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Abstract

Chinese, Rangoon, and local are the 3 types of ginger (*Zingiber officinale* Roscoe) grown in Sri Lanka. Local ginger is high in pungency, used in indigenous medicine, beverage industry, and culinary purposes. Local ginger is comparatively tolerant to some diseases. Kurunegala, Gampaha, Kandy, Badulla, and Rathnapura were the major growing districts of ginger. Ginger is imported, in every year by spending of large amount of foreign currency. Climatic and soil conditions in Kurunegala district are more favorable for ginger cultivation. There is a huge potential to cultivate ginger in Kurunegala district as a monocrop or intercrop under coconut plants. Coconut palms are generally spaced 8 m × 8 m resulting in 75% of area remaining unproductive. Therefore, coconut based intercropping farming systems is important to increase the productivity of the land. Objectives of this study were identification of morphological variations among local ginger accessions and identification of high yielding local ginger accessions for low country intermediate zone under coconut cultivation. Collected 21 accessions from farmers' fields, were evaluated at three consequent years, at the Intercropping and Betel Research Station, Department of Export Agriculture, Dampelessa, Narammala, Sri Lanka, that is situated in low country intermediate zone, by practicing of randomized complete block design with three replicates. Mean separation for collected morphological and yield data were done by using statistical analyzing software package. Among the evaluated accessions, G31 local ginger accession had the most predominant morphological characters. After the three-year field experiment, the highest fresh yield of rhizome per clump for local ginger accessions was given by the accession of G26 (624.47 g/clump). The second highest yield was given by accession of G16 (523.17 g/clump). A wide yield variation was observed. This may be due to the genetic variations among the accessions. The G26 accession can be used to cultivate under coconut plants as an intercrop to increase the productivity of coconut lands.

Keywords: : local ginger accessions, coconut plants, low country intermediate zone

Artificial Intelligence and Data Science

Wind and Solar PV Generation Forecasting Methods Based on Weather Data

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Abstract

In the Maruthankerny region, where energy demand is high but power generation capacity from traditional sources is limited, the unpredictable, weather dependent nature of solar and wind energy strains limited power generation capacity, challenging real time supply demand balance. This variability complicates scheduling, dispatch, and grid stability, risking frequency and voltage issues. Insufficient storage further hampers flexibility, causing energy loss during peaks and shortages during low generation. Accurate forecasting of renewable energy sources like wind and solar power becomes crucial. This study explores two distinct forecasting methods: Gaussian process regression (GPR) for solar energy and stepwise linear regression for wind energy. For solar energy forecasting, GPR achieved an root mean squared error (RMSE) of 0.82059, R-squared of 0.26, mean square error (MSE) of 0.67336, and mean absolute error (MAE) of 0.64445. These metrics indicate that GPR can reasonably capture patterns in solar energy production, albeit with some limitations in accuracy. Conversely, wind energy forecasting using stepwise linear regression resulted in an RMSE of 0.55209, R-squared of 0.02, MSE of 0.3048 and MAE of 0.40409. Despite providing point predictions, this method struggles to model the variability inherent in wind energy generation. The integration of solar PV and wind power poses additional challenges due to their reliance on environmental conditions and different output types are DC for solar, AC for wind, necessitating effective DC to AC conversion for grid integration. The choice of GPR for solar forecasting was driven by its ability to model complex relationships and quantify uncertainties, facilitated through MATLAB. In contrast, stepwise linear regression was selected for wind forecasting due to its simplicity and interpretability in understanding how variables like wind speed and humidity influence power generation. Wind and solar power generation suit Maruthankerny well, with sunlight from February to September and wind from September to February, balancing demand. Recommendations based on this study advocate for the adoption of these methods in region of Maruthankerny.

Keywords: intermittency, fluctuation, wind, solar, forecasting

Deep tRF-Net: A Deep Learning Approach for Multi Class Cancer Classification Using tRNA Derived Fragments Expression Patterns

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Abstract

The identification of tRNA derived fragments (tRFs) as a unique class of short noncoding RNAs (sncRNAs) has garnered a great deal of attention in last decades, especially because of its correlation with different types of cancer. Tumor samples from a variety of cancer types have consistently shown dysregulated expression of tRFs, which is defined as either upregulated or downregulated compared to normal samples. Our goal is to present a deep learning algorithm that can recognize dysregulated patterns of tRF expressions and use these patterns to precisely categorize various cancer types. In this study, we leverage convolutional neural networks (CNNs) to analyze tRF expression profiles across 32 distinct cancer types, encompassing a total of 10,572 samples. It's challenging to come up with a more accurate and sophisticated model architecture due to the complexity of the dataset. CNN provides inherent capability to process high dimensional data, equipped with the ability to automatically learn and extract hierarchical features and provides a form of spatial invariance. However, our approach highlights tRF expression patterns' potential as a robust diagnostic tool by accurately classifying (up to 70% accuracy) 32 different cancer types. This method is related to molecular and genetic type cancer diagnosis, which distinguishes it from existing methods such as imaging techniques, biopsy procedures, etc. and this uses tRFs which is a novel approach for cancer prediction. The findings underscore the promise of tRFs as biomarkers, paving the way for advancements in cancer research and clinical practice. Further, these results demonstrate the possibility of dysregulated tRF expressions as biomarkers, providing a viable path for cancer early diagnosis.

Keywords: tRNA derived fragments, deep learning, convolutional neural networks, cancer type prediction

Deep Learning Based Sentiment Analysis of Public Opinion Mining on Sri Lankan Government by Extracting Facebook Comments

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Abstract

In recent times, sentiment analysis on public opinion has become an important tool for understanding public perception. Facebook comments are a rich source of real time information because they reflect diverse opinions and emotions from a wide user base. Traditional surveys on government policies are costly, time intensive, and may fail to capture the full spectrum of public opinion due to limited sample sizes. To address this limitation, the study aims to analyze public sentiment on Sri Lankan government policies by extracting Facebook comments. The findings of this study can help government policymakers become more attuned to citizens' needs in policy making. To achieve this, an initial 7,500 comments were gathered using Facepager, a tool that provides access to the Facebook API. After extraction, the comments were preprocessed, resulting in a dataset of 5,396 comments. The comments were classified into three classes: positive, negative, and neutral. Sentiments were then analyzed using VADER and RoBERTa natural language processing (NLP) models, which were chosen for their popularity and suitability. The accuracy of the VADER model was 57.03%, while that of the RoBERTa model was 77.65%. Results revealed that the RoBERTa model performed better than VADER. Subsequently, a custom BERT model was trained for the same dataset to achieve higher accuracy. The trained BERT model achieved an overall accuracy of 87.64% after five epochs, indicating its effectiveness in capturing the sentiments. Sentiment analysis with the custom trained BERT model revealed a majority of negative sentiments. Out of 5,396 analyzed comments, the model predicted 2,490 as negative, 1,723 as positive, and 1,183 as neutral, indicating public dissatisfaction with the Sri Lankan government policies. To address this, the government should take necessary actions to reassess policies based on public feedback and implement regular sentiment monitoring to better align with public expectations.

Keywords: sentiment analysis, NLP, VADER, RoBERTa, BERT

Mitigating Catastrophic Forgetting in Convolutional Neural Networks through a Systematic Analysis of the Dropout Layer

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Abstract

Finding a machine learning model that trains flawlessly requires retaining prior knowledge. Forgetting previously learned information is an intrinsic issue in neural networks, which is known as catastrophic forgetting. This research aims to mitigate catastrophic forgetting in neural networks, particularly convolutional neural networks, by adding a dropout layer, a mechanism that can be generalized to other neural networks. Regularizing the training process is one of the effective ways to mitigate catastrophic forgetting. Suppose that in a neural network, a specific neuron (i) has been trained to identify a pattern (p), while the other neurons do not contribute to identifying (p). In such a case, if we retrain the neural network and neuron (i) is trained to identify a new pattern (q), the network will no longer be able to recognize pattern (p), as the only neuron capable of identifying (p) is now assigned to a different task. Therefore, overfitted neurons like (i) contribute to catastrophic forgetting. To mitigate this, pattern recognition should be distributed across multiple neurons. One such technique for distributing learning is dropout, which prevents specific neurons in a neural network from being trained to identify certain patterns. However, dropping out all the neurons is not an effective training approach. Identifying the best possible dropping out percentage without affecting the training process is crucial. This research analyses the impact of dropout rates on catastrophic forgetting in convolutional neural networks, with dropout percentages ranging from 0 to 0.9%. The results demonstrate when dropout rates are minimal, such as 0.0001, 0.001, 0.005, or 0.01 the accuracy and overall performance of the neural networks remain within an optimal range. Additionally, precision, recall, and F measure values are maintained at effective levels compared to the architectures without dropout layers. These findings suggest that lower dropout rates may effectively mitigate catastrophic forgetting while preserving model performance.

Keywords: catastrophic forgetting, convolutional neural network, dropout layer, machine learning

Deep Learning Based Human Nail Disease Recognition System

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Abstract

Nail diseases are conditions that alter the appearance and function of nails, often serving as indicators of underlying health issues. Common nail problems include acral lentiginous melanoma, Beau's line, nail clubbing, and nail pitting. Early detection is crucial as it helps prevent complications and improves quality of life. This study presents a novel approach for classifying and detecting human nail diseases using advanced You Only Look Once (YOLO) models, specifically YOLOv5 and YOLOv8. The goal is to develop a robust, automated system that accurately identifies and classifies four types of nail diseases with healthy nails, enhancing diagnostic accuracy and efficiency. A total of 4,983 images of nail diseases were labelled and preprocessed using the Roboflow software tool. The YOLOv5 and YOLOv8 models were then trained to recognize the unique patterns characteristic of each condition. Model evaluation metrics included the F1 score, which represents the balance between precision and recall, and mean average precision (mAP), which measures the average precision across different detection thresholds. YOLOv5 achieved an F1 score of 88.3% and a mAP of 87.5%, while YOLOv8 outperformed it with an F1 score of 92.7% and a mAP of 90.9%. These results indicate high classification accuracy and effectiveness in disease identification. The system's strong classification performance offers a promising tool for dermatologists and healthcare professionals, enabling efficient and accurate identification of nail diseases.

Keywords: deep learning, detection, nail diseases, recognition, Roboflow

Stacking Machine Learning Model for Bus Dwell Time Prediction with Low Sampling Rate GPS Trajectory Data

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Abstract

A significant proportion of bus travel time is aggregated by the dwell time at the bus stops for passenger boarding and dropping, especially in urban areas with frequent stops. A more accurate prediction of bus dwell time (BDT) can enhance the reliability of real time advanced traveler information systems and hence, the public transportation systems. Moreover, it contributes to more accurate arrival time prediction models, reduces anxiety among passengers about potential delays, enables dynamic planning, and time control by bus drivers (schedule adherence), as well as efficient monitoring for transportation authorities. The uncertainty of the variations of dwell times is affected by various factors such as the time of day, the day of a week, points of interest, driver behavior, weather conditions, etc. Recently, machine learning models have shown significant accuracy in travel time prediction. Since they are data driven approaches, we collected global positioning system (GPS) trajectory data, which consists of sequences of trip points with latitude, longitude, and timestamp information. However, the sampling rate of GPS signals highly influences the bus stop dwell time data mapping, extraction, and prediction, since at some stops buses stop for a few seconds and that cannot be captured well. At the same time, there exist high demanding stops. Such variations of dwell times between bus stops and the above mentioned features cause the BDT prediction model more complex. Hence, we developed a stacked machine learning model for BDT prediction with low sampling trajectory data. This stacked model comprises the bus stop type classification XGBoost classifier model as the first layer and dwell time prediction at the predicted stop with XGBoost regressor model as the second layer. Further, our model showed 84% accuracy in classification and 19% MAPE in BDT prediction and overall, 12% improvement in the prediction of single-layer state-of-the-art models.

Keywords: intelligent transportation systems, bus dwell time, predictive modelling, XGBoost

Association Rule Enhanced Isolation Forest: A Method for Reducing False Positives in Anomaly Detection Systems

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Abstract

Anomaly detection plays a crucial role in sectors such as public health and industrial applications. The isolation forest (ISF) algorithm is widely used for its efficiency in handling high dimensional data, yet its high false positive rates (FPR) can lead to excessive false alarms, especially in industrial settings, where analysts have to go through the flags manually, adding to their workload. This overwhelm diminishes trust in the system and hampers its effectiveness. This study aims to improve ISF by reducing FPR, making it more suitable for scenarios, where low alarm rates are critical. To address this, we propose a novel approach that integrates association rule mining (ARM) with ISF. ARM identifies normal records by uncovering relationships among variables capturing typical behavior in the dataset. The hybrid model posits that records that align with these associations showing few rule violations or strong rule coverage are more likely to be normal. Adjustments were made to the ISF algorithm to increase path lengths for such records, and these changes were tested across five weightage levels: 10, 25, 50, 75, and 100%. The model was evaluated using five real world datasets from UCI repository: Mammography, Ionosphere, Annthyroid, Statlog, and Pima. The results demonstrated significant reductions in FPR with minimal impact on TPR, while maintaining comparable AUC levels. At 10% weightage, FPR reductions were as follows: Mammography (2%), Ionosphere (3%), Annthyroid (1%), Statlog (4%), and Pima (3%). These reductions increased to 16, 18, 8, 16, and 15%, respectively at 100% weightage. This approach shows a strong potential for reducing FPR in applications requiring human oversight, such as marketing interventions and manufacturing anomaly detection. By minimizing false alarms, the model helps alleviate analyst fatigue and fosters greater trust in the anomaly detection system, making it a promising solution for real world applications.

Keywords: anomaly detection, false positive rate, isolation forest

AI-Powered Driving Assistant: Reducing Road Accidents with Object Detection and Lane Keeping

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Abstract

Road accidents are a leading global cause of mortality, with over one million fatalities annually, underscoring the urgent need for enhanced safety measures in driving. This paper presents a solution to mitigate road accidents by developing an AI powered driving assistant. The system consists of two key components; an object detection model and a lane keeping algorithm. The object detection model, based on a convolutional neural network, identifies road objects and triggers autonomous actions, achieving an overall accuracy of 90.77%, as measured by the mean average precision on the validation and test datasets. Each identified object is mapped to an autonomous action to notify the driver as needed. The lane keeping algorithm, employed using image processing techniques, ensures the vehicle stays within the road boundaries with steering angles displayed alongside highlighted road areas. This ensures that the vehicle always stays within the road and notifies the driver otherwise. Both components were evaluated using a small scale physical vehicle model, controlled by a Raspberry Pi 4, in a controlled environment. The controlled environment, which included consistent lighting and varied road curvatures, was instrumental in evaluating system performance. The results demonstrate the effectiveness of the system in assisting drivers by accurately detecting objects and lane positions to notify the driver if all the required conditions are not met. For real world scalability, object detection would require training on a diverse dataset encompassing varying weather and lighting conditions, while lane keeping could benefit from multi-sensor fusion for enhanced accuracy on roads with inconsistent markings. Tested in a controlled environment, this system offers a promising step towards safer road navigation by establishing a safer and more efficient vehicle safety system through reliable object recognition and lane maintenance capabilities.

Keywords: driving assistant, object detection, lane keeping, road safety, artificial intelligence

Improving the Quality of Wikipedia Article Content using Deep Learning: A Doc2Vec and CNN Model for Quality Classification

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Abstract

Maintaining consistent content quality on Wikipedia, the internet based encyclopedia poses significant challenges due to its open source, collaborative nature. Issues such as factual reliability, anonymous editing, and lacking neutrality, along with the limitations of automated tools like ORES, hinder the platform's credibility. These factors contribute to skepticism in academic circles. It hinders the platform's ability to ensure the credibility and integrity of its vast, frequently revised content. This research addresses these challenges by proposing a novel automated approach to assess Wikipedia article quality using deep learning techniques. Unlike empirical studies which primarily focus on human evaluations or automated systems with poor contextual understanding, this study leverages Wikipedia article content with Doc2Vec to enhance quality evaluation. The proposed methodology involves representing Wikipedia article content using Doc2Vec embeddings. The ground truth is prepared according to Wikipedia's existing quality grading system and preparing it for binary classification. The dataset includes 1,000 articles, divided as 500 high quality (featured articles), and 500 low quality (Good, A, B, C, Start, and Stub) extracted using the Wikipedia API. These labeled embeddings are input into a convolutional neural network (CNN) for binary classification of article quality. The model achieved impressive results with an accuracy of 95.83%, precision of 95.23%, recall of 0.9677, and F1 score of 96.00%, successfully distinguishing between high and low quality articles. Despite the promising results, the study is limited to articles in the English language and focuses solely on article content without considering metadata or reviewer comments. Future work aims to enhance the classification model by incorporating these additional factors, thus generalizing the findings and improving the robustness of quality assessments across a broader range of Wikipedia content.

Keywords: Wikipedia, content quality, Doc2Vec embeddings, convolutional neural network, quality assessment

AI-Driven Bud Detection and Emasculation Assistance in Okra (*Abelmoschus esculentus* L.)

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Abstract

This study presents the development of a vision based autonomous system for assist in the emasculation of okra (*Abelmoschus esculentus* L.), offering a significant advancement in agricultural technology. Precise flower bud identification is essential for ensuring the success of the emasculation process, but conventional methods remain manual, labor intensive, and prone to error. Therefore, through integrating advanced computer vision techniques and artificial intelligence were used to overcome these challenges. In this study, the images of okra buds at different stages were obtained in day lighting conditions and nine image augmentation techniques, including flips, rotations, shears, brightness, saturation, exposure adjustments, blur, and noise were applied. From 791 original images, 2,057 augmented images were generated and annotated using LabelImg. All images were resized to 640×640 pixels and split into training (80%) and validation (20%) sets for model training. Three variants of the YOLOv8 model YOLOv8n, YOLOv8m, and YOLOv8s were applied to determine the optimal model considering accuracy, detection speed, and frames per seconds (FPS). Although all variants achieved a mean average precision at 50% (mAP50) close to 90% YOLOv8n model was selected in this study since it demonstrated a lower detection speed of 3.15 seconds and FPS rates between 15 to 20. Further refinements to the YOLOv8n model, including threshold adjustments successfully minimized the false detections as per the test results. Therefore, the viability of integrating deep learning techniques to flower bud identification and emasculation marking a significant advancement to enhance productivity and accuracy in crop breeding.

Keywords: bud identification, okra, emasculation, YOLOv8

Design of a M-Learning System with Collaborative Filtering for Enhancing English Speaking Proficiency in University Students

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Abstract

English is recognized as a language of international communications. Although Sinhala is the primary language of Sri Lanka, fluency in English is equally valued, especially for university students entering the workforce. However, students often struggle to achieve proficiency in spoken English due to limited opportunities for immersive practice and diverse linguistic backgrounds. Research has shown that m-learning is an effective method for non-native speakers to learn English, but previous studies have not addressed students' varying levels of English knowledge or preferred learning styles. Hence this research was carried out to design and implement a personalized m-learning system with an activity recommendation model to improve the English speaking proficiency of university students. This m-learning system has two main parts, one is the mobile application where the user is dealing with, which is capable of running on both Android and iOS devices and the other is the recommendation algorithm which recommends learning activities to the user. Mobile application and algorithm are connected through APIs. This algorithm is a collaborative filtering algorithm and data which is needed for the algorithm were collected through a survey among the university students. The questionnaire in the survey was created in order to capture preferred learning styles of students to improve English skills based on the visual, auditory, reading/writing, and kinesthetic (VARK) model. Based on the initial activities selected, the future activities are suggested to the user through the mobile application. This is done as per the ratings test users gave for each activity during the survey, by calculating the similarities of ratings. As the initial results of the collaborative filtering model, it was capable of recommending 5 activities to the user based on the initial activities selected by him through the mobile application. The accuracy of the model obtained was 0.46. The main limitation identified is the quantitative amount of data collected is less than expected and as a future enhancements data should be collected from students who are from different linguistic backgrounds to achieve a higher accuracy in the model.

Keywords: English speaking proficiency, mobile learning, recommendation algorithm, collaborative filtering, VARK model, machine learning

LLM-powered Voice Assistant for Bookstores: Enhancing Customer Experience through Personalized Recommendations

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Abstract

Interaction between customers and retailers is critical to the success of a business. The quality, efficiency, and availability of customer service significantly impact sales performance. This paper presents the implementation of a voice assistant system powered by OpenAI's GPT-3.5 Turbo, accessed via the OpenAI API, for customer interaction in a bookstore setting. The assistant integrates a speech-to-text module, a text-to-speech module, real time inventory data, and a Python-based purchasing script, enabling efficient handling of customer queries. The choice of a bookstore serves to highlight the limitations of human based service in such environments and demonstrates how the proposed system overcomes these challenges. The effectiveness and limitations of this system is demonstrated through three key scenarios. In scenario 1, a customer requests a specific book that is available in the store. The assistant immediately confirms the availability and processes the purchase seamlessly, showcasing the system's efficiency in handling straightforward transactions. In Scenario 2, the customer requests a book not in stock, and the assistant offers relevant recommendations based on the customer's preferences, leading to a successful alternative purchase. This highlights the assistant's ability to provide personalized recommendations even when inventory limitations exist. In Scenario 3, when a customer is undecided and open to exploring, the assistant engages in a conversation to understand the customer's preferences, recommending a suitable book and facilitating the purchase. The assistant's ability to respond to customer queries, suggest books tailored to individual tastes, and instantly access inventory information enhances customer satisfaction. While the assistant offers valuable personalization, one of the limitations is that customers must wait until the assistant has finished speaking fully before responding, potentially interrupting conversation flow. Nonetheless, by focusing on personalized interactions and streamlining the purchasing process, this system has the potential to ultimately increase the conversion rate and contribute to more profitable business outcomes.

Keywords: voice assistant, large language model, customer interaction, bookstore automation, personalized recommendations

Forest Fire Detection and Burned Area Prediction Using Meteorological, Geolocational, and Forest Fire Variables

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Abstract

The forest fire phenomenon has proved hazardous via destruction of habitats including human beings, animals, and vegetation. It may lead to starvation and financial losses as well as the contamination of the atmosphere with pollutants. Forest fires have serious consequences on the environment and it is essential to drive the public for advanced and robust approaches for its prevention. Current strategies seek the use of satellite imagery to locate fires and notify local authorities, providing crucial information to extinguish the fire. The time delay in relaying back information proves its inability to perform in dire circumstances, increasing the likelihood of conflagrations. Soft computing techniques and data mining techniques display promise as an efficient approach to forest fire prevention. Such techniques utilize environmental and forest fire information to process and generate results. This study explores the application of the aforementioned methods and evaluates the individual performances to create a superior strategy. The study utilizes the dataset from the University of California, Irvine machine learning repository which contains the environmental and physical conditions as well as the forest fire elements of the Montesinho park in Portugal.

Keywords: forest fire, forecasting, artificial neural networks, burned areas

Transforming Software Development: The Evolutionary Role of AI, ML, and Blockchain

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Abstract

The software evolution landscape is being profoundly transformed by emerging technologies such as AI, ML, and blockchain, which are changing the way that organizations develop, operate, and utilize software systems. These developments improve software development's effectiveness, speed, flexibility, and adaptability, allowing organizations to rapidly offer solutions that satisfy changing customer needs and technological advancements. A variety of these developments, there is still a significant research gap concerning the direct integration of these technologies into software evolution. The purpose of this study is to investigate the trends, difficulties, and opportunities related to the combination of AI, ML, and blockchain technology within this framework. The research methodology consists of an extensive literature review evaluating these technologies' effects on software evolution, which is complemented by interviews conducted with three organizations and an open ended questionnaire intended to gather software professionals' experiences implementing these new technologies into practice. The results show that there are a number of major benefits that organizations may gain from, such as better automation of repetitive operations, increased error detection accuracy, and the capacity to develop software systems that can optimize itself. While blockchain technology guarantees data integrity and security, increasing confidence in AI applications, AI and ML speed up development cycles by simplifying the coding and testing processes. To obtain the best use of these technologies, organizations require to improve security, protect data privacy, and address scalability concerns. The study additionally points out limitations such continuing concerns regarding data protection and scalability problems. In conclusion, while the convergence of AI, ML, and blockchain offers significant potential for software innovation, in order to maximize the benefits of these technologies, organizations need to purposefully address the associated challenges.

Keywords: emerging technologies, software development, software evolution

A Feasibility Study of Machine Learning Approaches for Automated Classification of Real Estate Documents in the United States

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Abstract

Document classification in the real estate sector, particularly within US government agencies, has become increasingly crucial for efficient information management and decision making processes. This paper evaluates the feasibility and effectiveness of various machine learning methods for classifying real estate documents in US government contexts through a comprehensive literature review. The analysis compared different algorithms, including traditional machine learning approaches like support vector machines (SVM) and more recent deep learning techniques such as convolutional neural networks (CNN) and BERT-based models. Using a 5-point scale, we evaluated 11 different models based on classification accuracy, precision, recall, F1 score, and processing speed. The findings revealed varied performance: traditional SVM models achieved accuracies ranging from 86 to 98.889% depending on dataset complexity, while BERT-based models achieved 86.91% accuracy on large scale datasets (3,280 documents). RoBERTa demonstrated strong performance on legal documents with a micro F1 score of 0.812 and CNN-based models reached accuracies up to 92.89% on large scale datasets. While traditional methods like SVM still perform well for certain types of real estate documents, deep learning approaches, particularly those utilizing pre-trained language models such as BERT, RoBERTa, and XLNet, achieved superior accuracy and flexibility across diverse document types. However, these advanced models required significantly more computational resources compared to traditional methods. Challenges related to interpretability, computational resources, and the need for large labeled datasets were identified as significant barriers to widespread adoption. Future research should focus on developing hybrid approaches combining traditional and deep learning methods, investigating domain specific pre-training techniques, and creating more interpretable architectures that can handle varying dataset sizes effectively. Further work is needed to address practical implementation challenges and improve adaptability to the unique characteristics of government real estate documents. This study contributes to enhancing document management and information retrieval in the US government real estate sector through advanced classification techniques.

Keywords: document classification, real estate documents, machine learning, deep learning, US government

Deep Learning-Based Growth Monitoring and Yield Approximation of Oyster Mushroom

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Abstract

The oyster mushroom (*Pleurotus ostreatus*) is one of the world's most commonly cultivated edible mushroom species. The application of recent technological improvements in production would majorly impact the economy of this industry. The present study focuses on a deep learning-based mechanism for growth monitoring and yield approximation of oyster mushrooms. The convolutional neural network architecture-driven deep learning model, YOLOv5, has been used to detect the mushrooms and monitor their growth, while forecasting the yield. A data set comprising 1,000 images (80% - training, 10% - validation, and 10% - testing) captured using an OV2640 camera module under the standard temperature (24 - 27 °C) and humidity (90 - 100%) was utilized. The mushrooms were categorized and annotated (Roboflow) into three classes: yield_01 (premature), yield_02 (mature), and yield_03 (over mature) based on the growth features. The model was then trained, and the hyperparameters (batch size: 16, epochs: 80) were optimized to enhance the model performances. The average mushroom weights of the three classes were measured at the standard temperature and humidity and then integrated with the mushroom count of each class for yield approximation. An automated guided vehicle equipped with a DHT22 (temperature, humidity) sensor and OV2640 camera module controlled by an ESP32 microcontroller was developed to transmit data via Wi-Fi to Google Colab. Finally, the model demonstrated accuracies of 94.70, 82.14, and 81.82% along with, F1 scores of 87.09, 77.47, and 78.33% for yield_01, yield_02, and yield_03 classes, respectively, in terms of growth monitoring. The yield approximation against the actual harvest of each class showed average percentage errors of 7.2, 1.4, and 4.6%, respectively demonstrating the high accuracy and reliability of the developed model over the other available manual methods. The capturing images of mushrooms across varying sizes from multiple locations, the resolution of the camera, and internet bandwidth, which determines the image uploading speed were encountered as challenges during the study. Further, the system can be improved to identify the early risks associated with environmental factors, pests, and diseases and the application of controlled inputs: substrate, water, and nutrients while enhancing productivity and profitability.

Keywords: deep learning, growth monitoring, yield approximation, AGV, oyster mushroom

AI in Autonomous Vehicles: Challenges and Future Directions - A Focus on Machine Learning Algorithms and Regulatory Frameworks for Safe Deployment

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Abstract

Autonomous vehicles (AVs) possess the potential to revolutionize transportation by enhancing safety, efficiency, and sustainability. However, while advanced machine learning (ML) algorithms play a critical role in enabling AVs to interpret their surroundings and navigate complex environments autonomously, significant challenges impede their reliable deployment in diverse and unpredictable conditions. This review addresses the central research question: how can ML techniques optimize AV functionality while overcoming key obstacles in real world AV deployment? By identifying critical gaps in current ML applications and regulatory frameworks, this paper underscores the need for robust, standardized safety, liability, and privacy measures. Essential ML techniques such as deep learning for precise object detection, reinforcement learning for dynamic decision making, and sensor fusion for robust environmental modeling are analyzed to assess their contributions and limitations. Despite these advancements, issues such as sensor reliability under environmental variability, extensive data privacy requirements, and ethical dilemmas in decision making highlight unresolved challenges in AV technology. This review advocates for a cohesive regulatory approach and interdisciplinary collaboration among AI researchers, automotive manufacturers, and policymakers. Establishing comprehensive safety standards, transparent algorithms, and robust data privacy measures is vital to the safe, responsible, and globally scalable integration of AVs into transportation systems.

Keywords: autonomous vehicles, machine learning, safety frameworks, regulatory frameworks, liability in AV deployment

AI Powered Hand Gesture Recognition with Flex Sensors: A Real Time Solution for Improving Communication Individuals with Hearing and Speech Impairments

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Abstract

Effective communication is a key component of human interaction, but it can be a significant challenge for auditory impaired dumb people to use this vital skill. A range of assistive technologies, including text based communication and sign language, have been created to tackle this issue, but there are limitations in their usability, accessibility, and accuracy. Modern wearable technologies and AI have opened up new avenues for addressing communication difficulties in the last few decades. Highly accurate gesture recognition and interpretation are achieved by AI powered systems, while wearable sensors provide a non-invasive means of obtaining physical data from the body. A large portion of the task of capturing precise hand movements will be completed by flex sensors, which are thin, flexible strips that can detect changes in resistance when bent. This study introduces a revolutionary AI powered hand gesture detection system that uses flex sensors to help dumb individuals with auditory impairments communicate in real time. The wearable glove's flex sensors, integrated into the system, sense hand and finger movements and send the information to an AI powered processing unit. Here, sensor data was analyzed, and visual language on a display screen was translated into intelligible outputs using machine learning methods like naive Bayes, support vector machine, and K-nearest neighbours. The 80% training and 20% testing sample of 500 data points from 10 different hand gestures were used to compute performance metrics. A positive outcome was observed in each algorithm with at least 95% of the performance indicated, including recall, accuracy, F1 score, and precision. This system's limitations included a limited variety of recognizable gestures and variations in flex sensor readings due to differences in users' hand movements. However, this technology can completely change how individuals with auditory impaired dumbs engage with the outside world as it develops, opening up new possibilities for participation in both personal and professional contexts. The design, implementation, and performance evaluation of this system will highlight its potential as a transformative instrument for assistive technology.

Keywords: artificial intelligence, assistive technology, deaf and non-verbal individuals, wearable devices

Time Series Analyze of Tea Production in Sri Lanka

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Abstract

This study utilizes time series analysis to develop accurate tea production forecasts for Sri Lanka, where tea is a cornerstone of economic and agricultural sectors. Reliable production forecasting is crucial for effective supply chain management, production scheduling, and policy development, especially given the industry's sensitivity to climate factors. Using historical data, we applied several time series models, including ARIMA, SARIMA, and exponential smoothing, to capture trends, seasonal patterns, and elevation based climate variations across key tea producing regions. Model performance was evaluated with mean squared error (MSE) and mean absolute percentage error (MAPE) metrics, which confirmed strong predictive accuracy across different approaches. Given the distinct agro-climatic conditions of Sri Lanka's tea growing areas, models were refined to reflect elevation specific patterns. For instance, high grown teas in Nuwara Eliya and low grown teas in Rathnapura exhibit unique seasonal and production trends influenced by elevation and rainfall. Among the exponential smoothing models tested, single exponential smoothing proved effective for capturing straightforward trends. For ARIMA models, ARIMA (1,0,1), ARIMA (3,1,7), ARIMA (5,0,6), and ARIMA (6,1,3) were selected as optimal for Galle, Rathnapura, Nuwara Eliya, and Matara, respectively, accurately representing climate driven variability in each region. These tailored forecasting models have the potential to support various stakeholders' producers, agribusinesses, and policymakers in making informed decisions for production, export, and market stabilization. Importantly, they also enable proactive adaptation to changing climate patterns by offering insights into future production volumes. With growing climate variability, there is a pressing need for continuously updating these forecasting models with current data to ensure precision. Future research will focus on integrating updated climate data and further refining model parameters to enhance forecasting accuracy across Sri Lanka's diverse tea growing regions, ultimately contributing to the long-term resilience and stability of the tea industry.

Keywords: time series analysis, ARIMA, SARIMA, tea production, forecasting

Automotive Engineering

Assessment of Circular Economic Principles for the Automotive Industry: A Systematic Review

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Abstract

The automotive sector mostly relies on innovation and brand initiatives to accomplish its success. They have soared into a prosperous corporate environment thanks to technologies like autonomous driving, lightweight construction, and emission reduction. The optimal choice for process optimization has been determined to be sustainable manufacturing principles. Several theoretical ideas support the manufacturing process's competitive edge. Even though the automotive industry continues to be the largest in the world, a significant decline in productivity has been noted due to the inadequate implementation of sustainable practices. With a defined screening process to detect gaps in research interests, the focus has been launched to determine the role of circular economic factors in the automotive sector. This paper summarizes the circular economic concepts for developing technology in the automotive sector. The study was designed with the support of 50 different articles on the keywords identified. The research questions were formulated to widen the scope of the study and identify the involvement of sustainable manufacturing concepts in the automotive industry. It is highlighted that 80% of the articles dominated the importance of environmental perspectives rather than giving equal interest to three pillars. Thus, this review opens up a door for analyzing several tracks for process optimization in the automobile industry. The study highlighted the importance of sustainability assessment based on triple-bottom-line concepts in the automobile industry which is still a lacking area to analyze. The researchers are expected to widen the scope of the research by linking the process optimization techniques to the automotive sector.

Keywords: sustainable manufacturing, circular economy, automobile industry, process optimization, triple bottom line

Modelling, Simulation and Testing of Scotch Yoke Mechanism for IC Engines

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Abstract

This research concerns the design, simulation and testing of a scotch yoke system for internal combustion engines, specifically on noise, vibration and stress levels. In IC engines, NVH is a fundamental concern that affects engine performance, durability and user comfort. In a compact cylinder design, the scotch yoke mechanism offers many advantages such as ease of operation, lower vibrations, low friction, and increased torque output, which may improve engine performance. The study examines the effectiveness of an unwanted engine vibration reduction mechanism in this context through modelling, simulation, and testing. Developing detailed mathematical models, conducting simulations to analyse performance under different conditions and validating findings through experimental testing is part of the research approach. One of the major milestones of the project was being able to successfully plan, design, and simulate the scotch yoke mechanism using software such as SolidWorks and MATLAB. Results indicate that the scotch yoke mechanism can contribute to a lower level of NVH in IC engines, which will make for smooth operation and more efficient combustion. This research will positively impact the development of IC engine technology and design, which may lead to more efficient, quieter and balanced engine systems for automobiles and other applications.

Keywords: scotch yoke mechanism, NVH, slider-crank mechanism, engine balancing, finite element analysis

Improving Wheel Slip Control in Older Off-Road Vehicles on Challenging Terrains

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Abstract

The increasing popularity of off-road vehicles has highlighted the need for effective methods to prevent wheels slipping on uneven and slippery terrains. Wheel slip occurs when there is a mismatch between the rotational speed of the vehicle's wheels and its actual speed over the ground, indicating a loss of traction. This can lead to the wheels spinning faster or slower than the vehicle's speed, making it difficult for the driver to maintain control. Modern vehicles are equipped with advanced safety features like anti-lock brakes (ABS), traction control, and stability control, which help to prevent wheel slip and ensure driver control. However, older vehicles, particularly those made before 2000, often lack these features, making them more vulnerable to loss of traction, especially in off-road or slippery conditions. In Sri Lanka, a significant number of older off-road vehicles are still in use. These vehicles are commonly operated on highly uneven and slippery terrains, where wheel slip is a frequent and critical issue. The need for a reliable, cost effective solution to control wheel slipping in such environments is evident. This research paper aims to address this problem by developing a prototype solution designed specifically for older off-road vehicles, with a focus on traditional four-wheel drive systems. The proposed system uses Hall effect sensors on each wheel's axle to detect individual tire slip. By applying selective braking, it enhances traction on slipping wheels, allowing the vehicle to maintain control and proceed safely on challenging terrains. This system can also be adapted for two-wheel drive vehicles with minor modifications, improving stability and safety on challenging terrains such as ice, mud, and gravel. By offering a practical and cost effective solution, the proposed system provides a valuable upgrade for older vehicles that lack modern traction control technologies, significantly improving their performance and safety in off-road conditions.

Keywords: wheel slip prevention, selective braking, vehicle safety technologies, Hall effect sensors, traction enhancement

Development of a Steering Mechanism for Road Trains in Sri Lanka

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Abstract

Road trains offer significant economic and environmental advantages but still remain underutilized in Sri Lanka due to infrastructural limitations and maneuverability issues on narrow roads. This study addresses these challenges by developing a novel steering mechanism tailored to enhance the handling of road trains in Sri Lankan conditions. The study analyzed the effects of speed, pivot angles, and various steering configurations on off-tracking and turning behaviours using dynamic and kinematic modelling. Simulations and analytical models informed the design, focusing on real world maneuverability in tight spaces, sharp curves, and parking. The configuration connects two 20 ft trailers to a prime mover, with a converter dolly coupling the trailers. To assess the system's reliability and steering response, a scaled-down prototype was developed and tested under diverse scenarios, including various load conditions and terrains. Results demonstrated that the drag link steering mechanism for the rear trailer notably reduced the turning radius and improved overall handling, with the rear trailer steering opposite the tractor's direction significantly enhancing off-tracking reduction, cornering, and turning efficiency. Conversely, parallel steering facilitated smoother lane changes but proved less effective in off-tracking correction. The study also explores the integration of an active feedback system to optimize steering adjustments based on real time driving conditions, thereby increasing precision and safety. This project underscores the potential of active trailer steering mechanisms to make road trains a viable option for Sri Lanka's freight transport, with implications for reducing emissions, operational costs, and infrastructure wear. By refining road train designs for emerging economies, this research lays a foundation for future advancements in sustainable freight transport policy and technology.

Keywords: road trains, steering mechanism, maneuverability, vehicle dynamics, off-tracking

A Comprehensive Review of Transportation Systems: Trends, Challenges, and Innovations of New York and Tokyo

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Abstract

This paper presents a comparative analysis of transportation systems in New York City (NYC), USA and Tokyo, Japan, two of the world's most populous urban centers, highlighting their current trends, challenges, and innovative solutions. Urban transportation is crucial for economic vitality, social equity, and environmental sustainability. As urban populations grow, both cities face pressures to adapt transportation systems that are resilient and efficient. This study identifies key similarities and differences in the transportation infrastructure of NYC and Tokyo, particularly in their public transit systems, road networks, and adoption of emerging technologies. For example, NYC's extensive but aging subway contrasts with Tokyo's efficient, punctual public transit, revealing distinct strengths and limitations in each city's approach. Additionally, challenges like congestion, environmental impact, and equitable access are discussed, alongside innovations like sustainable practices and public-private partnerships. This study informs urban planners and policymakers on effective strategies for developing sustainable urban transportation, emphasizing the importance of collaboration and innovation in urban mobility planning.

Keywords: transportation systems, New York, Tokyo, urban mobility, public transport, innovations

Study on the Use of Electric Locomotives to Face Current Fuel Crises in Sri Lanka

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Abstract

The world is moving to electric vehicle technology to achieve greater energy efficiency and reduce environmental pollution. Electric locomotives play a major role in daily transportation as they require no batteries and can transport thousands of passengers and tons of goods with minimum energy consumption. In Sri Lanka, using diesel-electric locomotives has contributed to economic issues which cause huge amounts of money to be spent due to fossil fuel import. This research major aims to explore the feasibility study of converting diesel-electric locomotives to fully electric ones and whether it is cost-effective for the government to do the conversion. It focuses on the feasibility study of the associated costs of upgrading both the railway line infrastructure and locomotive electrical systems. It focuses on the viability analysis of the related expenses of upgrading locomotive electrical systems and infrastructure. The study assesses the advantages of this conversion, especially the possible savings in foreign exchange and the environmental benefits. It also looks at the additional costs associated with installing overhead electric lines (pantograph systems) and the necessary changes to the rail lines. The M08 locomotives were used as a case study for the conversion process. The diesel-electric locomotives already have electric motors and electric controllers. So, the conversion only requires the removal of IC engines and generators and then retrofitting the transformer and inverters. Findings indicate that electric locomotives cost only 13.20% of the total operating cost of diesel-electric locomotives. Furthermore, labour requirements when doing the service would decrease significantly by 75%. Other key benefits include the elimination of environmental pollution and considerable energy savings. Although the conversion requires a substantial initial investment, the cost can be recovered within six years through operational savings, particularly in daily routines, while reducing pollution in urban areas.

Keywords: fully electric locomotive, electric locomotive, full electric locomotive conversion in Sri Lanka

Automatic Fire Detection and Fire Damage Mitigation System for Automobiles

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Abstract

There are thousands of vehicle accidents happening day to day in the world. Among them, most vehicle accidents happen due to vehicle fires. Vehicle fires can be fatal, also it could damage properties, and increase pollution. The engine compartment, dashboard area, and passenger compartment are especially vulnerable to vehicle fires. This project addresses these critical areas by implementing a controlled system designed for fire detection, warning, and suppression to reduce fire-related risks. In this project, the controlled system uses several sensors to detect fires, including IR flame sensors, IR temperature sensors, and smoke sensors. When a fire is detected by the fire detection system, the control system provides visual and audio alerts to notify the passengers about the fire hazard. Meanwhile, the built-in fire suppression system is activated by the control system, which opens two solenoid valves to release CO_2. This CO_2 flows through nine nozzles, directing it into the engine compartment, passenger compartment, and under-dashboard area. Also, the smoke reduction system activates blowers to reduce smoke in the passenger compartment. The prototype was tested using primary parameters of temperature, and smoke variation. To evaluate the system's response, tests were conducted by intentionally igniting a controlled fire. According to test results, they detected fire within less than two seconds and responded to it within less than another two seconds. In conclusion, this project achieved comprehensive coverage in the engine compartment, under the dashboard, and the passenger compartment for fire detection, warning, and fire suppression to improve passenger safety with higher accuracy and efficiency. Future developments include reducing system activation time, creating a full-scale prototype, implementing the system in actual vehicles, and expanding its application to other vehicle areas.

Keywords: automobile fire safety, fire detection, fire notification, fire damage mitigation, vehicle fire

Biotechnology, Bioengineering, and Industrial Bioprocessing

GC-MS Profiling and Antioxidant Activity of *Salacia chinensis* Leaf and Bark Extracts

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Abstract

Salacia chinensis (*heen himbutu wel*) is a plant indigenous to various parts of Southeast Asia, including Sri Lanka, India, and China. It is valued in traditional medicine for its antidiabetic, anti-inflammatory, and antioxidant properties. It has been used to manage blood sugar levels, aid in weight loss, and support liver health. The plant's roots and stems contain compounds that inhibit enzymes involved in carbohydrate digestion, making it beneficial for controlling diabetes. Additionally, it is used for treating skin diseases and improving overall metabolic health. The plant's extracts are often used in herbal supplements aimed at managing metabolic health. In this study, leaf and bark extracts of *S. chinensis* were analyzed using gas chromatography-mass spectrometry (GC-MS) to determine the bioactive compounds, their bioactivity, and antioxidant activities. *S. chinensis* plant sample was collected and it was authenticated by the Royal Botanic Gardens, Peradeniya. Leaves and bark samples were collected from that authenticated plant, air dried and powdered samples were subjected to Soxhlet extraction using ethanol as the solvent. Crude extracts were tested for antioxidant activities and the phytochemicals present in the extracts were identified by GC-MS. According to the GC-MS analysis, sixty important phytochemicals were identified in both tested samples: forty-nine in leaf and nine in bark extracts. Out of those, two compounds were found to be common in both samples. GC-MS analysis revealed the presence of phytochemicals with biological activities such as antidiabetic, antimicrobial, anticancer, anti-inflammatory, antioxidant, and antiobesity effects. 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay was used to determine the antioxidant activities and leaf extract exhibited a higher antioxidant activity than bark extract. The bioactivity of those phytochemicals present in leaves and barks indicates the future potential of using not only bark but also leaves of *S. chinensis* in the pharmaceutical industry.

Keywords: *Salacia chinensis*, antidiabetics, antioxidant, gas chromatography-mass spectrometry

Preliminary Study on the Extraction Efficacy of Two Polar Solvents on Polyphenol Content, Antioxidant, and Bactericidal Properties of *Capsicum frutescens* Leaves

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Abstract

The *Capsicum* species are highly prized for nutritional content, but their antioxidant and antibacterial activity in leaves is a lesser-known fact. Targeting the replacement of synthetic antioxidants with natural ones, leaves of *Capsicum frutescens* (2 g) were extracted in methanol (100 mL), and water (100 mL) separately to identify the most efficient solvent to exhibit bactericidal and antioxidant qualities when leaves are extracted. Water and methanol extracts were prepared by maceration technique for a period of 48 hours at 25 °C using a roller mixer. Polyphenols were assessed by Folin-Ciocalteu method and total flavonoid content (TFC) by aluminium chloride method in both water and methanolic extracts. Total antioxidant capacity (TAC) was detected by Phophomolybdenum method. Free radical scavenging activity was investigated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbbenzothiazoline)-6-sulfonic acid (ABTS) free radical scavenging assays. Bactericidal effects were determined using *Escherichia coli* and *Staphylococcus aureus*. Phenols, flavonoids, and coumarins were detected in both extracts, while tannins, terpenoids, steroids, and quinones were present only in the methanolic extract as observed by qualitative analysis. The total phenolic content, TFC and TAC were present in methanolic extracts of *C. frutescens* which were 1499.4 µg GAE/mL, 139.5 µg QE/mL and 1615.1 µg AAE/mL respectively. The DPPH free radical scavenging activity in methanolic extract and water extract were 113.9 and 1894.5 µg/mL, respectively (p value<0.05). The ABTS free radical scavenging activity were 703.6 and 720.7 µg/mL in water and methanolic extracts respectively (p value>0.05). The greatest inhibition zones (1.00 cm) against *E. coli* and *S. aureus* were recorded in methanolic extracts (20 mg/mL) of *C. frutescens.* Therefore, methanol is more effective than water to extract polyphenols from leaves of *C. frutescens.* Methanolic and water extracts possess effective bactericidal and antioxidant activity.

Keywords: *Capsicum frutescens* leaves, antioxidants, bactericidal, methanol, polyphenols

Antityrosinase Activity and Bioactive Potential of Ethanolic Extract of the *Elaeocarpus serratus* L. Leaves and Fruit for Novel Cosmeceuticals

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Abstract

The increasing demand for natural skin lightening agents has led to significant interest in researching plant-derived compounds with antityrosinase activity. The inadequate availability and poor quality of raw materials are major obstacles for manufacturers of herbal cosmetics. The present study aimed to investigate the antityrosinase activity and bioactive potential of the ethanolic extract of *Elaeocarpus serratus* L. (*veralu*) leaves and fruit as a source for novel cosmeceuticals. Extraction was performed using 70% ethanol through the cold maceration method at a 1 : 20 w/v ratio. The total polyphenolic content (TPC) and total flavonoid content (TFC) of the extracts were quantified using the Folin-Ciocalteu and aluminium chloride colorimetric assays, respectively. The mushroom tyrosinase enzyme inhibition assay was conducted following previously reported methods, with Arbutin and Kojic acid serving as positive controls. According to the results, the leaf and fruit extracts showed TPC values of 142.8±7.25 mg Gallic acid Equivalent/g and 44.92±0.19 mg Gallic acid Equivalent/g (dry weight), and TFC values of 124.27±7.48 mg Quercetin Equivalent/g and 25.51±0.29 mg Quercetin Equivalent/g (dry weight), respectively. The extraction yield percentages were 19.50±0.23% for leaves and 16.87±0.31% for fruit. The highest extraction yield, TPC, and TFC values were reported for the leaves. The *in vitro* mushroom tyrosinase inhibition assay determined the IC_{50} values, with the leaf extract demonstrating a higher inhibition (IC_{50} value of 498.30±17.37 µg/mL) compared to the fruit extract (IC_{50} value of 803.26±25.81 µg/mL). These findings support the sustainable utilization of *E. serratus* L. leaf extracts as effective natural ingredients in the formulation of skin-whitening products, emphasizing their TPC and TFC content may contribute to their bioactivity. However, further research is needed to confirm their potential for cosmeceutical usage.

Keywords: *Elaeocarpus serratus* L., tyrosinase inhibition, total polyphenolic content, total flavonoid content, skin lightening

Isolation and Characterization of Thermostable Cellulase-Producing Bacteria from Compost Production Plant in Kurunegala

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Abstract

Thermostable microbial enzymes are considered a better alternative to chemical catalysts towards green chemistry. Cellulase plays a significant role in diverse industrial applications including textile, paper and pulp, animal feed, waste management, and wine brewery. This study aimed to isolate and characterize thermostable cellulase-producing bacteria from compost-production plants. The samples were collected from municipal solid waste compost production plant in Sundarapola, Kurunegala, Sri Lanka (7° 30' 31.50" N, 80° 21' 9.84" E). At the site, the sample and the environmental temperatures were recorded, and the samples were transported to the laboratory under cool conditions (below 4 °C). Morphologically different bacterial colonies were isolated using the standard pour plate method on nutrient agar at room temperature (29 °C). Primary screening for the cellulase-producing bacteria was conducted using carboxymethylcellulose plates assay. The secondary screening for cellulase activity was carried out by measuring the amount of reducing sugar produced by the enzymes using the di-nitrosalycilic acid method. Subsequently, the optimum temperature and pH for cellulase activity were determined. According to the results, a total of 10 morphologically different bacterial colonies were isolated, and 3 isolates (SP2, SP4, and SP5) showed positive results for cellulase production in primary screening. The isolate SP5 showed the highest cellulase activity at room temperature (29 °C) with an enzyme activity of 0.6274 UmL^{-1}. The highest optimum temperature for the cellulase activity shown by the isolates was recorded at 70 °C, with an enzyme activity of 1.84 UmL^{-1}. The optimum pH for cellulase activity of SP5 was recorded as pH 6. Based on the results, isolate SP5 was found to be the most potent thermostable cellulase-producing bacteria that could be valuable for industrial applications operating at elevated temperatures. Thus, further optimization of bacterial culture conditions and enzyme purification are necessary for the successful utilization of the enzyme in industrial applications.

Keywords: thermophiles, thermostable enzymes, cellulase-producing bacteria

Comparative Studies of Chitosan and $CaCO_3$ Submicron Particles as Delivery Vehicles for Natural Larvicidal Extracts

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Abstract

One of the major challenges of using plant extracts as effective larvicides in water-based media is the impact of environmental conditions, which cause the bioactive compounds in the extracts to degrade before they can be optimally used as larvicides. In this study, bioactive plant extracts were encapsulated in water-insoluble chitosan and $CaCO_3$ submicron-carriers, which are of great interest as targeted drug delivery systems due to their bio-adhesive, bio-compatible properties, and eco-friendly nature. This approach was applied to achieve the highest efficiency with controlled-release of bioactive compounds. Chitosan and $CaCO_3$ submicron particles were synthesized utilizing the ionotropic gelation method, and with $Ca(CH_3COO)_2$ and $NaHCO_3$ in H_2O and diethylene glycol solvent mixture, respectively. Combined plant extract of *Capsicum frutescens* (*naimiris*) and *Allium sativum* (garlic) known for its significant larvicidal properties against dengue mosquito larvae in our previous study was encapsulated into both particles separately and their release properties were examined. Morphology and structure characterization of the both particles were confirmed by SEM and FTIR respectively. The diameter of chitosan particles was about 350 - 450 nm and diameter of $CaCO_3$ particles was about 344 - 865 nm. 96.10±2.77% of plant extract was encapsulated to chitosan particles and of which, 90% of encapsulated plant extract was released to the medium up to 14 days while 36 and 60% release were observed within 24 and 48 hours, respectively. Furthermore, 85.56±4.65% of plant extract was encapsulated to $CaCO_3$ particles and about 27% of encapsulated product was released to the medium up to 10 days and 17 and 18% release were observed after 24 and 48 hours, respectively. The comparative results revealed the highest encapsulation and releasing efficiency of chitosan submicron particles compared to $CaCO_3$ submicron particles. These results conclude that chitosan submicron particles can be used as target delivery vehicles for natural larvicidal extracts in water-based media.

Keywords: bioactive compounds, $CaCO_3$ submicron particles, chitosan submicron particles, encapsulation efficiency, releasing efficiency

Species of *Colletotrichum* Associated with Anthracnose and Brown Blight of Tea in Sri Lanka

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Abstract

Tea [*Camellia sinensis* (L.) O. Kuntze] is widely cultivated in more than 50 countries and is the second most consumed non-alcoholic beverage in the world. Approximately 350 fungal diseases are directly affecting the quality and quantity of tea production. Among them, anthracnose and brown blight caused by *Colletotrichum* species are particularly prominent. This study aimed to investigate the potential causative agents of anthracnose and brown blight and their pathogenicity. Fungi were isolated from 42 typical anthracnose and brown blight symptomatic tea leaves and characterized based on morphological and molecular data. The molecular study involved multi-locus phylogenetic analysis using three loci viz., internal transcribed spacer 1, 2 with 5.8S of the ribosomal RNA gene cluster (ITS), β-tubulin (TUB2), and translation elongation factor 1-α (TEF1-α). Representative isolates of each species were tested for pathogenicity by inoculating a spore suspension of 1×10^6 spores/mL on wounded detached tea leaves, followed by incubation in moist chambers until symptoms appeared. Results revealed that the isolates obtained from anthracnose and brown blight belong to *Colletotrichum gloeosporioides* species complex. The specific groups were further classified as *C. fructicola*, *C. siamense*, and another previously unknown, but well defined monophyletic group designated herein as *Colletotrichum* sp. indet.1, based on multi-gene phylogeny. Pathogenicity assays revealed that all these isolates were potential pathogens on tea leaves. The isolates of *C. siamense* induced typical anthracnose symptoms while *C. fructicola* and *Colletotrichum* sp. indet.1 induced brown blight symptoms. Hence, this study provides a crucial insight into the diversity of anthracnose and brown blight causing fungi on tea within Sri Lanka. These findings lay the groundwork for investigating fungal species complexes associated with foliar diseases and implementation of species specific disease management strategies to mitigate the potential economic losses by these fungal pathogens.

Keywords: anthracnose, brown blight, *Colletotrichum*, phylogeny, tea

Study on Algae-Based Microbial Fuel Cells for Electricity Production

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Abstract

As the world faces growing energy demands and urgent need for environmental sustainability, the exploration of renewable energy sources is becoming crucial. Algae-based energy production stands out as a promising approach, which effectively captures solar energy and converts it into chemical energy that can be utilized in microbial fuel cells (MFCs) to generate electricity. Furthermore, algae-based MFCs contribute to carbon sequestration by absorbing CO_2 during photosynthesis, thereby reducing greenhouse gas emissions. This study explores the use of *Chlorella*, *Spirulina*, and *Anacystis* (Beira lake algae) in MFCs to evaluate their effectiveness in sustainable energy generation. MFCs operate by utilizing electrogenic microorganisms to degrade organic materials and generate an electrical current through electron flow. In this study, Zarrouk medium was prepared to optimize the growth of algae species in MFCs, and proton exchange membrane enables ion transfer between the anode and cathode chambers. Experimental setups for each algae type were monitored over a 12-day period, to assess the electrogenic potential of each algae, focusing on voltage production and growth dynamics. Experimental results revealed that *Chlorella* consistently produced stable average voltage outputs of 0.092 mV, highlighting its potential as a reliable power source in MFCs. *Spirulina* showed moderate voltage production but exhibited variability across trials, peaking at 0.075 mV in one experiment. *Anacystis* displayed fluctuating voltage outputs, ranging from 0.049 to 0.058 mV, suggesting challenges in stabilizing its performance. The growth rates further support these findings, with *Chlorella* showing the highest growth rate and stability, followed by *Anacystis* and *Spirulina.* The correlation between optimal density and voltage outputs suggested that higher algae densities generally corresponded with increased electricity generation. These findings underscore the potential of algae-based MFCs as a sustainable solution for renewable energy production and environmental remediation.

Keywords: microbial fuel cells, proton exchange membrane, wastewater treatment, renewable energy

Decolorization of Remazol Brilliant Blue R Textile Dye by Solid State Cultures of *Lentinus squarrosulus* and *Trametes flavida*

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Abstract

Textile industry is a significant contributor to environmental pollution, due to the discharge of synthetic dyes into wastewater causing severe ecological and health risks. Thus, removal of synthetic dyes from textile wastewater is crucial for maintaining ecological balance, environmental health, human health, and for the expansion of textile industry. Conventional chemical and physical treatment methods for textile dye effluents have several drawbacks. Thus, this study explores the use of white rot fungi, *Lentinus squarrosulus* and *Trametes flavida* grown on coirdust to decolorize commonly used textile dye Remazol Brilliant Blue R (RBBR). The methodology included the collection of samples from surrounding environment, isolation, and molecular identification of the fungi, agar plate screening assays on Kirk's media supplemented with RBBR and liquid medium decolorization assays with mycelial blocks made from fungi immobilized on coirdust. The decolorization efficiencies were tested under various operational conditions, such as different dye concentrations, pH levels, temperatures, and agitation states. Results demonstrated that both fungi exhibited high decolorization efficiencies, surpassing 90% across various dye concentrations while the controls showed no significant decolorization. Two-way analysis of ANOVA showed the experimented operational conditions have a significant effect on decolorization efficiency in each species ($p<0.05$). Further, *T. flavida* species was found to outperform *L. squarrosulus* in dye decolorization under some parameters. Optimal decolorization occurred at pH 4 and 32 °C temperature, and agitation improved decolorization rates. Notably, live fungal biomass have significantly higher decolorization capabilities compared to dead biomass, highlighting the role of biodegradation over biosorption in the dye decolorization process. Therefore, this research confirms that *L. squarrosulus* and *T. flavida* are promising candidates for the bioremediation of textile dye containing effluents. The findings encourage further exploration into the long-term stability and reusability of fungal biomass, aiming to develop a cost-effective and environmentally sustainable technology for treating textile wastewater.

Keywords: white rot fungi, decolorization, textile dyes, bioremediation, biodegradation

Isolation and *in vitro* Potential of Producing Industrially Important Enzymes from the Halophilic Rhizosphere Bacteria Associated with the Saltmarsh Halophyte, *Suaeda maritima* (L.) Dumort in Sri Lanka

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Abstract

Halophilic bacteria isolated from the rhizosphere of halophytes have exhibited a broad spectrum of biotechnological applications including salt tolerance, enzyme production, bioremediation, and production of bioactive compounds, etc. The halophilic enzymes produced by the halophilic bacteria in the rhizosphere of halophytes can be used in various industries such as food processing, detergents, pharmaceuticals, etc. Hence, the present study aims to isolate, characterize, and investigate the *in vitro* potential of producing enzymes in halophilic bacteria from rhizosphere of the *Suaeda maritima* (L.) Dumort from salterns in Sri Lanka. Rhizosphere soil samples were collected from a saltern located at Hambantota, Sri Lanka (6° 07' 15.69" N, 81° 04' 13.80" E). Nine pure cultures of halophilic bacteria were obtained via subsequent subculturing on halophilic media. These isolates were screened to produce amylase and protease enzymes using starch agar and skimmed milk agar plate assays respectively. Positive isolates for amylase activity on plate assays were subjected to a quantitative assay using the dinitrosalicylic acid method. For the optimal enzyme production, growth temperature, pH, and salt concentrations were adjusted accordingly. Out of nine isolates, six isolates (R02, R03, R04, R06, RA01, and RA03) were positive for the production of amylase while four isolates (R04, R05, R06, and RA01) were positive for protease. Based on the quantitative amylase enzyme production, R02 isolate exhibited the highest enzyme activity (109.33 U/mL). This preliminary study concludes, halophilic bacteria living in the hypersaline environments associated with the rhizosphere of saltmarsh plants have the potential to produce various industrially and biotechnologically important enzymes. Further, studies are recommend continuing the plant growth promoting ability of these rhizosphere isolates.

Keywords: enzyme producing bacteria, halophiles, halophilic bacteria, halophytes, rhizosphere

Synergistic and Antimicrobial Activity of Curcumin-Modified Silver Nanoparticles

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Abstract

Urethral catheters are the most commonly deployed medical devices in the hospital setting. Prolonged catheterization predisposes to catheter-associated urinary tract infections. Therefore, there is a timely need for modifications to the inner surface of urinary catheters to prevent biofilm formation and encrustation. This study aimed to evaluate the synergistic and antimicrobial effect of curcumin-modified silver nanoparticles (Cur-AgNPs) and use it as a catheter coating to minimize microbial biofilm formation. Silver nanoparticles (AgNPs) and Cur-AgNPs were synthesized by the chemical reduction method. Each nanoparticle and commercially available curcumin were characterized structurally and morphologically, and its antimicrobial efficacy was evaluated. The formation of bonds and the relevant peak positions were examined using Fourier transform infrared analysis. The X-ray diffractograms confirmed the crystalline structures of the synthesized nanoparticles. X-ray photoelectron spectroscopy analysis confirmed the successful synthesis of Cur-AgNPs. Transmission electron microscopic and scanning electron microscopic imaging described the morphology of the nanoparticles and confirmed that their dimensions are on the nanoscale. Cur-AgNPs exhibited a greater antimicrobial activity (16.73±1.64 mm) than AgNPs (11.18±0.42 mm), and curcumin (11.03±0.10 mm) alone, as shown by larger inhibition zones in agar well diffusion assay. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of AgNPs, curcumin, and Cur-AgNPs ranged from 50 - 25 mg/mL, 100 - 50 mg/mL; 50 - 25 mg/mL, 100 - 50 mg/mL; and 50 - 6.25 mg/mL, 50 - 6.25 mg/mL, respectively. In comparison to the inhibition zones, MIC, and MBC values, it was proven that the synthesized Cur-AgNPs could be used as an effective antimicrobial agent confirming the synergistic effect of both curcumin and AgNPs.

Keywords: nanoparticles, silver, curcumin, catheter, biofilms

Effect of Titanium Dioxide on the Function of Human Stem Cells

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Abstract

Titanium dioxide (TiO_2) has gained considerable attention across multiple fields due to its distinctive physicochemical properties and diverse applications. While TiO_2 was once widely considered a safe material, growing concerns about its potential toxicity have led to increased scrutiny. Recent studies have highlighted possible adverse effects on various organs, including the lungs, gastrointestinal system, liver, and kidneys. Accumulated evidence also demonstrated the transplacental permeability of TiO_2, thereby indicating that susceptible individuals such as fetuses face a heightened vulnerability upon maternal exposure. This study aimed to investigate the effect of TiO_2 exposure on the pluripotency of human inducible pluripotent stem cells (iPSCs), which can be used as a surrogate of fetal stem cells. iPSCs were incubated with different concentrations of TiO_2 (0.4 - 40 μg/mL), and their impact on cell viability and the expression of genes involved in maintaining pluripotency of stem cells (*NANOG*, *OCT3/4* and *SOX2*) were assessed by PrestoBlue™ viability assay and qRT-PCR, respectively. These concentrations were within a reasonable range for possible human exposure because the median titanium concentration in the cord blood was 320.07 μg/L. Treatment with different concentrations of TiO_2 for up to 12 days did not affect the cell morphology nor significantly affect the viability of human iPSCs. The expressions of *NANOG*, *OCT3/4*, and *SOX2* mRNA were decreased at 0.4 and 4 μg/mL compared to the control (0 μg/mL), while cells with 40 μg/mL showed an increased expression of all studied genes compared with the control. The concentration specific alteration in the expression of pluripotency related genes demonstrated the potential toxicity of TiO_2 particularly in relation to the differentiation ability of fetal stem cells. These findings emphasize the need for further research to fully elucidate the potential adverse impact of maternal exposure to TiO_2 on the development of the fetus's organ systems to establish safe levels for their use in food, cosmetics, and other commercial products.

Keywords: titanium dioxide, human inducible pluripotent stem cells, fetal stem cells, pluripotency

Identification and Virtual Screening of Natural Compounds from *Acalypha indica* as Potential Inhibitors of Senecavirus A 3C Protease

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Abstract

Senecavirus A (SVA), a single-stranded RNA virus from the *Picornaviridae* family, is associated with swine idiopathic vesicular disease (IVD) and epidemic transient neonatal losses (ETNL), particularly in North America. The virus encodes several proteins, including the crucial 3C protease (3Cpro), essential for viral replication. *Acalypha indica*, a plant native to the Asiatic region, has been traditionally used for treating microbial infections, stomach ulcers, snake bites, wounds, liver/kidney problems, and rheumatism. In this study, we conducted a comprehensive electronic search of databases including SCOPUS, PubMed, EMBASE, Elsevier, Web of Science, ResearchGate, ScienceDirect, Google, and Google Scholar, focusing on natural compounds from *A. indica*, which are available up to June 2024. We identified 58 compounds and assessed their pharmacokinetic properties using SwissADME, applying Lipinski's rule of five to evaluate potential drug safety. From this, 28 compounds were deemed promising. These compounds were further screened for binding affinity using PyRx 8.0 in their 3D SDF forms. Compounds with binding affinities greater than -5 kcal/mol were subjected to blind docking with 3Cpro using CB-Dock2. The results identified two compounds: Etioporphyrin III and Harderoporphyrin, with same binding affinities of -8.3 kcal/mol, matching that of the known SVA inhibitor luteolin (PubChem ID: 5280445). Both compounds effectively interacted with key amino acids in the active site of SVA's 3Cpro, potentially inhibiting the enzyme and preventing viral replication. Our findings suggest that these two compounds from *A. indica* may serve as effective SVA inhibitors. However, further molecular dynamic simulations, *in vitro* and *in vivo* studies are necessary to validate their therapeutic potential against SVA.

Keywords: Senecavirus A, *Acalypha indica*, 3C protease inhibitors, virtual screening, *in-silico*

Enhanced Removal of Heavy Metals (Copper, Cadmium, and Chromium) from Textile Wastewater Using Crab Shell-Derived Chitosan/Alumina Composite

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Abstract

This study investigates the removal of heavy metals from textile wastewater using chitosan derived from Sri Lankan crab shells collected in Negombo, Sri Lanka as well as a composite of chitosan and alumina. The chitosan was extracted in powder form, and a chitosan-alumina composite was synthesized by creating a slurry of 20 g alumina in distilled water, followed by the addition of chitosan dissolved in acetic acid, with cross linking facilitated by glutaraldehyde. Characterization of both chitosan and the chitosan-alumina composite was performed via Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD). FTIR analysis revealed key functional groups in chitosan, including –OH and –NH stretching at 3440 cm^{-1}, as well as important peaks in the chitosan-alumina composite, such as a characteristic metal-oxygen stretch at 625 cm^{-1}. XRD results confirmed the presence of both chitosan and alumina phases. Adsorption studies utilized pure heavy metal standard solutions for copper (Cu), cadmium (Cd), and chromium (Cr), each at an initial concentration of 1000 µg/L, diluted to 20 µg/L for testing. Adsorption capacity tests, quantified using atomic absorption spectroscopy, show promising heavy metal removal capabilities, with significant adsorption potential for Cu^{2+}, Cd^{2+}, and Cr^{3+} ions. This study offers insights into optimizing adsorption conditions for textile wastewater treatment and supports the use of crab shell-derived chitosan and its alumina composite as effective adsorbents.

Keywords: chitosan, chitosan-alumina composite, heavy metals, textile wastewater, adsorption

Establishment of *Stevia rebaudiana* Cell Cultures and Phytochemical Profiling via GC-MS and HPLC

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Abstract

Stevia rebaudiana, a plant renowned for its high content of non-caloric steviol glycosides, is widely used as a natural sweetener. This study focused on the establishment of Stevia cell suspension cultures from *in vitro*-derived calli and the comparative phytochemical analysis of leaves, calli, and cell suspension cultures using GC-MS and HPLC. Six-weeks old leaf disc derived calli (~5.0 g) were transferred into 150 mL of liquid MS medium supplemented with 2.0 mg/L BAP and 1.0 mg/L NAA and they were agitated at different speeds (50, 100, and 150 rpm) on a rotary shaker at 25±1 °C and kept under both light and dark conditions. Cultures were monitored for contamination and cell aggregate formation. Phytochemical analysis via GC-MS and HPLC was conducted on three-months old plant leaves, six-weeks old calli, and two-weeks old cell cultures. Phytochemical extraction of leaves, callus and cell pellet obtained by centrifugation was performed using methanol as the solvent and filtered extracts were used for analysis. The optimal agitation speed for successful culture establishment was 100 rpm, which ensured effective cell separation. Lower speeds resulted in cell clustering, while higher speeds caused cell damage. HPLC analysis showed that plant leaves accumulated significantly higher levels of steviol glycosides (Rebaudioside A: 8.234±0.04 mg/mL, Stevioside: 10.132±0.03 mg/mL, Rebaudioside C: 1.585±0.02mg/mL, Dulcoside A: 0.477±0.01 mg/mL) compared to callus (Rebaudioside A: 1.793±0.01 mg/mL, Stevioside: 2.228±0.03 mg/mL, Rebaudioside C: 0.365±0.03 mg/mL, Dulcoside A: 0.118±0.01 mg/mL) and cell cultures (Rebaudioside A: 0.272±0.02 mg/mL, Stevioside: 0.384±0.01 mg/mL). This disparity is likely due to the higher levels of photosynthetic pigments in leaf tissues, which positively correlated with steviol glycoside content. Callus exhibited lower glycoside levels, and cell cultures produced minimal amounts, underscoring the essential role of light in glycoside biosynthesis. GC-MS identified distinct phytochemical profiles across the different culture systems (22 in leaves, 16 in callus, and 12 in cell culture), revealing bioactive compounds with pharmacological properties. These findings indicate that *in vitro* systems hold potential for bioactive phytochemical production including steviol glycoside, although further optimization is needed.

Keywords: *Stevia rebaudiana*, steviol glycosides, cell suspension culture, GC-MS, HPLC

Textile Dye Decolorization by Selected Ascomycete Fungi from Urban Dumpsites and Freshwater Habitats in Sri Lanka

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Abstract

Dyes are integral elements used to impart color to textile materials. In textile industry, the use of synthetic dyes is very common. The wastewater effluent generated during the processing and treatment of the dye contains inorganic and organic compounds that are hazardous, thereby posing a serious threat to ecosystems. This study focused on valuating the decolorization capability of textile dyes using selected ascomycetous species. The potential of dye decolorization was assessed for fourteen ascomycetous fungal isolates, obtained from selected local dump sites and freshwater habitats in Colombo district. These fungi were tested against three synthetic dyes: crystal violet, congo red, and brilliant green, which belong to the chemical groups of triphenylmethane, azo, and triarylmethane, respectively. Results revealed that *Fusarium falciforme* (USJCC-0046) has the highest decolorization potential, removing 83% of crystal violet and 74% of brilliant green. *Talaromyces purpureogenus* (USJCC-0047) showed the most effective decolorization of congo red, achieving 70% removal within seven days of incubation in a dye solution (50 mg/L, pH 7, 27±2 °C, and 150 rpm). The biosorption of the dye into fungal mycelia was relatively low, less than 30% for all three dyes, indicating a predominance of enzymatic degradation over physical adsorption. Lignin peroxidase, a type of lignolytic enzyme was found to be the primary enzyme involved in degrading these dyes. Moreover, Fourier transform infrared spectroscopy analysis conducted before and after fungal treatment of each dye revealed the biodegradation of the chromophore structures of crystal violet and congo red by fungal enzymatic activity. This study concludes that *F. falciforme* effectively decolorizes crystal violet and brilliant green through lignin peroxidase activity, altering dye structures for breakdown, while *T. purpureogenus* efficiently decolorizes congo red via biosorption and enzymatic action. These findings suggest that *F. falciforme* and *T. purpureogenus* could be optimized for large-scale textile dye effluent treatment due to their ability to effectively target diverse dye structures.

Keywords: bioremediation, enzymes, mycoremediation, textile dyes

Assessment on the Genetic Diversity of Genotypes from 2022 - Hand Pollinated Progeny of *Hevea basiliensis*

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Abstract

Hevea brasiliensis (Willd. ex Adr. de Juss.) Muell. Arg. plant is the major producer of natural rubber, which is an important industrial raw material. The genetic base of cultivated *Hevea* is heavily constricted since it has been derived from narrowed Wickham's genetic base as well as due to a long period of directional selection. Therefore, it is important to raise genetically diverse clones for commercial cultivation. Ten *Hevea* genotypes selected from the year 2022 - hand pollinated progeny, which used two different female parents from non-Wickham's germplasm, were subjected to analyze for genetic diversity among them. A total of ten *Hevea*-specific simple sequence repeat markers were used for this study. Amplified PCR products were separated using 1.2% agarose gel electrophoresis and visualized under a gel documentation system. Depending on the primer, it was possible to identify that three primers have produced one allele, six have produced two distinguishable alleles, and Primer hmct - 05 has produced multiple alleles. NTSYSpc software (version 2.10e) was used for the generation of the genetic distance matrix and the dendrogram. The dendrogram analysis of genotypes revealed two main clusters (A and B), with cluster A primarily consisting of genotypes from specific parentages, notably those involving RRISL 2006 and RRISL 211. Genotypes in cluster A share relatively low genetic distances, with 2022HP_59 exhibiting higher divergence. Cluster B showed lower similarity among genotypes despite being in the same cluster. The genetic distance matrix highlighted significant dissimilarities, particularly between genotypes 2022HP_25, 2022HP_52, and 2022HP_65. These genotypes represented a high genetic variability, and they can be selected for further study due to their notable genetic distances and potential common basis, with 2022HP_25 serving as a focal point for comparison. Accordingly, from 2022 - hand pollination progeny, genetically diverse clones can be added to enrich the *Hevea* genetic pool for future breeding programs.

Keywords: DNA extraction, genetic diversity, *Hevea brasiliensis*, SSR markers

Morpho-Molecular Characterization of Pitcher Fluid and Endophytic Fungi from *Nepenthes distillatoria*

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Abstract

Nepenthes distillatoria L., is a carnivorous pitcher plant endemic to Sri Lanka and it is the sole representative of the genus *Nepenthes* found in Sri Lanka. Their pitchers are adapted to capture, digest, and absorb insect prey to satisfy the nitrogen requirement of the plant, which enables them to grow and survive in poor nutrient habitats. The micro environmental conditions of the pitcher plants are considered as a unique environment for various diverse microorganisms. The aim of this study is to isolate and characterize pitcher juice inhabiting and endophytic fungi from *N. distillatoria*. Pitcher fluid samples and tissue samples were collected from two locations in Kalawana, Rathnapura district, Sri Lanka. Twelve open pitcher fluid samples and twenty four pitcher tissue segments were collected. Seven filamentous fungi from pitcher and eleven fungal endophytes were isolated. Fungi were morphologically characterized to the genus level and ITS sequences were obtained for two selected isolates. Morphological characterization revealed four fungal isolates inhabiting the pitcher fluid of *N. distillatoria*, belonging to the genus *Aspergillus*. Based on the molecular characterization, one endophyte was identified as *Annulohypoxylon stygium* (*Xylariales*, Hypoxylaceae) and one pitcher fluid inhabiting fungus was identified as *Sporothrix* sp. (*Ophiostomatales*, *Ophiostomataceae*). This is the first record of *A. stygium* in Sri Lanka. According to available literature members of genus *Aspergillus* has wide variety of industrial applications such as production of enzymes, organic acids, and for the fermentation processes. *A. stygium* is also a known organism to produce amylase. This study reveals that *N. distillatoria* pitcher hosts diverse and interesting fungi with potential industrial applications.

Keywords: *Aspergillus*, endophytes, *Nepenthes distillatoria*, pitcher fluid, *Annulohypoxylon stygium*

In silico Identification of Hub Proteins Responsible for C_3 Photosynthesis Using a Network-Based Approach

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Abstract

Photosynthesis serves as the primary mechanism sustaining life on Earth yet increasing food demand has strained crop yields as populations grow and crop productivity plateaus. As many crops utilize the less efficient C_3 photosynthesis pathway, improving photosynthetic efficiency is crucial to meeting global food needs. Identifying target genes or proteins could enable the manipulation of major crops to boost photosynthetic efficiency. However, despite numerous studies, large-scale proteomic analyses in this area are still limited. To address this gap, this study conducted an *in silico* analysis of the protein-protein interaction (PPI) network in C_3 photosynthesis to identify hub proteins that could serve as potential candidates for improving photosynthetic efficiency. Using *Oryza sativa japonica* as a model, a C_3 PPI network was constructed by retrieving the global PPI network from the STRING database and extracting known photosynthesis related proteins and their interactions. The Louvain community detection algorithm partitioned the C_3 network into submodules and visualized with Cytoscape (version 3.10.1). Functional enrichment analysis of the submodules was performed using g:Profiler in Python, to identify the functions related to the respective submodules. To identify both inter- and intra-modular hub proteins, the within-module degree z-score and participation coefficient of the proteins within the network were calculated. The C_3 PPI network contained 239 proteins and 4,116 interactions, organized into eight submodules. Light reaction-related PPIs were distributed across several submodules, while dark reactions were concentrated in one. There were 12 intra-modular hubs, including phosphoglycerate kinase, transketolase, triose phosphate isomerase, and phosphoribulokinase which are involved in the Calvin cycle. Additionally, 20 inter-modular hubs were identified, including protochlorophyllide reductase, oxygen evolving complex proteins, and cytochrome b_6f complex iron-sulfur subunits. These hub proteins are essential for stabilizing the C_3 photosynthesis PPI network module and represent valuable targets for genetic engineering to enhance photosynthetic efficiency in C_3 crops especially in *O. sativa japonica*. Hence, this study offers insights into developing high yield C_3 crops aiding global food security.

Keywords: protein-protein interaction network, C_3 photosynthesis, submodules, hub proteins

Repellent Effect of Essential Oil Extracted from African Marigold, *Tagetes erecta* Flowers against *Aedes aegypti* Mosquitoes

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Abstract

Aedes aegypti mosquito, a major vector for dengue fever, poses a significant public health issue in Sri Lanka. This study evaluates the effectiveness of essential oil derived from African marigold (*Tagetes erecta*) flowers as a natural mosquito repellent, presenting an eco-friendly alternative to synthetic repellents. The essential oil was extracted using the steam distillation. Approximately 100 g of air dried marigold flowers were used per extraction, yielding about 0.25 mL of oil per 100 g of flowers. The repellent efficacy was assessed following World Health Organization guidelines, using one control cage and three treatment cages, each containing 50 *Aedes aegypti* mosquitoes. Six different concentrations of the essential oil diluted with ethanol (5, 6, 7, 8, 9, and 10% v/v) were applied to a 600 cm^2 area on the forearms of a single volunteer, restricting the mosquitoes' landing area to the hands. Each concentration was tested in triplicate, with a 30-minute interval between applications to maintain consistency. Mosquito landings were counted, and percent repellence was calculated as a proportion of the number of mosquito landings on the treated arm with the number of landings on the control arm of the same individual. Probit values of repellence were plotted against log doses. Statistical validation of the equation was tested through linear regression analysis. The effective dosage (ED 50 and ED 99.9) values of 5.98±0.92% and 9.64±1.63%, respectively, were computed from the linear equation. The 9.64±1.63% concentration provided complete protection for up to (150±10) minutes. Field tests were conducted in two selected rooms with similar environments, within a known mosquito prone area. A vaporizer containing the essential oil (25 mL) was activated 30 minutes before peak mosquito landing time in the treatment room. Significant mosquito reduction was observed, providing up to 180 minutes of protection in the treatment room. These findings demonstrate that *Tagetes erecta* oil is a promising natural solution for mosquito control, offering an eco-friendly alternative to synthetic repellents in laboratory and field conditions.

Keywords: *Aedes aegypti*, mosquito repellent, African marigold, essential oil

Evaluation of Antifungal Potential and Synergistic Effects of Selected Medicinal Plant Extracts Against Dermatophytes and *Candida* Species

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Abstract

Fungal infections caused by dermatophytes and *Candida* species are becoming increasingly resistant to conventional treatments. This study evaluated phytochemicals and antifungal effects of the *Tinospora cordifolia* stem, *Momordica charantia* leaves, and *Cardiospermum halicacabum* leaves and their combined antifungal potential against *Trichophyton mentagrophytes*, *Trichophyton rubrum*, and *Candida albicans* (ATCC 10231). Antimicrobial efficacy of ethanolic extractions of the above plant materials was evaluated against selected fungi using agar well diffusion assay, minimum inhibitory concentration (MIC), and minimum fungicidal concentration (MFC). The extracts that showed good antifungal activity were combined in different ratios to calculate fractional inhibitory concentration index (FICI). Phytochemicals were identified using Borntrager's, Mayer's, Ferric chloride, and alkaline reagent tests. All tests were conducted in triplicate and compared to 10% DMSO, the negative control (10.00 mm) using R at a 5% significance level. Fluconazole was used as the positive control. *M. charantia* leaf extract contained alkaloids, glycosides, quinones, and flavonoids, while *T. cordifolia* had glycosides, quinones, and flavonoids. *C. halicacabum* extract contained glycosides, phenols, tannins, quinones, and alkaloids. Inhibition zones for *M. charantia*, *T. cordifolia*, and *C. halicacabum* against *C. albicans* (15±0.40, 16±0.90, and 14±0.15 mm), *T. mentagrophytes* (18±0.15, 14±0.20, and 13±0.43 mm), and *T. rubrum* (12±0.35, 14±0.20, and 13±0.32 mm), respectively. MIC/MFC values for *M. charantia* leaf, *T. cordifolia* stem, and *C. halicacabum* leaf extracts were reported as follows: for *C. albicans* (250, 50, and 250 mg/mL), *T. mentagrophytes* (3.125, 0.0122, and 3.125 mg/mL), and *T. rubrum* (50 mg/mL each). *M. charantia* leaves and *T. cordifolia* stem were the most efficient. The combination extracts did not show any significant synergistic activity. The findings highlighted the antifungal potential of selected medicinal plant extracts as natural, alternative antifungal agents, offering promising avenues for developing effective treatments for certain fungal infections.

Keywords: antifungal activity, *Momordica charantia*, *Tinospora cordifolia*, dermatophytes, *Candida albicans*

Nature's Anti-Inflammatory Arsenal: Harnessing Green Synthesized Silver Nanoparticles for Therapeutic Applications

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Abstract

Silver nanoparticles (AgNPs) have gained significant attention due to their therapeutic applications in medical sciences and disease treatment. This study employed chitosan for the bottom up green synthesis of AgNPs through a cost effective method and investigated its potential anti-inflammatory activity. The formation of AgNPs was confirmed through a set of analysis techniques. A key indicator of the successful synthesis of AgNPs was the shift in the reaction mixture's color from pale white to reddish-brown, which gave a surface plasmon resonance peak at 420 nm in the UV visible spectrum. Transmission electron microscopy images revealed spherical shaped AgNPs with sizes ranging between 2 and 12 nm. From X-ray diffraction, it was confirmed that the nanoparticles (NPs) are in the face centered cubic structure with a high crystallinity index equal to 0.94. Energy dispersive spectrometry results confirmed the presence of a high amount of metallic silver in the NPs. The human red blood cell membrane stabilization method was used to assess the anti-inflammatory ability of synthesized AgNPs, which measures the prevention of heat induced hemolysis. The activity was tested across concentrations ranging from 62.5 to 1000 µg/mL and compared to aspirin as a reference. Aspirin reported a high inhibitory effect at its lower concentrations, indicating its IC_{50} value at 67.16±1.93 µg/mL, while AgNPs exhibited a higher maximum inhibition of 85.06±1.61% at 1000 µg/mL. Although AgNPs had a relatively slightly higher IC_{50} value (79.754±1.65 µg/mL), they provided superior inhibition at higher concentrations, suggesting a distinct anti-inflammatory mechanism compared to aspirin. Their interaction with the cell membrane might be one of the reasons behind their activity in erythrocyte membrane stabilization and cell lysis reduction, by surface charge modification. This study underlines biosynthesized AgNPs' potential as a natural anti-inflammatory agent promising alternative to conventional nonsteroidal anti-inflammatory drugs with less probable side effects.

Keywords: anti-inflammatory, AgNPs, asprin, IC_{50}, human red blood cell

In vitro Antimicrobial Activity of Selected Medicinal Plants against *Escherichia coli* and *Staphylococcus aureus*

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Abstract

Antibiotic resistance is one of the most significant challenges of the 21st century, leading to increased global healthcare expenditures due to the necessity for more complex and expensive treatments. In response, researchers are actively investigating target product profiles as alternative antimicrobial sources capable of combating this prevalent issue. Medicinal plants used in traditional practices have emerged as promising candidates for developing new drug compounds effective against antibiotic resistant bacteria. This study aimed to evaluate the *in vitro* antimicrobial activity of selected medicinal plants against common human pathogenic bacteria; *Escherichia coli* (ATCC® 25922™) and *Staphylococcus aureus* (ATCC® 29213™). The plant materials examined included *Abelmoschus moschatus* (leaves and stems), *Aporosa cardiosperma (Gaertn.) Merr.* (leaves and stems), *Celosia argentea* (leaves and flowers) as well as *Nauclea orientalis* (leaves and roots). A sequential extraction procedure using industrial solvents was performed, followed by qualitative phytochemical analysis to identify secondary metabolites present in the extracts. The antimicrobial susceptibility was assessed using the EUCAST disk diffusion assay. As the main findings of the research, the methanolic crude extracts of all plants exhibited inhibitory effects on the proliferation and growth of both tested microorganisms. Among all plant extracts, methanolic extracts of *Nauclea orientalis* leaves exhibited the highest zone of inhibition against gram negative *E. coli* (12.67±0.58 mm) and gram positive *S. aureus* (10.00±2.65 mm). Preliminary phytochemical screening of plant extracts, conducted using standard qualitative methods; Hager's test, foam test, alkaline reagent test, and Ferric chloride test, revealed the presence of alkaloids, saponins, flavonoids, phenols, and tannins, respectively. The antimicrobial activity observed in the plant extracts may be caused by the presence of these secondary metabolites. Hence, this study emphasizes the potential of the selected medicinal plants as the sources of novel antibacterial agents that can be further improved and developed for pharmaceutical applications against antibiotic resistant bacteria.

Keywords: antimicrobial, ethnopharmacology, natural products, medicinal properties, phytoconstituents

A Comparative Study to Find Effective Methods for Rhamnolipid Extraction and Purification from *Pseudomonas aeruginosa* towards Their Antibacterial Efficacy against Uropathogenic *Proteus mirabilis*

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Abstract

Rhamnolipid, a biosurfactant derived from *Pseudomonas aeruginosa* is known to exhibit antibacterial activity against *Proteus mirabilis*. *P. mirabilis* is a potentially serious urinary tract infection causing uropathogens due to formation of crystalline biofilms. In the present study, we aimed to find effective methods for rhamnolipid extraction and purification from *P. aeruginosa* towards their antibacterial efficacy against uropathogenic *P. mirabilis*. Mineral salt medium (MSM) and tryptic soy broth (TSB) were tested to identify the more effective fermentation broth for *P. aeruginosa* in rhamnolipid production and then compared its composition. Rhamnolipids were extracted using chloroform : methanol : acetone (1 : 1 : 1), chloroform : methanol (2 : 1), and acid precipitation methods. Cold acetone was used to purify rhamnolipids. Fourier transform infrared spectroscopy was used to characterize the obtained rhamnolipid. Antimicrobial activity of rhamnolipid were examined against six *P. mirabilis* strains using well diffusion, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC). Among TSB and MSM, the optimal medium was MSM with a carbon/nitrogen ratio of 18 : 1, yielding 1.04 g/L. Chloroform : methanol : acetone method was effective in rhamnolipid extraction, resulting 1.04 g/L of rhamnolipid followed by chloroform : methanol (0.67 g/L), and acid precipitation (0.31 g/L) methods. Cold acetone purification resulted honey color, sticky rhamnolipids at room temperature. Rhamnolipids exhibited inhibition zones at 20 mg/mL ranging 11.00 - 17.67 mm and 30 mg/mL ranging 13.33 - 22.67 mm against six *P. mirabilis* strains, but not in 10 mg/mL. The MIC and MBC were ranged between 12.50 - 50.00 mg/mL, and 12.50 - 50.00 mg/mL, respectively. Findings highlight that rhamnolipid is a promising antibacterial agent against *P. mirabilis* causing urinary tract infections.

Keywords: rhamnolipid, *Proteus mirabilis*, antibacterial

Developing a Sunscreen from *Leucas zeylanica* Plant Extract

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Abstract

This research aims to develop a sunscreen utilizing *Leucas zeylanica* extract, addressing the increasing demand for natural, effective, and sustainable skincare solutions. *L. zeylanica* (*geta thumba*/Ceylon slitwort) is a herbaceous perennial belonging to the Lamiaceae family. In this study, sunscreen lotions were formulated using this medicinal plant extract to assess their efficacy and photostability. Dried leaves and green stems of *L. zeylanica* were extracted using 70% methanol solution and afforded a total flavonoid content of 7.96 (QUE) mg/g. The extract was formulated into four different sunscreen lotions with the following ratios of cream base to plant extract: 10 : 1 (lotion 1), 4 : 1 (lotion 2), 2 : 1 (lotion 3), and 4 : 3 (lotion 4). The pH, UV filtering capacity, and photostability were assessed. Thus, the pH of the lotions measured 6.71, 6.89, 6.66, and 6.38, respectively, all within the acceptable limit in skincare products. The initial sun protection factor (SPF) values were high, with SPF for lotions 4, 3, 2, and 1 recorded at 26.31, 20.62, 12.44, and 6.57, respectively. The gradual decrease in UV absorption and SPF values over the 21 days of sunlight exposure indicates potential photodegradation. Still, lotions 3 and 4 maintained an SPF value above that of the positive control. The photostability was determined by the area under curve (AUC) index of the entire UV spectrum, UVA1, UVA2, and UVB. AUC indexes for lotions 1, 2, 3, and 4 were 0.91, 0.95, 1.00, and 0.95, respectively, indicating that after exposure all formulations maintained more than 80% of their capacity to absorb in the UV range. The findings suggested that *L. zeylanica* extract could be effectively used in sunscreen formulations, offering significant sun protection with proper application and reapplication. This research underscored the potential of *L. zeylanica* as a natural alternative to the available artificial sun protection products, contributing to public health and supporting the sustainability of the healthcare system.

Keywords: *Leucas zeylanica*, sunscreen, flavonoid, SPF value

Application of Polyisocyanopeptide Polymer Matrix for 3D Biomimetic Cell Culture Studies under Simulated Microgravity Condition

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Abstract

In space microgravity, mechanical unloading impacts on mechanosensitive cells in bone tissue, which lowers bone mineral density in the weight-bearing bones. Due to disuse, bedridden patients for an extended period have a similar condition. It is yet unclear how mechanical unloading causes cytological changes. This research aims to investigate cellular alterations due to exposure to simulated microgravity in a 3D biomimetic matrix. The use of a 3D biomimetic cell culture is favored over 2D systems, with altered behaviors due to cell flattening and abnormal polarization. Among various hydrogel systems developed for 3D cell culture, polyisocyanopeptide (PIC) polymer hydrogels show unique properties, including thermosresponsive behavior and stress stiffening in response to mechanical forces, similar to naturally occurring biopolymers. Two types of PIC polymers were synthesized using separate isocyanide monomer-to-catalyst ratios, resulting in polymers of two different molecular weights. FTIR was used to monitor reaction completion, while viscometry was used to calculate the molecular weights. Mechanical properties were determined by rheological analysis, focusing on bulk stiffness and critical stress. Additionally, conjugating the polymer with a c(RGDyK) peptide via copper-free strain-promoted alkyne-azide cycloaddition click-reaction enhanced biocompatibility by mimicking specific integrin binding sites. Following peptide conjugation, optimization was performed by adjusting polymer concentration and ligand density to identify mechanical properties suited for osteocyte cell morphology. Osteocytes, known for their high mechanosensitivity in bone tissue, were selected, with the OCY454 cell line chosen for its rapid differentiation into mature osteocytes. To simulate microgravity, a random positioning machine, an advanced and effective tool, was employed. This multifaceted approach used confocal microscopy to observe cellular morphology at different polymer conditions. Findings suggest a synergistic effect of the polymers' mechanical and biochemical signals on morphology of osteocytes under simulated microgravity.

Keywords: microgravity, 3D cell culture, stress stiffness, confocal microscopy

In vitro Cytotoxicity Assessment of a Marine *Bacillus* sp. Crude Biopigment from Sri Lanka: A Potential Natural Food Colourant

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Abstract

Synthetic food colourants are often utilised to replace the inherent natural colour of food products that may degrade due to processing or storage conditions. While these colourants can enhance consumer appeal and sensory characteristics, their documented associations with health hazards due to their acute toxicity and non-biodegradability have necessitated safer and sustainable naturally derived alternatives. Marine bacteria offer a promising source of natural colourants. Therefore, the present study aimed to investigate the probability of incorporating marine bacterial crude biopigments as food colouring agents. A marine pigment producing bacterial isolate (KKD1), exhibiting red colour in the visible light spectrum was isolated from epipelagic marine water samples collected from Kadolkale, Negombo lagoon, Sri Lanka. Morphological and biochemical identification assays confirmed the identity of the bacterial isolate as *Bacillus* sp. The intracellular crude pigment was successfully extracted using ultrasound assisted sonication buffer extraction with composition 5% (w/v) SDS and 0.5 M Tris-HCl (pH 7). Subsequently, the extracted crude pigment was characterised using UV spectrometry in the visible light region and found to comprise prodiginine. The animal model, *Artemia salina nauplii* was used to assess the cytotoxicity profile of the extracted crude pigment. For comparison, a commercial food colouring agent was tested under the same conditions as the crude pigment extract. Hydrogen peroxide of 3% (v/v) was the positive control, while distilled water was the negative control. According to Meyer's and Clarkson's toxicity indices, the LC_{50} value (required for 50% mortality) for the KKD1 crude pigment extract (0 mg/mL) was cytotoxic while the LC_{50} value for the commercial food colouring agent (10 mg/mL) showed no cytotoxic effects. The findings of this study suggest that the sonication buffer extracted crude biopigment of the marine bacterial isolate, *Bacillus* sp. (KKD1) cannot be used as a non-toxic food colouring agent, but may have implications as an antimicrobial or anticancer agent due to implied high bioactivity.

Keywords: biopigments, cytotoxicity, food colourants, pigment producing bacteria

Building Construction and Infrastructure Technology

Effectiveness of Organic and Inorganic Preservatives in Controlling Blue Stain Fungi in Pine Wood

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Abstract

The occurrence of blue stain fungi is one of the severe problems in the pine wood industry. This significantly reduces the market value of pine wood due to its visible discoloration. This study investigates the occurrence of blue stain fungi growth in pine wood plantations in Sri Lanka, the effectiveness of organic and inorganic preservatives and environmental exposure conditions in controlling them. This study was conducted over six months from October 2023 to March 2024 in Bandarawela, Sri Lanka (annual average temperature 21.2 °C and average relative humidity 82.8%) using fifty four wood samples. Wood samples were treated with commercially available two inorganic chemicals and two organic preservatives developed in Sri Lanka using the dipping method with 48 hours of dip duration. One-half of the wood samples were kept exposed to the natural environment and the other half were kept in a shaded area where a shelter was provided against the rain. Three samples were kept non-treated in both sets as the control samples. Results showed varying levels of fungal growth across treatments and environmental conditions, with shaded wood samples exhibiting a lower growth of blue-stain fungi. The study emphasises controlling environmental exposure, particularly providing shelter, which leads to mitigating fungal infestation in pine wood. However, the efficacy of different treatment methods in controlling blue stain fungi remains inconclusive, highlighting the need for further research to assess long-term treatment effectiveness and sustainability. By understanding the challenges posed by biological attacks on wood durability, this research contributes to enhancing the preservation and performance of timber in construction applications in Sri Lanka and beyond.

Keywords: blue-stain fungi, fungi existence, organic preservatives, wood treatment

The Effect of Long-Term Permeation of Inorganic Salts on the Geotechnical Characteristics of Bentonite-Amended Clay Liners

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Abstract

Bentonite-amended clay liners of the engineered landfills are used to prevent the migration of hazardous pollutants in the leachate into the groundwater. This study was conducted to evaluate the alteration of geotechnical characteristics of bentonite mixed clays upon exposure to long-term contact with inorganic salts present in the leachate. Plasticity, compressibility, and hydraulic conductivity characteristics of clayey soil mixed with 10 and 20% bentonite were tested under the permeation of water and 1 M solutions of $CaCl_2$, $MgCl_2$, and NaCl and were compared with the samples soaked in 1 M solutions of $CaCl_2$ and NaCl for 180 days to understand the effect of long-term leachate contact. The results showed that the liquid limit and plastic limit of bentonite-amended soils decreased with the presence of $CaCl_2$, $MgCl_2$, and NaCl salt solutions compared to those results when the water is pore fluid. The samples immersed in salt solutions exhibited much lower liquid limit and plastic limit when compared to fresh samples prepared using those salt solutions and those were lower than the unamended soil indicating unfavorable effects of these salts on the liner plasticity. Coefficients of consolidation values of the samples with 10 and 20% bentonite immersed in $CaCl_2$ and samples with the 10% bentonite immersed in NaCl show an increasing trend with the increase in effective stress. The hydraulic conductivity of all the samples immersed in $CaCl_2$ and NaCl exhibit a decreasing trend with the effective stress and those reached values lower than 1×10^{-9} m/s after submerging in salt solutions for 180 days. The improvement of hydraulic conductivity with adding a higher amount of bentonite is not significant when submerged in different salt solutions. It can be concluded that samples with higher amounts of bentonite are more vulnerable to attack by the inorganic salts in the long term.

Keywords: bentonite, leachate, plasticity, swell

A Systematic Review of Sustainability Indicators in Construction: Towards an Integrated Framework for Enhancing Economic, Environmental, and Social Performance

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Abstract

Global climate change as well as other environmental issues are a real threat to the construction industry in the adoption of sustainable construction. As a result of increasing concern with sustainable measures in an effort to address issues of sustainable construction, this study undertakes a systematic review of measures for evaluating sustainability performance of construction projects alongside economic, environmental and social performance indicators. Previous literature has enumerated a number of relevant metrics; however, current typologies tend to be non-systematic, non-based on contingency, more cross-sectional, without involving the stakeholder, and lacking as to paths to operationalization. This study fills these gaps by developing an integrated framework that examines project performance at critical phases: preliminary, design, construction, use, and deputation. The present study will use systematic literature review to define research questions, search strategies, articles screening, and result extraction. For these only articles which are in English language and peer reviewed only will be used, and only articles that has been published from year 2000 to 2024 will be included. Sustainability indicators are divided across separate categories, for instance, energy efficiency, resource utilization, reduction in emissions, social welfare and the like, and then analyzed to determine the suitability for the stated phases. The framework defines concrete, practical measures to reduce costs, increase quality, reduce the adverse effects on the environment and benefit key stakeholders at each phase of the project. For these reasons, it provides clear guidelines and objectives for evaluating and improving the sustainability of construction projects and helpful application of these indicators within industry decision making. This particular study aims to highlight as to how this framework can make pragmatic practices better in the real world by providing a depictive model that the stakeholders can follow to accomplish their long-term goals and objectives in a sustainable way while pushing technological evolution forward and improving the efficacy of projects. Future researches would help to polish these indicators in context, incorporate new technologies, and verify this framework in different institutional environments proved that this approach contributed to changing the sustainable construction standard globally.

Keywords: construction industry, integrated assessment, performance evaluation, sustainable construction, sustainability indicators

Development of Conformity Checking Framework in Revit for Two-Story Residential Buildings in Sri Lanka

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Abstract

This study introduces a comprehensive approach to ensuring that small residential houses in Sri Lanka meet regulatory standards using Building Information Modeling (BIM). It tackles the challenges posed by unregulated residential construction and its effects on sustainable development by proposing a novel BIM-based method to facilitate compliance checks with the Urban Development Authority Planning & Development Regulations 2021 in Sri Lanka. Improper residential designing and construction may lead to noncommunicable diseases among occupants, interpersonal violence, inefficient energy consumption, food and water insecurity, and waste generation. An inadequate living atmosphere with polluted water, soil, and noise may lay a road to diseases such as tuberculosis, diabetes, cancer, and diarrhea. Also, insufficient ventilation will drastically increase power consumption of dwelling units. Unsustained house planning also can lead to unintentional injuries such as household accidents caused by unsafe building elements. Focusing on two-story residential buildings, the study integrates dynamo scripts with Autodesk Revit to automate verification of regulatory requirements. The framework's effectiveness is displayed through a series of compliance checks, including assessments of plot coverage, room dimensions, and setbacks from electricity lines. The findings show that the proposed BIM approach can significantly enhance the quality of residential construction, promote sustainable living, and drive growth in Sri Lanka's construction industry. The study also highlights BIM's potential to improve design accuracy, reduce construction mistakes, and ensure compliance with environmental and building regulations. By providing a methodological foundation for applying BIM in the planning and construction of sustainable residential homes in urban areas, this study addresses a significant gap. The study concludes with recommendations for advancing and integrating BIM practices within Sri Lanka's construction sector, underscoring its role in driving future industry development.

Keywords: building information modeling, building regulations, dynamo, Revit, urban development authority

Developing an Effective Cost Management Methodology for Project Success: A Case Study in the Western Province, Sri Lanka

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Abstract

The construction industry is a major contributor to Sri Lanka's economy and is currently facing challenges where cost overruns significantly impact project success, particularly in the economically crucial Western Province, Sri Lanka. This region plays a vital role as the country's economic hub, with major cities like Colombo and a large concentration of industrial and commercial activities. Therefore, this study aimed to develop an effective cost management methodology to address cost overruns and ensure successful building projects in this province. A mixed-methods approach involving questionnaires and interviews with construction professionals was employed to gather quantitative and qualitative data. The data were collected from 51 construction experts in the Western Province, Sri Lanka, who proposed a wide array of solutions based on their experience with project cost management, achieving a response rate of 73%. The analysis revealed key challenges, including inaccurate cost estimation (59%), data inaccuracies (36%), external economic factors (33%), insufficient project tracking and reporting (31%), frequent scope changes (31%), and integration difficulties (31%) with existing cost management systems. To address these issues, effective strategies such as data analysis for budgeting (57%), parametric estimation for cost forecasting (41%), earned value analysis (41%), and project management information systems (37%) for cost control were highlighted. Additionally, methodologies like life cycle costing, lean management, and activity-based costing were emphasized as effective cost management methodologies. Best practices recommended include the regular cost monitoring and reporting (13%), use cost management technology and software (11%), risk mitigation strategies (10%), proper planning and estimation (9%), communication and stakeholder strategies (9%), conduct progress meeting (4%), and incorporating lessons learned from previous projects (3%). To improve cost management in the construction industry, implementing cost management software, Building Information Modeling, waste reduction practices, professional training and advanced estimation techniques is recommended. These strategies aim to enhance cost efficiency, reduce the risk of overruns, and support successful project completion and economic growth in the Western Province.

Keywords: cost management, cost overrun, project cost, project management, Sri Lanka

Communication and Networking Technologies

Automatic Identification of Steganography Images Using Machine Learning

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Abstract

Steganography presents a significant challenge in digital security due to its ability to conceal sensitive information within data, making detection critical for maintaining data integrity. Traditional methods of steganography detection often fall short of accurately identifying hidden content, particularly in images, due to their inability to detect subtle anomalies. In comparison, this study introduces a novel approach using machine learning, specifically convolutional neural networks (CNNs), to significantly enhance detection accuracy and address these limitations. This study aims to address this challenge by developing a robust steganography detection system utilizing machine learning techniques. The core of this research involves using a CNN trained on a diverse dataset of least significant bit (LSB) steganographic images sourced from Kaggle. The dataset comprises 44,000 images, allowing for a comprehensive training process that enhances the model's accuracy. CNN achieved an impressive 80% accuracy in detecting hidden messages within images. Additionally, bit-level analysis using the Outguess tool further refined our understanding of the steganographic techniques employed. To complement the detection model, we developed a user-friendly application designed for hidden message identification. This application provides a comprehensive solution for users to manage steganographic threats effectively. It includes features for embedding and extracting hidden messages, thus, offering practical functionality alongside theoretical advancements. The results demonstrate that the developed system not only enhances the detection accuracy of hidden data using machine learning but also provides a practical tool for digital forensics and cybersecurity. This research significantly contributes to the field by addressing the limitations of traditional methods and proposing a machine learning-based approach that is both effective and user-friendly. Future work will focus on expanding the dataset to include a wider variety of steganographic techniques, enhancing format compatibility, and exploring real time implementation to continuously improve the system's robustness and accuracy.

Keywords: steganography, LSB steganography detection, machine learning, steganalysis

Enhancing the Performance of Chatbots by Improving the Cognitive Analysis Techniques

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Abstract

Chatbots are being used with increasing frequency in a variety of industries, including customer service, education, and healthcare, to improve user engagement by imitating human communication. This research project focuses into integrating cognitive analysis methods to enhance user experience and chatbot performance. Chatbots that integrate cognitive capabilities are able to comprehend human context and intent more effectively, resulting in more individualized and productive conversations. The research suggests a framework that enables chatbots to recognize linguistic, social, and emotional tones in user inputs by integrating IBM Watson Tone Analyzer with the CrewAI chatbot platform as well as other advanced platforms such as RASA and Hugging Face, which leverage natural language processing and machine learning algorithms. To improve user input comprehension, these frameworks specifically utilize the techniques of sentiment analysis, entity recognition, and contextual understanding. A thorough analysis of the literature reveals the gaps in chatbot technologies that currently exist, with many of the systems finding it difficult to have context-aware interactions. In order to overcome these constraints, the research suggests a framework that improves chatbots' emotional intelligence and conversational abilities defining the current status of chatbots, investigating the uses and advantages of cognitive analysis, and recognizing implementation challenges are some of the main objectives. Gathering requirements, analyzing gaps, and evaluating the proposed system's technology constitutes every part of the process. According to the research, intelligent chatbots can greatly increase user engagement and satisfaction in a variety of applications by offering insights into the potential of intelligent chatbots to revolutionize user interactions, this research advances the rapidly developing field of conversational AI and explores the ethical constraints and concerns regarding the application of AI, such as bias elimination, accountability and transparency, and data privacy compliance. In order to further test the proposed framework's efficacy in delivering emotionally intelligent and contextually aware chats, future work will concentrate on building a prototype chatbot.

Keywords: cognition analysis, conversational AI, customized interactions

Electrical, Electronics, and Embedded Systems

Innovative Smart Fabric Recycling Stations for Sustainable Waste Management in the Sri Lankan Apparel Industry

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Abstract

The Sri Lankan apparel industry, a major contributor to the economy, faces significant difficulties in managing fabric waste, necessitating innovative solutions to enhance efficiency and sustainability. This research introduces the development and optimization of smart fabric recycling stations to address these challenges by leveraging advanced technologies such as machine learning and internet of things (IoT). This station is designed to automate the identification and sorting of fabrics, reducing dependence on manual techniques that are prone to inaccuracies and contamination. The smart fabric recycling stations are equipped with weight sensors in each bin to monitor fabric quantities in real time, improving the efficiency of collection schedules. A convolutional neural network (CNN) model, trained on a comprehensive fabric image dataset, deploys on a Raspberry Pi to accurately classify fabrics. Real time data monitoring will be facilitated through an Android application, enabling seamless tracking of fabric types and bin fullness. The research methodology involves hardware integration using Raspberry Pi, cameras, weight sensors, servo motors, and a light source, along with developing a CNN-based fabric identification system and real time data monitoring platform. Experimental validation is ongoing, and we expect classification accuracy to be around 90% upon completion. By introducing this innovative approach, the study aims to enhance the sustainability of the Sri Lankan apparel industry, reduce landfill waste and promote a circular economy. Also, this research represents a significant step towards making fabric recycling more efficient, cost effective, and environmentally friendly, ultimately benefiting both industry and community.

Keywords: fabric recycling, IoT, machine learning, real time monitoring, sustainable waste management

Innovative Personalized Asthma Management: Integrating Real Time Environmental and Patient Monitoring with Wearable Technology for Enhanced Patient Outcomes

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Abstract

Asthma is a long-term respiratory condition that requires constant monitoring and effective management to prevent severe exacerbations. Traditional techniques of asthma management often lack the real time data integration and predictive abilities which are necessary to effectively manage asthma attacks. This research introduces an advanced system that integrates a wearable device, an inhaler and a mobile application to enhance asthma management through real time monitoring, data analysis, and predictive analytics. This system utilizes a wearable device equipped with sensors that continuously tracks environmental factors such as air quality, dust, humidity, temperature, and physiological parameters including heart rate and oxygen saturation levels. The inhaler is equipped with sensors to track its usage and status (ON/OFF and count), which are transmitted to the wearable device. The collected data is then communicated to the mobile application, which provides real time insights to the user, such as number of remaining doses in the inhaler and alerts for usage. A linear regression-based predictive model analyzes the data to identify patterns preceding asthma attacks, allowing the system to send personalized alerts that advise the patient to use their inhaler proactively. We anticipate achieving an accuracy rate of approximately 85 - 90% for the linear regression model, based on simulated data and controlled testing environments. Upon study completion, mean squared error will validate the model's accuracy in predicting asthma exacerbations. Thresholds for emergency notifications will be tailored to individual patient baselines, derived from initial testing and literature on safe heart rate and SpO_2 levels. This approach will guide the system's decision-making process, minimizing false alarms and ensuring meaningful interventions. In the event of an emergency, the system triggers alerts to both the patient's mobile device and their healthcare providers, ensuring timely intervention. By integrating patient-specific data with real time environmental data, the system offers a personalized approach to asthma management that is tailored to meet the individual needs of each user.

Keywords: asthma management, personalized healthcare, predictive analytics, real time monitoring, smart inhaler, wearable technology

3D Electro-Geometric Analysis of Lightning Vulnerability at Anuradhapura's Sacred Sites

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Abstract

The eight sacred places in Anuradhapura, Sri Lanka, are important Buddhist pilgrimage sites linked to events in Buddha's life. These include Jaya Sri Maha Bodhiya, Ruwanwelisaya, Thuparamaya, Lovamahapaya, Abhayagiri Dagaba, Jetavanarama, Mirisaveti Stupa, and Lankarama. Lightning, a common natural phenomenon, can cause irreversible damage to manmade structures, including ancient temples, which are a unique representation of our global heritage. Most monuments are usually built tall since these signify symbols of victory, thereby invariably becoming vulnerable to lightning. Researchers have successfully implemented lightning protection systems (LPS), but significant variations in stroke currents during lightning are due to climate change and geographical topography complexities. This research focuses on carrying out analysis based on three primary objectives. First, it conducts the comparison of LPS such as the protection angle method (PAM) and/or rolling sphere method **(**RSM) with the help of 3D geometric modeling, 3D geometric designs are combined with electrostatic models using finite element modeling of the COMSOL Multiphysics® software to calculate step and touch voltages. The outcomes will provide specific suggestions for improvement of lightning protection about architectural characteristics and geographic location of the sacred sites. Second, it assesses the effect of the degree of lightning protection and various striking distance methods on air terminal location. Third, it translates those results into a cross-validation study to evaluate the sufficiency of the proposed LPS, and in the process, it defines areas that require further protection based on shielding failure analysis. Moreover, the research presents a new lightning counting method to set the foundation of data-based risk analysis and integration into further protection. The research aims to preserve cultural assets by providing scientific solutions for improving lightning protection.

Keywords: protection angle method (PAM), rolling sphere method (RSM), stroke current, lightning protection system (LPS), lightning protection zone (LPZ), heritage preservation

Assessment of Power Factor and Energy Demand Reduction in an Apparel Industrial Load Using Capacitor Banks and Solar PV System

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Abstract

Electrical power quality is important in industrial operations due to the impact it has on the technical and economic performance of any electrical system. In the apparel sector, which relies on equipment like induction motors and transformers, inductive reactive currents reduce the power factor, leading to inefficiencies, power losses, increased electricity costs, and higher peak demand. Implementing power factor correction and demand-side management can improve efficiency. This study addresses the issue of poor power factor, identified at a facility with a power factor of 0.84 and a maximum demand of 362.4 kVA, aiming to improve energy efficiency and reduce costs. The objective of this study is to improve the power factor and reduce energy demand through the use of a capacitor bank combined with a solar PV system. In most cases, capacitor banks, using various installation methods, have been employed to enhance the power factor. Over three years of data were analyzed to determine the optimal power factor correction (PFC) solution. The methodology involved selecting a 130 kVAR PFC unit, with the size determined as optimal based on a simulation model that assessed the facility's reactive power demands. The 130 kVAR unit, using distributed correction with capacitors on individual motors, effectively compensated for 95% of no-load reactive power, meeting the facility's efficiency needs. A timer-based power factor correction unit is more suitable for integrating into a system in which the demand fluctuation is considerably lower during the working hours to minimize the overcorrection of the power factor. It can improve the power factor to 98.29% and lead to a reduced maximum demand of up to 316.5 kVA. A solar PV system was also designed based on 24 hour solar irradiance data to meet the site's peak power demand. The final PV array output was calculated to be 759 kW. The case study demonstrates the effectiveness of the power factor improvement performance for a real-world industrial load.

Keywords: energy efficiency in industry, power factor correction, reactive power, sustainability

IoT-Enabled Semi-Automated System for an Optimized Tea Withering Process

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Abstract

Withering is the most important step in the tea manufacturing process. It reduces the initial moisture of the tea leaves from 70 - 83% to 55%. Traditionally, this process is manual, time consuming, and energy intensive, often resulting in inconsistent tea quality. To avoid these challenges, an Internet of Things (IoT)-based semi-automatic system was created to optimize the tea withering process, making it more efficient and reliable. The system controls two key elements: the fan and the damper. The fan blows a stream of air which is essential for moisture removal, while the damper controls the flow of hot air from the boiler to maintain the air temperature. This process ensures that the fan provides the optimal airflow for withering, helping to control both temperature and humidity. Together, these components are vital for maintaining an ideal environment for withering. The real time data of temperature, humidity, air pressure, and rate of airflow are processed by a control system that automatically adjusts the fan speed and the damper angle for an optimal tea withering process. A “moisture estimator” algorithm predicts the moisture content of the tea leaves, enabling precise control adjustments. The system operates in two modes: manual and semi-automatic, providing flexibility based on specific needs. The system includes a user-friendly human-machine interface and an IoT feature for remote monitoring and control. The variable frequency drive (VFD) controls the fan speed whereas the damper actuator controls the damper angle. In manual mode, the VFD runs at full speed 50 Hz for 12 hours, consuming 54.95 kWh of electrical power even under severe environmental conditions. Under semi-automatic mode, the withering process takes 13 hours, for different fan speed levels and damper angles. This mode consumes 39.23 kWh of electrical power, a significant 28.6% improvement in energy efficiency. These results highlight the system’s potential to improve efficiency and consistency in the tea withering process.

Keywords: energy saving, IoT, agricultural automation, tea withering, sustainable agriculture

Energy, Environment, and Sustainability

The Assessment of Leachate Pollution in Kerawalapitiya Waste Management Park and its Impact on Hamilton Canal and Dutch Canal, Sri Lanka

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Abstract

Ground and surface waters can be contaminated by landfill leachate, which is considered a major environmental concern. The research aims to evaluate the leachate pollution using the leachate pollution index (LPI) at the Kerawalapitiya waste management park (KWMP) and its surrounding water bodies. Twelve sampling points were identified and coordinates were recorded. Twelve surface water samples were collected monthly during the year 2023 from surface water bodies surrounding KWMP at various distances and tested for parameters distances using acid-washed polypropylene bottles. Samples were transported in ice boxes at 0 to 5 °C for laboratory analysis, while some parameters tested in the field. Parameters tested included pH, electrical conductivity, dissolved oxygen, total dissolved solids, turbidity, ammonia, nitrate, phosphate, chloride, sulphate, chemical oxygen demand, biological oxygen demand, and various metals (i.e., chromium, manganese, cadmium, zinc, and copper). The LPI was calculated by assigning weights to these pollutants and deriving sub-indicator values from their concentrations. Results show LPI values ranging from 6.1211 to 23.6424 indicating “very low pollution” around KWMP. The highest LPI values near Hamilton canal indicate that additional sources of pollution besides KWMP contribute to the pollution of Hamilton canal. A positive correlation between LPI (0.6001) indicates that pollution increases with distance from KWMP to Hamilton canal and a negative correlation with Dutch canal (-0.8673) indicates that pollution decreases with distance. The findings indicated that the leachate pollution around the KWMP with “very low contamination” levels in surrounding canals. However, high LPI values in the Hamilton canal indicated its own sources of pollution which are independent from KWMP leachate pollution.

Keywords: leachate pollution index, Kerawalapitiya waste park, Hamilton canal, Dutch canal, solid waste management

Advancing Environmental Bioremediation Practices with Soil Bacteria from Metropolitan Gardens

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Abstract

Polycyclic aromatic hydrocarbons (PAH) are organic compounds with individual homologues and isomers containing condensed aromatic rings and considered as primary soil pollutants due to their genotoxic and carcinogenic effects. This study investigates on naphthalene and phenanthrene degrading bacteria isolated from three soil samples of urbanized gardens from Colombo, Wattala, and Gampaha, Sri Lanka. Isolates were identified using the morphology of spread plates and Sanger sequencing. Evaluation of PAH degradation potential and percentages were screened with plate assay and confirmed with spectrophotometric analysis with methylene blue (609 nm). The results of spectrophotometric analysis revealed that strains, *Bacillus paramycoides* strain SS1-SF1 (PP340949), *Bacillus tropicus* strain SS2-SF5 (PP340953), *Staphylococcus saprophyticus* strain SS3-SF8 (PP340954), and *Bacillus cereus* strain SS3-SF9 (PP340955) were capable to degrade at more than 40% for phenanthrene and at more than 35% for naphthalene within 7 days of incubation. *Staphylococcus saprophyticus* strain SS3-SF8 with population density 1×10^6 is considered the most effective phenanthrene degrader with 55.39% of degradation percentage. The bacterial sensitivity for antibiotics of isolates were tested with six antibiotics (amoxicillin, chloramphenicol, erythromycin, gentamycin, tetracycline, and vancomycin), and the average diameter values of zone of inhibition showed that 90% were potentially sensitive to antibiotics. According to the toxicity assay results, intermediates within 7 days of all four strains had greater than 80% of viability for cytotoxicity within 24 hours with *Artemia salina*, confirming their non-toxic nature. Furthermore, in phytotoxicity assay results with *Vigna radiata*, the length from the shoot to the root of the germination within a period of 7 days confirmed the non-toxicity of intermediates towards plants and seed germination. Therefore, the results concluded that these soil bacterial isolates can be efficiently used against soil pollution as effective degraders for PAHs through bioremediation.

Keywords: polycyclic aromatic hydrocarbon, phenanthrene, naphthalene, bioremediation, phytotoxicity

Feasibility of Usage of Corn-Biochar on Efficiency and Capacity of Heavy Metals Removal from Aqueous Solutions

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Abstract

Environmental remediation is crucial due to the increasing levels of environmental pollution. This study shows a practical and flexible method for using corn plant residues, including corn husks and cobs, in aqueous solutions to effectively remove heavy metals such as copper (Cu), manganese (Mn), and zinc (Zn) from polluted water. In this study biochar produced at three different pyrolysis temperatures namely 450, 550, and 650 °C. Further, three different sizes of corn husk biochar prepared at 650 °C were used to study the efficiency of the Cu^{2+}, Mn^{2+}, and Zn^{2+} removal. According to the results, the highest removal efficiency and capacity was observed from the bio char produced at 650 °C, from corn husks, and works as an adsorbent material, compared to other sizes of corn-derived biochar. Among these, biochar with a particle size range of 0.02 - 0.075 mm has been identified as the optimum size for removal efficiency. Optimal treatment parameters obtained by Minitab are pH range of 4.5 - 6.15, with a biochar dose of 1.6 - 2.2 g, temperature of 35 - 45 °C, contact time of 60 - 80 min, and mixing speed of 250 rpm. Heavy metal removal efficiency can be increased by 98.9%. As per the study it could be highlighted that agricultural waste could be a viable and eco friendly mode for low cost water treatment solutions. However, the full-scale application of this kind of technologies requires setting the level of the technology, conducting field trials for practical validation, assessing comprehensive economic and environmental implications, and developing policies for the promotion of agricultural waste in environmental remediation.

Keywords: biochar, corn waste, heavy metal removal, adsorption, removal efficiency

Exploring Community Perception on the Quality and Values of Public Open Spaces in Colombo District

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Abstract

Urban green spaces hinder the negative consequences of urbanization. Public open spaces (POS) are a part of urban green space network, offer numerous social, cultural, and ecological services to urban dwellers. This study explored the visitors' perception on urban POS in Colombo district via a questionnaire survey, using a total of 300 visitors. Three main, most popular POS in the Colombo city were chosen for research namely, Vihara Maha Devi park (VMDP), Diyatha Uyana park (DUP), and Urban Wetland park (UWP). Meanwhile, descriptive statistics and Chi-square test of association were used for data analysis. A majority of 56.12% respondents were residing at a proximity (<10 km) to these places, highly active in using with frequent visits at least once a week (70%). Most of the respondents have visited POS for relaxation, physical exercise and to enjoy the environment. According to the perception of the respondents, cooling the atmosphere (MS=4.0), allowing contacts with nature (MS=3.9) and reduction of the air pollution (MS=3.8) were ranked as the top three consequential of these POS. There are different amenities at POS to enhance the contentment. According to the mean score calculated, the 1st rank of satisfactions of all three parks has been given to the attractiveness. In DUP 2nd and 3rd highest satisfactions were with walking pathways and water features, while in both VMDP and UWP 2nd and 3rd ranks were given for the availability of more trees and turf areas. Out of the evaluated features, improper maintenance, inadequate lighting, access to disable people and sitting areas were the main negativities. According to Chi-square test of association education level, marital status, living area, and time spent at these POS significantly (p<0.05) influenced the perception of the visitors. Meaningful POS at city level has an important role in achieving more socially interconnected cities. Hence the finding of the study can be utilized for the improvements in planning and management of these urban POS.

Keywords: Colombo, public open parks, urban green spaces, urban planning

Assessing Greenhouse Gas Emissions in Polyethylene Terephthalate (PET) Flake Production: A Case Study of Sustainability Improvements in a Sri Lankan Recycling Facility

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Abstract

Plastic pollution poses a significant threat to our oceans, natural environment, and wildlife, with a considerable amount of plastic waste accumulating in landfills and the natural environment. Polyethylene terephthalate (PET), the most widely used single-use plastic, plays a major role in this issue. Recycling is a critical measure to mitigate these impacts and PET recycling is a dynamic sector within the plastics industry. To ensure the sustainability of the recycling industry, it is essential to rigorously assess resource utilization and environmental impacts, given the intensive machinery operations involved in its processes. This study aims to quantify the greenhouse gas (GHG) emissions within the PET recycling industry while identifying innovative strategies to enhance the sustainability of the recycling process. The study was conducted in a large-scale PET recycling plant in Sri Lanka and focused on GHG emissions at a facility producing PET flakes from post-consumer bottles. GHG emissions were calculated using the Intergovernmental Panel on Climate Change (IPCC) methodology, with emission sources categorized by the ISO 14064-1:2028 standard. Primary data were obtained from company records for the year 2023, and emissions factors were sourced from the IPCC emissions database. Results show that, on average 249±36.65 tons of PET bottles were collected monthly, producing 195.29±40.84 tons of PET flakes and emitting 94.88±17.35 tons of CO_2e. The average GHG emission rate was 0.5 kg CO_2e per kilogram of PET flakes. The majority of emissions originated from electricity consumption (70%) and fuel consumption (25%), highlighting potential improvement areas in machinery operations. Minor contributions came from categories 3 and 6 representing 3 and 2% of emissions suggesting that optimizations in these areas could further reduce emissions. The reliance on electricity and fuel underscores the need for energy efficiency measures/alternative sources to reduce emissions within the recycling industry. The study suggests that switching to biomass energy, optimizing transportation and lighting, conserving water, and reducing waste are effective strategies for enhancing sustainability in PET recycling.

Keywords: polyethylene terephthalate, recycling, flakes, greenhouse gas

Development of a Smartphone-Based Water Turbidity Monitoring System

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Abstract

Monitoring water quality is crucial for environmental protection and public health, particularly as water turbidity can rapidly change due to the presence of bacteria, pollutants, and other harmful particles. This study introduces a cost effective and portable turbidity monitoring system that leverages smartphone technology to provide rapid and accurate measurements of water turbidity. The proposed system uses a smartphone camera to photograph water samples under controlled lighting. A customized image processing algorithm is then employed to analyze these photographs, specifically extracting the mean grey index of the images. This index serves as a predictor for the turbidity of the water samples. A regression model was developed to establish a relationship between the mean grey index and turbidity values, measured in Formazin Nephelometric Units (FNU). The system was calibrated using fifty natural water samples, and it demonstrated a robust predictive capability with a strong nonlinear relationship, achieving an R^2 value of 0.945. This indicates high accuracy in predicting turbidity levels within the range of 0 to 260 FNU. To enhance user accessibility, a web application was created, allowing non-experts to easily operate the system and interpret the results. The application provides a user friendly interface for uploading images and receiving turbidity predictions, thereby facilitating practical use in various environmental and public health contexts. Overall, this smartphone-based turbidity monitoring system represents a significant advancement in water quality assessment, offering an affordable, portable, and user friendly solution for rapid turbidity measurements.

Keywords: water quality, turbidity, image processing, mobile camera

Evaluation of the Feasibility of Pyrolyzing Cinnamon Waste Biomass for the Production of Sustainable Biofuel

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Abstract

Sri Lanka is investigating alternate renewable energy sources in the wake of environmental degradation and high energy demand. Sri Lanka is one of the major exporters of cinnamon and will be a potential biomass for energy production as it is abundant in Sri Lankan nature. Cinnamon biomass is a major waste after removing the bark of cinnamon. Cinnamon waste biomass was subjected to pyrolysis at 400 - 900 °C in an oxygen-free environment using a lab-scale reactor into three major products; bio-oil, syngas, and biochar aiming to evaluate its potential as a sustainable energy source. Gravimetric measurements and mass balance analyses were conducted to determine the yield and composition of each product. The energy content and composition of syngas were analyzed using an infrared syngas analyzer, while a bomb calorimeter measured the calorific value of the solid raw materials and produced bio-oil. Additionally, the viscosity and density of the cinnamon bio-oil were assessed based on the synchronized viscosity measurement method. Results from the cinnamon biomass were compared with bagasse and oil palm empty fruit bunches (EFB) by evaluating the energy yields and composition of syngas, bio-oil, and biochar to determine the effectiveness. The study discovered that cinnamon biomass produced the maximum syngas yield (27% w/w) with a calorific value of 2,978.9 kcal/m^3 during pyrolysis with 27.9% CO (v/v) and 17.2% H_2 (v/v). Cinnamon showed lowest viscosity (3.01 mm^2/s) and density (1.07 g/cm^3) in the bio-oil while bagasse and oil palm EFB produced more biochar and bio-oil. Overall, cinnamon biomass was considered as the most promising for energy production due to its high calorific value of solid raw material (19.87 MJ/kg) and lower viscosity of the bio-oil with a calorific value of 30.0 MJ/kg. The study revealed that the cinnamon waste biomass is a promising candidate for sustainable energy production and pyrolysis is an effective waste management and energy recovery solution for Sri Lanka.

Keywords: cinnamon biomass, pyrolysis, sustainable energy source, biofuel

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Sustainable Biodiesel Production Using Waste Cooking Oil: A Case Study in Sabaragamuwa University of Sri Lanka

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Abstract

Improper disposal of waste cooking oil from restaurants and various establishments into the environment creates environmental as well as technical problems. This research investigates the feasibility of converting waste cooking oil from the canteens of the Sabaragamuwa University of Sri Lanka into biodiesel on a laboratory scale. Conversion of the waste cooking oil to biodiesel through a transesterification process to optimize of the conversion process and evaluate biodiesel fuel quality parameters. Two samples (sample 1 and 2) of waste cooking oil from two selected canteens were taken, and the water and unwanted particles in the waste cooking oil were removed by centrifugation, filtration and heating. Free fatty acid (FFA) content of the waste cooking oil was measured and sample 1 and 2 showed 2.66 and 7.33% FFA levels, respectively, which exceeded the common suitable limit for efficient biodiesel production. This was brought to a suitable level by the saponification process. Transesterification was done to the waste cooking oil by mixing with methoxide followed by purification using warm water washing. Purified biodiesel samples were analyzed for calorific value (CV), viscosity, and density to determine their fuel properties. CV was 42.18 MJ/kg for sample 1 and 33.8 MJ/kg for sample 2 with biodiesel yields of 78.9 and 76.8%, respectively. Density was shown as 0.86 and 0.88 g/cm^3 and viscosity was 3.66 and 8.53 mm^2s^{-1}, respectively. Although these values show that the viscosity of sample 2 is higher than that of conventional biodiesel, the values of sample 1 and the density value of sample 2 are within acceptable ranges, indicating that the produced biodiesel has comparable characteristics to conventional biodiesel. By reducing free fatty acid levels and achieving higher biodiesel yields with CV values, the study not only highlighted a sustainable renewable fuel option but also successfully addressed the environmental damage caused by waste oil.

Keywords: sustainable energy, waste cooking oil, biodiesel production, transesterification, free fatty acid

Optimizing Bioethanol Production from Jackfruit Waste: A Comprehensive Approach through Process Modeling

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Abstract

A significant amount of jackfruit is discarded as waste in Sri Lanka, emphasizing the need to transform this biomass into value-added products. This study investigated the feasibility of bioethanol production from jackfruit waste and conducted process optimization to achieve maximum efficiency. Preliminary studies were conducted in the laboratory to identify the factors that significantly influence ethanol yield. Subsequently, Aspen Plus process modeling software was employed to simulate the ethanol production process and evaluate optimal conditions. A continuous stirred tank reactor was used and the reaction occurred continuously. The experimental design was developed using Design-Expert software. Preliminary laboratory tests revealed the effectiveness of ripe jackfruit as a bioethanol feedstock. The experiments demonstrated that a pH level of 5 and a yeast concentration of 10 g/L contributing to optimal ethanol production, with an optimum mixing speed of approximately 115 RPM. Among various factors, the initial jackfruit mass, temperature, and residence time were found to significantly influence ethanol yield, with the initial jackfruit mass being the most influential. The present design space aimed to investigate the effect of initial jackfruit weight (3.75 - 6.25 kg), temperature (20 - 36 °C), and fermentation time (24 - 120 hours) on the ethanol fermentation process using *Saccharomyces cerevisiae*. Optimal conditions for bioethanol production were determined to be an initial jackfruit mass of approximately 5 kg, a fermentation temperature of 36 °C, and a residence time of 48 hours. The conditions resulted in an ethanol yield of approximately 745 g/L with minimal energy consumption of 0.61 kW. Simulation experiments using Aspen Plus validated these optimal conditions, showing high accuracy between predicted and actual values of ethanol yield and energy consumption. Thus, the findings underscore the exceptional efficacy of jackfruit waste in bioethanol production.

Keywords: Aspen Plus simulation, bioethanol production, RSM optimization, Design-Expert, fermentation, jackfruit waste

Green Synthesis of MgO Nanoparticles for Corrosion Inhibition of Stainless Steel Grade 202

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Abstract

Stainless steel (SS) grade 202 is known for its superior corrosion resistance ability compared to many other metals and alloys. Chromium, being a key alloying element of SS, leads to the formation of a passive film of chromium oxide, preventing its exposure to corrosive environments. Nevertheless, SS grade 202, under extreme and aggressive environments such as acidic media, is prone to corrosion, thus, requiring corrosion inhibitors. Introduction of polymer coatings, organometallic compounds, and molecules with hetero atoms have demonstrated corrosion inhibition efficiency for metallic objects including SS grade 202. However, the effect of the chemical composition of the medium to which SS grade 202 is exposed and corrosion inhibitors based on nanoparticles of low-cost material has not received adequate attention despite the widespread use of SS grade 202 in machines in industrial and automotive applications. This study aims at a detailed corrosion investigation of SS grade 202 under aggressive conditions containing HCl and NaCl, which are corrosion promoters, and the corrosion inhibition behavior of MgO nanoparticles synthesized through a green approach using waste orange peel extract. The MgO nanoparticles analyzed using a dual scattering particle size analyzer confirm that they are in the nano-dimensions with an average diameter of 37.5 nm, while X-ray fluorescence spectroscopy and Fourier transform infrared spectroscopy confirm the presence of Mg and the Mg-O bond, respectively. Mass loss measurements of rectangular SS specimens immersed in HCl acid solutions of different concentrations in the presence and absence of NaCl, under ambient conditions indicate the corrosion promotion ability of Cl^- and H_3O^+ ions. Despite the pitting corrosion promotion action of Cl^- species, mass loss assessments, electrochemical impedance spectroscopy, and Tafel plots indicate that the corrosion rate of SS grade 202 in HCl environments is reduced by more than 75% in the presence of MgO nanoparticles in solution.

Keywords: corrosion, inhibition, MgO nanoparticles, stainless steel

Corrosion Inhibition of Stainless Steel Grade 202 Using Solid Tea Waste Extract

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Abstract

Stainless steel (SS), consisting of mainly Fe, Cr, Mn, Ni, and Cu, is corrosion resistant due to the formation of an anti-corrosive chromium oxide protective layer on the surface. However, SS undergoes corrosion under certain extreme environmental conditions, such as chloride or acidic medium, requiring the introduction of corrosion inhibitors. In this study, the effect of solid tea waste (STW) extract was investigated as a corrosion inhibitor of SS grade 202, an industrial alloy used in the production of valuable objects, in acidified sodium chloride medium. STW is environmentally friendly, cost effective, and a green corrosion inhibitor, hence, more attractive as compared to chemical corrosion inhibitors. STW extract characterized by Fourier transform infrared spectroscopy indicates the presence of compounds, such as caffeine, catechin, and gallocatechin, which contain heteroatoms, thereby acting as anti-corrosive agents. Corrosion inhibition investigated by a multi-technique approach with mass loss measurements, electrochemical impedance spectroscopy (EIS), and Tafel slope analysis conclusively demonstrate corrosion inhibitory action of solid tea waste extract. Higher average mass losses of 43.4% determined after a six-day period when blank SS grade 202 specimens are placed in a corrosive medium of 0.25 M in HCl and 0.50 M in NaCl is significantly decreased to 1.0 - 2.5% when coated with STW extracts of different concentrations. Moreover, the polarization resistance of SS grade 202, determined through EIS measurements, increases more than 75% when coated with STW extracts demonstrating the corrosion inhibitive characteristics of STW extracts, which supported by linear polarization experiments. As the inhibition efficiency increases with the increase in the concentration of STW extract, it is believed that the inhibitor is adsorbed on to the surface of SS grade 202. Extension of this research for longer time durations under different environmental conditions would be the next logical step.

Keywords: stainless steel, solid tea waste extract, corrosion, impedance, Tafel plots

Developing a Sustainable Heavy Metal Removal Mechanism from Leachate-Contaminated Soil Using Phytoremediation

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Abstract

Heavy metal contamination in soil, often stemming from leachate from open dumpsites, poses a significant environmental and health risk. This study investigates the phytoremediation potential of two fast-growing biomass crops; *Gliricidia sepium* and *Leucaena leucocephala* to remediate heavy metal-contaminated soil adjacent to the Karadiyana open dumpsite in Sri Lanka. Soil analysis revealed elevated levels of manganese, zinc, and copper concentrations with 24.08, 164.35, and 45.76 mg/kg, respectively, which exceeded the permissible limits. A pilot-scale phytoremediation model was employed to assess the plants' ability to accumulate and translocate heavy metals. Both species demonstrated a preference for accumulating zinc, with *Gliricidia sepium* exhibiting higher bioconcentration factors in leaves, branches, and roots compared to *Leucaena leucocephala*. However, *Leucaena leucocephala* showed a higher translocation factor for copper in leaves compared to *Gliricidia sepium*. The calorific values of both species were determined, with *Leucaena leucocephala* exhibiting a slightly higher value of 18.41 MJ/kg than *Gliricidia sepium*, which was 17.94 MJ/kg, indicating their potential for bioenergy production. Morphological analysis revealed that heavy metal contamination significantly impacted the growth of *Leucaena leucocephala*, particularly in leaf blade length, while *Gliricidia sepium* showed greater resilience. This research underscores the potential of phytoremediation as a sustainable and cost effective approach for remediating heavy metal-contaminated soils, with the added benefit of bioenergy generation.

Keywords: biomass energy, heavy metal, phytoextraction, soil remediation

A Comprehensive Design for Biomass Boiler Steam and Condensate Distribution System at Nestlé Lanka PLC KF

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Abstract

A systematic calculation methodology, based on mean velocity and pressure drops, was employed to design a main steam distribution network for Nestlé Lanka PLC KF. Adhering to ASME B31.3 and EN 13480:3 standards, a 98% dry saturated steam supply of approximately 330 m was planned from a new biomass boiler to the existing distribution header. The long-distance and elevation changes necessitated careful consideration of startup and operational/running loads. After identifying all the project requirements, they are elaborated upon with detailed calculations. By examining three pipe diameters (DN150, DN200, and DN250), DN200 STD was selected as the optimal pipe diameter accompanying, mean velocity, pressure drop, and heat loss considerations. Ansys simulations, utilizing the finite volume method in the Fluent solver, were employed to validate the thermal behavior and static pressure drop of the calculated model. Additionally, computational fluid dynamics simulations were conducted to analyze the velocity profile through 90° long-radius elbows (1.5 NPS=bend radius). By combining the systematic calculation methodology with advanced simulation techniques, this case study provides a comprehensive and optimized steam condensate system for Nestlé Lanka PLC KF.

Keywords: computational fluid dynamics, finite volume method, frictional pressure drop, viscous model

Development of Magnetic Flocculant Based on *Moringa oleifera* and Iron Oxide Nanoparticles for Water Quality Improvement

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Abstract

Water deterioration is initially based on multiple segments such as contamination with organic and inorganic substances. Approximately 80% of river and lake waters is severely polluted due to the damp raw sewage, garbage, and slit. Hence, it is primarily concluded that the water is being polluted and unsuitable for human consumption. Therefore, in this study, a magnetic flocculant based on *Moringa oleifera* (MO) and iron oxide nanoparticles (IONPs) was synthesized to improve water quality, for productive applications. Since MO is abundant in nature and low in cost, it can be considered an economical raw material. The IONPs were synthesized by the co-precipitation method. Then magnetic nanoparticles were functionalized with MO. The formation of the flocculant was confirmed using XRD and FTIR analysis. Magnetic flocculant (MO-IONPs) was then used in jar test experiments to find out the optimum conditions required for maximum flocculation efficiency of improving the water quality, using water samples collected from Beira Lake, Sri Lanka. The reduction efficiency of the parameters including *Microcystis spp*., *Spirulina spp.* cell density, turbidity, TDS, total phosphate, and total nitrate were evaluated. The MO-IONPs significantly reduced all the parameters tested namely; cell densities by 64% of *Microcystis spp.*, 68% of *Spirulina spp.*, 64% of turbidity, 58% of TDS, 56% of total phosphate, and 52% of total nitrate after 30 min exposure to MO-IONPs at 20 mg of IONPs and 400 mg of MO. It was found that prepared magnetic flocculant; the flocculation treatment MO-IONPs can be used as an efficient flocculant to reduce the cell density of harmful algal blooms, turbidity, TDS, total nitrate, and phosphate in the water samples.

Keywords: iron oxide nanoparticles, *Moringa oleifera*, magnetic flocculant, water treatment

Development of Oil Adsorbent Mat Using Waste Human Hair as a Natural Oil Sorbent

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Abstract

The transportation of oil by large vessels presents notable environmental challenges, particularly through the occurrence of oil spills. Although numerous techniques are available for the remediation of oil spills, most techniques are often considered as high cost approaches. Thus, it is crucial to adopt approaches that are both environmentally sustainable and economically viable. This research focuses on enhancing and utilizing waste human hair as a natural sorbent for oil spills. Various methods for porosity enhancement were explored while examine the surface of treated hair samples with the help of SEM Test. The adsorption capacity has been tested on untreated, steamed, and graphene-coated hair samples in both natural water and seawater with the use of engine oil as the pollutant. Adsorptivity was quantified by calculating the weight differences of samples before and after the adsorption process. The results showed that both treated and untreated hair samples could adsorb 5 to 8 times their weight in oil. Steamed waste human hair achieved the highest adsorption capacity under seawater conditions, with 8.21 g of oil per gram of hair, while untreated and graphene-coated hair samples showed adsorption capacities of 6.82 g and 5.83 g of oil per gram of hair, respectively. Further analysis examined the adsorption capacity of steamed hair samples in response to variations in contact time and temperature. The results indicated that the adsorptivity initially reached a steady level, followed by a slight decline with prolonged exposure. Furthermore, increasing temperatures of water resulted a reduction in adsorptivity. A hair mat was produced using raw latex as a binding agent. The reusability of the hair mat was evaluated by assessing its adsorption capacity after cleaning the mat using isopropyl alcohol. The results further indicated that the hair mat could be reused one to two times without a significant decline in adsorption ability, demonstrating its practical application in oil spill management.

Keywords: oil adsorption, waste human hair, oil spills, reusability

Adsorption of Cr (III) from Contaminated Water by Dried Powder of Water Hyacinth (*Eichhornia crassipes)*

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Abstract

Chromium contamination in water, particularly from industrial sources, poses significant environmental and health risks due to chromium species which would contribute to pollution if present in higher concentrations. This study investigates the use of water hyacinth, an abundant, low cost, and invasive aquatic plant, as a biosorbent for the removal of Cr (III) from aqueous solutions. The biosorbent was prepared by drying the whole plant at 60 °C followed by grinding the dried biosorbent into a fine powder, to obtain a particle size range of 300 - 500 µm, the optimum size for adsorption. Various experimental parameters, including biosorbent dosage, shaking time, and solution pH, were optimized to maximize the adsorption capacity. The study found that a biosorbent dosage of 0.25 g and a shaking time of 75 min provided the most effective removal of Cr (III), achieving over 95% adsorption with 70.66 mg/g adsorption capacity as per adsorption isotherm analysis. Notably, the process was effective at solution pH of above 4.0, eliminating the need for pH adjustment, thereby enhancing the practicability of the proposed method for real-world applications. Kinetics analysis revealed that the adsorption process followed the pseudo-second-order model, indicating that chemisorption was the primary mechanism involved, with chemical interactions between the Cr (III) ions and the biosorbent. The results suggest that *Eichhornia crassipes* is a promising, sustainable biosorbent for Cr (III) removal from water, offering a cost effective alternative to conventional treatment methods. This study provides valuable insights into the potential of *Eichhornia crassipes* for environmental remediation.

Keywords: adsorption, biosorbent, *Eichhornia crassipes*, remediation

Short-Term Quality Assessment in Drinking Water: A Case Study in Nilwala Basin, Sri Lanka

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Abstract

This research aimed to assess the changes in water quality within the Nilwala river basin and their impacts to communities. Between January and May 2022, 11 sampling sites were identified and data was obtained from the National Water Supply and Drainage Board. The physical and chemical attributes that were assessed to determine the quality of the water included the following fifteen parameters. Physical parameters were turbidity, colour, electrical conductivity, and total dissolved solids (TDS), while chemical parameters were pH, hardness, chloride, alkalinity, nitrate, nitrite, iron, phosphate, ammonia, sulphate, and fluoride. Comparison was made between results from both types of parameters with guidelines from the World Health Organization and specifications outlined in Sri Lankan Standards (SLS 614:2013) for drinking water. Over the period of the study, the values of all the parameters such as hardness, alkalinity, chloride, the electrical conductivity, TDS, phosphate, sulfate, fluoride, and pH tested from different water sources were significantly different from each other ($p<0.05$) through two-way ANOVA analysis. Significant difference was established in nitrite levels for the entire duration of the study. In the study period of five months, colour, turbidity, nitrate, iron, phosphate, and ammonia values were not found significantly different between the water source as per ANOVA test at $p>0.05$ level of significance. In conclusion, the studied areas are not endangered at the moment, therefore, it is recommended to prevent the depletion of water resources for future use.

Keywords: water quality, Nilwala river, drinking water, groundwater, surface water

Organic Dye Removal from Aqueous Solutions Using Magnesium Oxide and Activated Charcoal

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Abstract

This research investigates the adsorption capabilities of magnesium oxide (MgO), activated charcoal, and a composite mixture (1 : 1 ratio) of these materials as adsorbents. A batch experimental procedure was employed, ensuring the precision of results through triplicate sample preparation and experimentation. The study delved into the adsorption behaviors of reactive orange (RO16) and Amaranth dyes over the adsorbents, examining various experimental parameters such as contact time, adsorbent dosage, and pH levels. Results indicate that the 1 : 1 composite ratio of adsorbents yielded the maximum adsorption capacity. 8.62 mg/g of composite material was required for RO16 at pH 7 with a 5-minute contact time and 9.55 mg/g was needed for Amaranth at pH 7 with a 15-minute contact time for the maximum removal of the dye. Furthermore, improved regeneration studies conducted over five cycles showed that MgO exhibited superior reusability, with a mere 0.54 mg/g loss in adsorption capacity, outperforming activated charcoal, which experienced a loss of 3.63 mg/g.

Keywords: activated charcoal, adsorption, Amaranth dye, reactive orange 16, dye removal

Development of a Guideline to Select Industrial Boiler Fuels for Sustainable Boiler Operations

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Abstract

Industrial boilers play a significant role as a major source of energy utilization in the industrial environment. In line with Sri Lanka's nationally determined contributions (NDCs) to reduce carbon emissions, significant actions include converting boiler energy sources to biomass and implementing guidelines to support the transition of industries into eco-industrial parks while protecting industries within the country. Therefore, as energy sources, the selection of boiler fuel is significant to industries considering sustainability and NDC actions. In the present study, sets of criteria were identified, and a guideline was formulated to select industrial boiler fuels before starting the boiler operations for sustainable boiler practices in the Sri Lankan context associated with Seethawaka export processing zone (SEPZ) using primary and secondary data sources. The resulting guideline consists of major boiler fuels, including biomass, coal, oil (diesel, heavy furnace oil, and kerosene), processed waste (fabric), and electricity. The guideline covers criteria related to fuel quality, maintenance practices, environmental regulations, issues related to fuels, fuel handling requirements, and environmental protection practices for each fuel relating to environmental, economic, and social sustainability. The guideline's practical application was evaluated through a survey of industries at SEPZ. The survey results indicate that SEPZ industries meet the requirements of prepared guidelines by adhering to safety practices, holding necessary permits, and complying with environmental regulations, thus contributing to social sustainability. The environmental sustainability of fuel practices was assessed through compliance metrics (emission reduction, safe ash disposal, dust control, and fuel storage) and survey feedback from SEPZ industries. However, a life cycle assessment was not included, and it is recommended for future studies to compare the sustainability of various biomass types rigorously. The survey results indicate that 49% of SEPZ industries utilize biomass as boiler fuel, showing a trend towards environmental compliance and resource efficiency, thus contributing to sustainability. Additionally, economic sustainability has been attained through effective boiler maintenance, safety practices, and the widespread use of biomass. Also, awareness related to proper biomass is lower among industries and these guidelines aim to foster best practices and improve knowledge in Sri Lanka's industrial energy sector.

Keywords: boiler fuels, industrial boilers, NDCs, SEPZ, sustainability

Assessing the Antibacterial Activity of Acid Modified Rice Husk-Based Biochar-Magnetite Composite

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Abstract

Recent advances on nanotechnology focus on utilizing different waste materials for synthesizing nanomaterials especially as potential environmental remediating tools. This study focuses on synthesizing magnetite loaded acid modified rice husk-based biochar (MBC) composite and investigating their antibacterial activity. This composite was synthesized by dispersing acid-modified rice husks in a Fe^{2+} and Fe^{3+} mixture (1 : 1 v/v) through co-precipitation method under basic condition. Modified rice husks was then pyrolyzed at 500 °C and characterized using Fourier transform infrared spectroscopy (FTIR) and X-ray diffractometry (XRD). FTIR analysis showed a sharp band at 563 cm^{-1} indicating the stretching vibration of Fe—O bond. XRD analysis revealed Bragg's angles of 31.68°, 35.57°, 35.62°, 56.52°, and 62.90° that correspond with 220, 311, 100, 511, and 440 Miller indices of magnetite, respectively. The other main peaks at 20.85° and 75.32° likely be due to 111 and 533 Miller indices of γ-Fe_2O_3 or maghemite that are possibly formed through partial air oxidation of magnetite. Overall, this observation implicated that biochar (BC) lattice does not show any selectivity towards Fe^{2+} or Fe^{3+}. In order to assess the antibacterial activity, this composite was tested against Gram negative *Escherichia coli* and Gram positive *Staphylococcus aureus* using Muller-Hinton agar medium. These experiments were carried out using Gentamicin (100 mg/L) as the positive control, DI water as the negative control, and pristine BC as the control. According to the results obtained, MBC showed antibacterial activity against both *E. coli* and *S. aureus* for all the tested concentrations, but pristine BC did not show inhibition against any of them. This might possibly be due to incorporation of Fe_3O_4 to BC lattice enhance the surface area of nanomaterial such that it can effectively form free radicals that cause oxidative stress against bacterial strains. Overall, this study unveiled the possibility of using common agricultural waste to synthesize a MBC composite that has the potential to act as a remediation tool to minimize environmental pollution caused by certain microbes.

Keywords: biochar-based composite, antibacterial activity, inhibition, iron impregnation

Development of User Friendly Processes for Color Measurement in the Textile Industry Discharge Wastewater to Reduce Environmental Pollution

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Abstract

This research investigates the relationship between a newly developed reference color chart and various color measurement methods specifically platinum-cobalt (Pt-Co) color measurements and absorbance values at specific wavelengths (yellow, red, and blue) in the context of discharge effluent wastewater from the textile industry. Large scale textile industries produce huge quantities of wastewater and the color of wastewater varies with higher frequency. Therefore, the above color measurement methods by instrument are not practical for this type of system. A reference color chart was created using the following method including a dilution series and photographic documentation with a 12.2 MP camera under controlled conditions. Pt-Co color measurements were recorded with the "Spectrument Move 100" instrument, and absorbance values at selected wavelengths were measured using the same device. The absorbance values at specific wavelengths demonstrated varying degrees of correlation, with the strongest relationship observed for yellow absorbance values. This relationship showed a positive linear correlation with a high adjusted R^2 of over 90%. The study concludes that the reference color chart values correlate more reliably with yellow absorbance values compared to Pt-Co color measurements and other color wavelengths. Consequently, the reference color chart is a practical and effective tool for assessing color variations in textile industry discharge effluent wastewater, highlighting the importance of focusing on yellow absorbance values for accurate wastewater color assessments.

Keywords: reference color chart, absorbance values, platinum-cobalt standard (Pt-Co), discharge effluent wastewater, textile industry

Investigating the Potential of Biochar-Based Supercapacitors

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Abstract

Investigating renewable energy sources is essential to meet the world's growing energy needs and prevent the depletion of fossil resources. This research investigates the potential of coconut shell-derived biochar as a sustainable and cost effective electrode material for supercapacitors. Supercapacitors are promising for energy storage due to their high power density, long cycle life, and quick charge/ discharge capabilities, but their use is limited by the high cost of traditional materials like activated carbon. Significant improvement in electrochemical performance was achieved by producing biochar from coconut shells through chemical activation with potassium hydroxide and optimizing it with various binders, conductive materials, and electrolytes. Key parameters such as particle size, raw material mixing ratio, and acid washing were systematically studied, revealing that reducing the biochar particle size to less than 44 μm and acid washing increased conductivity from 0.000727 to 0.141 S/cm. Coconut shell biochar-based supercapacitor electrodes exhibited capacitive behavior by achieving a specific capacitance of 40 F/g with sodium perchlorate electrolyte. The research demonstrates the feasibility of using biomass-derived materials in energy storage, positioning coconut shell biochar as a promising low cost and sustainable alternative to conventional activated carbon for high performance, eco-friendly supercapacitor electrodes.

Keywords: biochar-based supercapacitors, coconut shell biochar, activated carbon electrodes, sustainable electrode materials

A Qualitative Study on the Application of Infrared Thermography for Non-Destructive Detection of Internal Cavities: From Tree Logs to Living Trees

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Abstract

Internal cavities can severely affect tree stability and health, yet they often go unnoticed with conventional visual inspection methods. This study addresses the challenge of detecting internal cavities in trees early by utilizing non-destructive infrared thermography. The main objective is to qualitatively detect hidden cavities in tree trunks by analyzing surface temperature differences between healthy and unhealthy sections. The research was conducted in two phases. In the first phase, the method's feasibility was evaluated using tree logs as models, employing an active approach. Cooling with water at 10 - 15 °C, followed by a 10 - 20 minutes waiting period, improved the thermal profiles of logs. The study concludes that the height and depth of cavities can be roughly estimated using infrared thermography. Increasing the distance between the camera and the log surface, enhanced image contrast by capturing a wider field of view. Additionally, lower material density correlates with a broader distribution in the temperature profile of defects. Larger cavity sizes and shorter distances between the internal cavity and the observed surface also increased the probability of successful cavity detection. In the second stage, the above knowledge was applied to living trees using a passive approach. After a thorough inspection, two defective trees, *Syzygium rubicundum* and *Dillenia suffruticosa* were selected. Images were captured with a FLUKE TI-105 camera, and thermograms were processed using MATLAB. The study shows that internal tree defects can be detected using thermograms, with defective areas typically cooler than their surroundings. Capturing images at optimal times is crucial to avoid altered temperature profiles. High contrast thermal images were preferred for defect detection, but when not possible, k-means clustering combined with edge detection was effective despite some limitations. This study is case specific due to varying influencing factors. Overall, this study contributes to maintaining the long term stability and health of tree populations.

Keywords: image processing, infrared thermography, thermogram, tree cavities

2D $KAlSiO_4$ Nanoplatelets from Abundant Muscovite via Microwave Solvothermal for Designing White Light LEDs

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Abstract

Harnessing the Earth's most abundant elements - oxygen (O), silicon (Si), aluminum (Al), sodium (Na), and potassium (K) - is essential for developing sustainable materials that address resource, environmental, and economic challenges. In this study, we synthesized 2D $KAlSiO_4$ nanoplatelets, a sustainable material with the potential for a wide range of green applications, including catalysis for transesterification (e.g., biodiesel production from sesame oil), adsorption, slow-release K^+ fertilizers, and phosphors for white light LEDs. Abundant muscovite was efficiently transformed into $KAlSiO_4$ nanoplatelets using a microwave assisted technique that mimics the natural weathering of Earth's minerals. SEM, XRD, and TEM analyses revealed nanoplatelets with widths of 25 - 45 nm, lateral lengths of 40 - 60 nm, and thicknesses of 10 - 20 nm. UV-Vis analysis showed band gaps of 4.02, 4.17, and 4.22 eV, alongside visible range luminescence. Using Design of Experiments, we studied the main factors influencing $KAlSiO_4$ crystallization, and a model based on response surface methodology was developed to optimize synthesis parameters, enabling control over crystal size and emission wavelengths. Additionally, by tailoring the entropy of nanomica crystals, emission wavelengths can be customized to produce specific colors. These findings demonstrate that the synthesized $KAlSiO_4$ nanoplatelets, with tunable particle sizes and emission properties, hold significant promise as phosphors for advancing white light LED technology.

Keywords: muscovite, $KAlSiO_4$, nanoplatelets, LED, white light, phosphors

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High Efficient Solar Panel System with Automated Water Distillation System

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Abstract

This proposed study develops a high efficient solar panel system which includes an automated water distillation function. The photovoltaic (PV) system aims to address two critical challenges in the Rajarata area, Sri Lanka; firstly, the reduction in solar panel efficiency due to increased dry climate resulting in PV panel overheating and secondly, the scarcity of clean drinking water. The system employs a water cooling method to reduce substantial temperature increase and consequently improve solar panel efficiency. The heat transferred from PV panels to the circulated cooling water within the cooling system is then utilized in a solar distillation unit to produce clean and distilled water. The entire process is regulated by an automated control system, which continuously monitors system parameters such as temperature and water levels, optimizing the operation of both the cooling and distillation systems. This innovative approach integrates energy efficiency measures and water distillation in a sustainable and scalable solution, making it suitable for application in remote communities and industrial settings in the Rajarata area.

Keywords: photovoltaic, solar water distillation, automation, renewable energy

A Comprehensive Waste Audit at National Zoological Gardens, Dehiwala, Sri Lanka

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Abstract

A waste audit is a physical and systematic process of quantifying all types of waste generated in an organization. It helps to identify the gaps and potential opportunities for a sustainable waste management approach. Proper management of zoo waste is important to reduce environmental and social problems and to enhance visitor attraction. The objective of this study was to conduct a comprehensive waste audit at the National Zoological Gardens, Sri Lanka. Overall zoo waste characterization was determined by collecting daily waste into a tipper for seven days. A 50 kg waste sample was taken from each corner and center of the tipper sorted into eleven categories and weighed. Bin composition analysis was conducted near canteens, resting places, along roads, and in less populated areas. Three samples of 5 kg waste, which were separated using the coning and quartering technique were taken from four bin locations separately for seven days and were sorted into eleven categories and weighed. According to overall zoo waste characterization, compostable organic matter comprises 81% of the total waste, which includes kitchen waste, grass/ wood, and fecal matter. High value recyclables including rigid plastic comprise 2 - 4%, and low value recyclables including soft plastic, paper, and textile comprise 8 - 10% of the total waste. When considering bin composition analysis, kitchen waste, grass/ wood, and paper account for more than 80% of total waste, near canteens and resting places where grass/ wood and stones/ ceramics account for more than 60% of total waste, along roads and in less populated areas. Waste collection is conducted by tractors daily and incineration is the main treatment method used for more than 70% of waste generated at the zoo. Field observations and discussions with responsible officials highlighted the need for targeted waste reduction strategies, visitor education, efficient waste separation practices, and sustainable waste treatment options such as making compost from organic waste and recycling recyclable waste within the zoo premises.

Keywords: Dehiwala Zoological Gardens, waste audit, incineration, composting, recycling

Vibrational Sensing Methods for Measuring Time of Flight to Assess Internal Characteristics of Trees

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Abstract

Tree cavities are vital for biodiversity in natural ecosystems. However, trees with structural defects like cavities and dying trees in an urban environment pose threats to public safety and their removal is crucial to avoid property damage, personal injury and loss of life in the worst case. Therefore, detecting cavities is crucial. The existing methods for cavity detection are often expensive and technically complex. Thus, their practical use is limited. This study focuses on the development of a handmade low cost sensor system using vibrational sensing methods to detect tree cavities to measure time-of-flight (ToF) and detect internal cavities in trees. The sensor system is still undergoing the development stage. The proposed system consists of microcontroller based sensors that emit and detect vibrational stress waves. The stress wave travels slower in decayed wood than in sound wood. The velocity of wood can be calculated when the Young's modulus of elasticity and the gross density is known. The microcontroller based system will measure the relevant ToF taken for the stress wave to travel along the trunk of the tree radially. It can be confirmed true, when the distance of the shock propagation path is measured manually, using the velocity calculated, by calculating the ToF. Preliminary tests were conducted on teakwood, yielding promising results, despite variations due to manual testing in the laboratory. The system was able to successfully provide ToF readings, and it suggests that this system can be successfully modified to identify decayed regions by detecting anomalies in wave propagation since the ToF readings obtained when cavity is present was higher than that of in healthy wood. After the complete development of the system, the validity and the application in the field will be tested. This is the very first study in Sri Lanka regarding tree cavity detection instrument development. This sensor system will be made entirely using locally sourced components. Though refinement is required, it was clear that the study demonstrates the potential of this system as a cost effective tool for tree cavity detection in urban forest management, contributing to not only urban tree care but also public safety.

Keywords: vibrational sensing, cavity detection, sensor, low cost, handmade

Microplastics in Personal Care and Cosmetic Products: A Systematic Review of Prevalence, Usage, and Mitigation Strategies

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Abstract

Microplastics are plastic particles smaller than 5 mm that have been recognized as a significant environmental issue due to their abundance and possible adverse effects on the environment and human beings. Microbeads are one of the most common types of primary microplastics used in personal care and cosmetic products (PCCs). Microplastics are small in size and are synthetic in nature, hence, they escape the conventional water treatment systems and end up in water bodies and land. This systematic review aims to identify the prevalence, usage, and countermeasures of microplastics in PCCs based on the peer-reviewed literature published between 2014 and 2024. The literature review involved a systematic search on Web of Science, Scopus, and Google Scholar, and 32 relevant papers were chosen. The review examines the different categories and applications of microplastics in PCCs, treatment issues, legal frameworks, and current measures that have been taken to minimize their use. The findings of the study show a clear relationship between the type and function of microplastics and their effects on the environment, focusing on the role of policy and corporate behavior to control the use of microplastics and the measures taken to address the problem. Most prominently, granular microplastics found in exfoliants, composed of low density polyethylene and ethylene-propylene copolymer, are highly resistant to biodegradation. Furthermore, current conventional wastewater treatment plants fail to fully eliminate these microplastics, allowing the particles to continue existing in the environment. Regulatory actions, including bans on microbeads and industry-led measures to eliminate microplastics have proven effective. However, the current international regulation remains fragmented, especially in the developing world, where microplastic pollution is least controlled. This review calls for the enhancement of the current policies, improved treatment procedures, and discouragement of the use of microplastics. It is also important to enhance the awareness of the public in relation to the rising danger of microplastics in PCCs. Therefore, international cooperation is needed to address the problem of microplastics in PCCs and secure a sustainable future for the environment and people's health.

Keywords: cosmetics, microplastics, microplastic mitigation, personal care products, plastic pollution, wastewater treatment

Acid Modified Jack Saw Dust as a Prospective Adsorbent for Removal of Cr (III) and Ni (II)

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Abstract

Contamination of water by heavy metals has significantly impacted the environment and human health. Although heavy metals are necessary for the humans, excessive amounts make adverse effects. Many studies have been done on removing heavy metals. Before releasing contaminated water into the environment, it can be treated using an adsorbent; this is more cost effective than utilizing commercially available activated carbon. This study focuses on determining the adsorption capacity of acid modified jack saw dust (AMJSD) and comparing the results with the commercially available activated carbon (AC). The 1000 ppm Ni (II) and Cr (III) stock solutions were prepared, and a concentration series was used. The adsorption parameters such as initial metal ion concentration, equilibrium time, adsorbent dosage, and solution pH were studied to determine the optimum condition. The highest adsorption capacities for metal ions were obtained for AMJSD with 0.75 M HCl solution. The point of zero charge of AMJSD was determined to be 5.52. The optimum initial concentrations for Ni (II) and Cr (III) were determined as 50 and 150 ppm, respectively, while the optimum contact time was 30 minutes for both Ni (II) and Cr (III). The optimum adsorbent dosage was 0.50 g for Ni (II) and Cr (III) in the adsorption process. The optimal initial pH for the adsorption process was determined to be 6 for both nickel and chromium. The optimal temperature for the adsorption process was 50 °C for Ni (II) and Cr (III). When comparing the adsorption by the two adsorbents, AC demonstrated higher absorptivity at higher pH and within the considered temperature range of 40 - 60 °C, while there was no significant difference when considering adsorbent dosage and contact time. The kinetic study revealed that AMJSD adsorption was well aligned with the pseudo-second-order kinetic model for both metals.

Keywords: adsorption, heavy metals, acid modified sawdust, activated charcoal

Assessing and Reducing the Carbon Footprint of Organic Rubber Mattress Manufacturing: A Comprehensive Life Cycle Analysis

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Abstract

This study explores the carbon footprint analysis of an organic rubber mattress manufacturing industry for the fiscal year 2023, focusing on scope 1, scope 2, and scope 3 emissions. Scope 1 emissions, totaling 3,960.09 t CO_2e/year, primarily originate from internal combustion sources such as diesel powered standby generators, company owned vehicles, forklifts, and boiler wood combustion for steam generation. The highest emitter within scope 1 is the boiler emissions, contributing 3,620.873 t CO_2e/year due to its critical role in steam generation for manufacturing processes. Scope 2 emissions, amounting 1,534.972 t CO_2e/year, stem from purchased electricity, which accounts for 26% of the industry's total emissions. The heavy reliance on purchased electricity underscores its significant impact on the organization's carbon footprint, driven by the energy intensive operations of mattress manufacturing and associated facility requirements. Scope 3 emissions, totaling 269.698 t CO_2e/year, arise from indirect sources including water consumption, raw material transport, product distribution, solid waste disposal, business travel, staff community, and hired vehicle usage. The study employs detailed quantitative data from the company's operational records, energy bills, and emission factors specific to Sri Lanka, facilitating a comprehensive analysis of greenhouse gas emissions across all three scopes. Findings reveal that scope 1 emissions contribute approximately 69% of the total carbon footprint, primarily due to high intensity emissions from boiler operations and standby generators. Scope 2 emissions constitute 26%, driven by electricity consumption, while scope 3 emissions represent about 5%, attributed to various value chain activities. The identified emission hotspots; boiler emissions, purchased electricity, and generator emissions are crucial areas for targeted mitigation strategies. Proposed measures include enhancing energy efficiency through technological upgrades, adopting renewable energy sources, optimizing waste management practices, promoting sustainable transportation options, and fostering a culture of environmental stewardship across the organization. These strategies aim to achieve substantial reductions in carbon emissions, enhance operational sustainability, and align with global climate change mitigation goals.

Keywords: carbon footprint, organic rubber mattress, greenhouse gas emissions, energy efficiency, Sri Lanka

Biodegradation of Polycyclic Aromatic Hydrocarbons by Phyllosphere Fungi: Potential Agents for Urban Air Pollution Remediation in Sri Lanka

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Abstract

As highly toxic pollutants, polycyclic aromatic hydrocarbons (PAHs) are released into the air by different anthropogenic sources, where they settle on the phyllosphere. Phyllosphere contains different microorganisms, which can degrade PAHs. This research attempt was to determine the PAHs (Naphthalene, Anthracene, Pyrene, and Phenanthrene) degradation capability of phyllosphere inhabited fungal isolates from leaf samples collected from Panchikawatta, Orugodawatta, Pettah, Maradana, Colombo Fort, and Sapugaskanda urban areas in Sri Lanka. PAHs degradation ability of fungal isolates was screened using plate assay and confirmed through high performance liquid chromatography (HPLC). The effect of produced intermediates was evaluated by toxicity assays. Intermediates were identified using gas chromatography mass spectrometric (GCMS) analysis and fungi were identified up to the species level. According to the results out of thirty five morphologically different fungal cultures *Trichoderma harzianum* P_4M-16 (OP101173.1), *Purpureocillium lilacinum* P_{10}T-28 (OP048139.1), *Penicillium griseofulvum* P_9B-30 (OP048136.1), *Aspergillus terreus* P_{21}B-34 (OP048138.1), *Fusarium solani* P_{11}M-46 (OP048124.1), *Aspergillus fumigatus* P_{19}B-56 (OP048137.1), *Aspergillus flavus* P_{22}T-82 (OP100314.1), and *Penicillium citrinum* P_{23}B-91 (OP048133.1) were the most efficient species, which showed significantly higher abilities in degrading all four PAHs. HPLC analysis confirmed that these fungi can degrade PAHs more than 40%. *Aspergillus flavus* P_{22}T-82 showed the best degradation in phenanthrene (86%) and pyrene (84%), while *Penicillium citrinum* P_{23}B-91 showed the best degradation in anthracene (88%) and *Fusarium solani* P_{11}M-46 showed the best degradation in naphthalene (84%). According to the GCMS analysis, the intermediates were identified as phenol 2-(phenylmethyl), which is an intermediate of phenanthrene degradation and 9, 10-anthracene-dione was intermediate for anthracene. The present study discovered that these intermediates were non-toxic to the phyllosphere by using *Vigna radiate* seeds and *Artemia salina*. Therefore, these selected fungal isolates can be used as potential biological agents in bioremediation of polluted air in urbanized areas.

Keywords: polycyclic aromatic hydrocarbons, bioremediation, HPLC, GCMS, toxicity assay

Food Security, Nutrition, and Processing Technology

Optimization of Organoleptic, Physicochemical, and Nutritional Quality of Guava Jam Enriched with Raisins

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Abstract

Guava (*Psidium guajava* L.) known as a highly nutritional fruit and has more health benefits. Guava crops can suffer losses due to various factors including pests, diseases, adverse weather conditions, improper harvesting techniques, and post harvest mishandling. This research aims to develop a value added product from guava fruit inclusion with raisins into a jam formulation, considering their rich content of essential nutrients and bioactive compounds. Jam formulations were developed by changing the proportion of guava pulp and raisins with different combinations (100 : 0, 90 : 10, 80 : 20, and 70 : 30% w/w). A low calorie guava jam was also developed by reducing the 25% sugar level compared to the control sample. Physicochemical properties such as pH, total soluble solids (TSS), and titratable acidity (TA) were evaluated by standard methods. Total antioxidant activity was evaluated by the DPPH assay method. Sensory evaluation was conducted using a 9-points hedonic scale by 50 untrained panelists. Microbial analysis (*Escherichia coli* test) was performed to determine stability of products. Results showed that the TA content was significantly decreased while pH and TSS were significantly increased in all samples during 4 weeks of storage study. The 30% raisins enriched jam had higher TSS% (73.63±0.23), TA% (0.73±0.02), and lower pH content (4.13±0.04) after four weeks of storage when compared to other samples. Evaluation of antioxidant results showed that there were significant increases ($p<0.05$) during storage period. Especially, 20% and 30% raisin enriched samples exhibit higher radical scavenging activity. Based on sensory evaluation, 30% raisins enriched guava jam was selected as the best treatment due to its sensory properties. Microbial stability also revealed that no *E. coli* detected in raisin enriched jams except control sample, and low calorie jam. Conclusively, 30% raisins enriched guava jam resulted as a nutrient rich healthy jam with better textural, sensorial, and functional qualities.

Keywords: enriched food product, guava raisin jam, physicochemical properties, raisins, sensory acceptance

Phytochemical Content and Antioxidant Activity of Two Varieties of *Alternanthera sessile* L. grown in Sri Lanka

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Abstract

Alternanthera sessilis commonly known as *mukunuwenna* is well recognized for its high nutritional and therapeutic value due to the presence of phytochemicals with antioxidant potential. These phytochemicals and antioxidant properties can vary depending on many factors. This study aims to evaluate the impact of genetic variation on the above properties by comparing two selected *A. sessilis* varieties (variety 1; light green color stem, variety 2; brown color stem) grown in Sri Lanka. The selected varieties were grown in pots under similar growth conditions. Edible parts (leaves and young stems) were cleaned, oven-dried at 45 °C, ground, and prepared methanolic extracts. All the experiments were triplicated. Total chlorophyll and the total carotene contents were determined using the colorimetric method and the total flavonoid and phenolic contents were determined using the aluminum chloride colorimetric assay (in Quercetin equivalents), and Folin-Ciocalteu method (in Gallic acid equivalents). The 1,1-diphenyl-2-picrylhydrazyl radical scavenging activity and ferric ion-reducing antioxidant power assay (in ascorbic acid equivalents) were used to determine the antioxidant activity. The results were analyzed using the independent sample t-test ($p<0.05$). Variety 2 showed significantly higher total flavonoid (16.61±0.24 mg/g), phenolic (5.64±0.68 mg/g) contents, and antioxidant activity (reducing power; 3.76±0.10 mg/g, radical scavenging activity; 22.74% inhibition) than those of variety 1 (total flavonoid; 15.45±0.15 mg/g, total phenolic; 3.39±0.97 mg/g, reducing power; 2.14±0.07 mg/g, and radical scavenging activity; 11.11%). Total chlorophyll and carotene contents were not significantly different among the tested varieties. These results prove that the total phenolic and flavonoid contents, and antioxidant activity of *A. sessilis* differ based on the variety. Furthermore, variety 2 can be more health beneficial due to its high antioxidant activity. This knowledge can be used to select better varieties of *A. sessilis* providing insights to enhance crop selection in agriculture improving the nutritional and therapeutic value.

Keywords: *Alternanthera sessilis*, antioxidants, phytochemicals, varieties

Sustainable Use of Fish Processing By-Products in Canned Pet Food Production

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Abstract

Efficient utilization of by-products from the fish processing industry is essential to minimize waste and enhance resource sustainability. This study explores the feasibility of repurposing waste raw fish, typically discarded during export quality fish processing, to produce canned pet food. Fish waste (sardine fish) was combined with rice and pumpkin to create a balanced diet, developed according to the Association of American Feed Control Officials (AAFCO) standards to meet pet dietary requirements. Ingredients were chosen based on their nutrient profiles, and adjustments were made to ensure the nutrient targets for pets were comprehensively met. This single treatment design followed traditional canned fish preparation methods, with adjustments to retain nutrient levels and enhance compatibility. Preparation involved preprocessing the sardine fish to remove non-edible parts and a steam cooking process to improve digestibility. Rice and pumpkin were cooked separately to specific textures suitable for nutrient blending, then incorporated at precise ratios of sardine : rice : pumpkin (60 : 20 : 20). The mixture was canned and sterilized at a temperature of 121 °C, under a pressure of 1.1 bar for 1 hour to ensure safety and shelf stability. Nutritional analysis confirmed that the product meets the AAFCO standards for pet food, with a high contents of protein (15.8±0.8%), calcium (0.11±0.09%), energy (123.0±1.6 kcal/100 g), and appropriate moisture content (71.0±0.4%), with confirming the product's suitability for animal consumption. This research underscores the potential of this approach to reduce fish processing waste by up to 15%, while producing nutritionally balanced and environmentally sustainable pet food. This innovative method addresses both environmental concerns and pet nutritional needs by offering a practical and sustainable solution.

Keywords: canned pet food, fish processing by-products, nutritional balance, waste reduction

Optimization of Physicochemical and Organoleptic Properties of Cookies Made with Cassava Flour

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Abstract

Cassava is a root crop whose post harvest processing remains minimal despite its good yield, produced even with limited resources. The current study aimed to develop a cookie incorporation with cassava flour, substituting the wheat flour to enhance the value addition to cassava while reducing the usage of wheat flour. The cassava flour was produced using cassava yams purchased from the local market and subsequently processed by washing, and cleaning it by peeling, slicing, drying, and grinding. Functional properties of cassava flour (bulk density, tapped density, water absorption temperature, oil absorption capacity, swelling capacity, transparency, foaming capacity, gelatinization temperature, and pH), which were analyzed following standard methods were found as 439.21 kg/m^3, 630.88 kg/m^3, 2.28 g/g, 2.12 g/g, 23.33%, 2.83%, 2.17 mL/g, 69.4 °C, and 7.01, respectively. Five different cookie samples were prepared using composite flour mixtures prepared with cassava: wheat flour in various ratios, T1: 80 : 20, T2: 60 : 40, T3: 40 : 60, T4: 20 : 80, and T5: 0 : 100, with sugar, butter, fresh milk, and baking powder, and finally baked at 150 °C for 30 minutes. Analyzed sensory data revealed that the T2 (60 : 40) showed the highest overall performance among five different samples, and secondary prepared T7 (70 : 30) scored higher ranks in most parameters, not being the least for any. The proximate data revealed that the selected best cassava cookies from T7 (70 : 30) consisted of 1.94±0.46% moisture, 5.49±3.60% total minerals, 6.35±0.25% crude protein, 22.63±0.60% crude fat, 1.30±0.06% crude fiber, and 62.29% total carbohydrate. The shelf life study, which involved storing the cookies in sealed, triple-laminated aluminium packages at ambient temperature (29±2 °C) for three months, confirmed that the cookies remained free from microbial contamination in total plate count, and yeast and mould count tests with the water activity value changed from 0.29 to 0.32. In conclusion, the composite flour made with cassava to wheat, 70 : 30, successfully developed a cookie with adequate nutritional content, consumer preference, and a shelf life of three months at ambient temperature.

Keywords: cassava flour, cookies, functional properties, nutrition, shelf life

Assessment of Sulphur Fumigation on Quality of Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume) Quills

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Abstract

Ceylon cinnamon (*Cinnamomum zeylanicum* Blume) quills are the prominent product form exported from Sri Lanka. Sulphur fumigation process on cinnamon quills is a common practice in the cinnamon industry as a post harvest treatment. This study aims to evaluate the quality of Ceylon cinnamon with respect to two different initial sulphur dioxide (SO_2) residual status, approximately 50 and 150 ppm. Twelve kilograms of cut cinnamon were fumigated with 24 and 42 g of sulphur doses, respectively inside 120 ft^3 of chamber for 15 hours. Moisture content, volatile oil content, total ash content, water activity, total residual SO_2 status, lightness coordinate (L*), redness to greenness attribute (a*), yellowness to blue attributes (b*), and yeast and mold count (YMC) were determined before and just after the sulphur fumigation. Additionally, sensory attributes were evaluated. Initial moisture of 15.77±0.02%, volatile oil content of 2.41±0.09%, water activity of 0.701±0.002 and total ash of 5.83±0.09% in cinnamon were not significantly affected by the process of sulphur fumigation ($p>0.05$). However, sulphur fumigation significantly affected on L*, a*, b*, and YMC of cinnamon. The fumigated cinnamon with approximately 150 ppm residual SO_2 status showed a significant increase in L* and b* values to 48.87±0.65 and 26.50±0.36, respectively while reducing the YMC from 2.67±0.06 to 2.02±0.06 CFU/g just after the fumigation ($p=0.000$). The sensory attributes of cinnamon such as color, overall acceptability were significantly improved by the fumigation process ($p<0.0001$). The sulphur fumigation process is an important post harvest practice in the Ceylon cinnamon industry that effectively enhances the color, sensory attributes, and the microbial safety of cinnamon quills. Maximum quality enhancement can be achieved with cinnamon having high residual SO_2 status around 150 ppm just after the fumigation, while still maintaining the food safety regulations.

Keywords: Ceylon cinnamon quills, post harvest treatment, quality, sulphur fumigation

Comparison of *in vitro* Antidiabetic and Antioxidant Activities of Different Phytochemical Extractions from *Gynura procumbens* and *Costus speciosus* Leaves

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Abstract

As diabetes rises globally, *Costus speciosus* is commonly used, while *Gynura procumbens* remains underutilized, though both are renowned in South-Asian medicine for their antidiabetic properties. This study aims to compare the *in vitro* antidiabetic and antioxidant activities of different extracts from these plants and explore their phytochemical compositions. Extracts from plants were prepared using ethanolic extraction (EE), hot water extraction (HWE), and hot water infusion (HWI). The phytochemical profiles of the extracts were assessed using total phenolic content (TPC), ranging from 0.01 - 0.14 mg/mL and total flavonoid content (TFC), ranging from 0.01 - 0.15 mg/mL, using Fourier transform infrared (FTIR) spectroscopy. The antidiabetic potential was assessed using an α-amylase inhibitory assay (5 - 0.06 mg/L), while antioxidant activity was measured through 2,2-diphenyl-1-picrylhdrayl (DPPH) scavenging activity (5 - 250 µg/mL). The experiment was conducted three times independently in triplicates, and the data was analyzed using completely randomized design using MINITAB 19 with a 95% confidence level. The leaves from both plants' extractions had significant differences. *G. procumbens* EE (64.17±1.41%) showed the highest antioxidant activity, followed by HWE (53.38±1.61%), and HWI (47.05±0.93%), with the strongest α-amylase inhibition (EE; 93.97±0.46%, HWE; 86.43±0.76%, and HWI; 75.47±1.18%), outperforming other extracts, including *C. speciosus*. The EE showed the highest TPC for *G. procumbens*, followed by HWE and HWI, while the TPC for *C. speciosus* was lower in EE, HWE, and HWI. The comparison with the TFC also showed that EE, HWE, and HWI of *G. procumbens* are higher than *C. speciosus*. The FTIR analysis revealed a variety of phytochemicals across the extracts, with *G. procumbens* extracts rich in alcohol (HWI), ester (HWE), and ketone (EE), while *C. speciosus* contained halogen (HWI), nitro compounds (HWE), and ester-carbonyl (EE). In terms of antidiabetic and antioxidant properties, the study shows that *G. procumbens* performs higher than *C. speciosus*, suggesting that it may be used as a treatment for diabetes.

Keywords: amylase, antidiabetic, antioxidant, FTIR, phytochemicals

Development of a Value-Added Tea from *Coccinia grandis* (*Kowakka*) Leaves

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Abstract

Coccinia grandis, commonly known as *kowakka*, is a wild edible plant in Sri Lanka with significant medicinal benefits. Despite its potential, there has been limited development of value-added products in the Sri Lankan market. This study was attempted to develop a value-added *kowakka* tea product. Disease free fresh leaves were collected, and cut it into small pieces. Then, *kowakka* leaves were blanched at 60 and 70 °C for 1 - 2 min, and dehydrated at 50, 60, and 70 °C until their moisture content reaches 8 - 10%. The physiochemical properties (moisture, crude ash, color, and pH; n=3 each), antioxidant properties [total polyphenol content (TPC; n=3 each), total flavonoid content (TFC; n=3 each), ferric reducing antioxidant power (FRAP; n=3 each), and DPPH and ABTS radical scavenging activities; n=3 each] and sensory properties (using a trained panel, n=12) were studied using a 7-point hedonic scale test. Results clearly showed that blanching was not an effective pre-treatment for dehydration of *kowakka* leaves. The drying times of unblanched *kowakka* leaves at 50, 60, and 70 °C were 7½, 6, and 4½ hours, respectively. The physicochemical properties of unblanched *kowakka* leaves dehydrated at selected temperatures did not show mark differences except for L* values for color. For antioxidant properties, *kowakka* leaves dehydrated at 50 °C exhibited significantly ($p<0.05$) high TPC (58.50±11.20 mg GAEs/cup), FRAP (28.40±0.18 mg TEs/cup), DPPH (6.71±1.06 mg TEs/cup), and ABTS (15.87±1.84 mg TEs/cup) radical scavenging activities. However, the lowest sensory properties in terms of all sensory attributes tested were observed for *kowakka* tea prepared from leaves dehydrated at 50 °C. In contrast, *kowakka* tea prepared from leaves dehydrated at 70 °C showed overall best sensory attributes studied. Considering all, it can be concluded that *kowakka* tea prepared from leaves dehydrated at 70 °C is the best formula and could be commercialized in the long run.

Keywords: antioxidant properties, *kowakka* tea, physiochemical properties, sensory properties

Improve the Texture of Sweetened Condensed Coconut Milk by Minimizing the Layer Separation

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Abstract

Sweetened condensed coconut milk (SCCM) is a widely available popular alternative for the cow milk based sweetened condensed milk. The study was conducted to minimize the creaming of the SCCM during its storage. Main objective was to evaluate the potential of adding a stabilizer to reduce layer separation in SCCM. Experiments were planned according to Taguchi's orthogonal array (L4) to systematically design the stabilizer combinations. Stabilizers [xanthan gum, guar gum, and carboxymethyl cellulose (CMC)] were added along with the table sugar following the homogenization of the coconut milk. Both individual and combined effects of xanthan gum, guar gum, and CMC on reducing the cream separation of the SCCM was evaluated. Physicochemical properties such as moisture content, total solids, brix value, pH, titratable acidity, relative density, and sensory evaluation were conducted at 9-point hedonic scale to determine color, odor, taste, texture, viscosity, and overall acceptability. SCCM formulated with the 0.075% xanthan gum showed a significantly lower cream index of 3.72±1.81%, had higher overall sensory acceptability, and had insignificant physicochemical properties similar to those of the commercial sample. Therefore, the treatment where the xanthan gum was used in 0.075% concentration was selected as the best treatment.

Keywords: cream index, layer separation, sweetened condensed coconut milk, xanthan gum

Enhancing the Shelf Life and Quality of Minimally Processed Carrots Using Alginate-Based Edible Coatings Incorporating Cinnamon and Lemongrass Essential Oils: A Novel Sustainable Approach

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Abstract

Minimally processed carrots (*Daucus carota L.*) are valued for their convenience, freshness, and nutritional benefits. However, they face significant challenges during transportation, processing, and marketing, which can affect their quality and pose potential health risks to consumers. This study explores the effectiveness of alginate-based active edible coatings enriched with cinnamon essential oil (CEO), and lemongrass essential oil (LEO) at 0.5, 1, and 1.5% (v/v) concentrations in preserving the quality and extending the shelf life of minimally processed sliced carrots stored at 4 °C over 21 days. The research evaluates critical quality parameters, including weight loss, moisture content (MC), total soluble solids (TSS), titratable acidity (TA), pH, color retention, and microbiological quality. The results demonstrated that alginate coatings with essential oils (EOs) significantly reduced weight loss, and preserved higher MC than uncoated samples. Among the treatments, alginate coatings with 1.5% CEO proved to be most effective in minimizing weight loss and retaining moisture, outperforming those with 1.5% LEO. Additionally, these active coatings stabilized TSS and pH levels, suggesting a more effective inhibition of carrot senescence, and quality deterioration. Both CEO and LEO coatings effectively maintained TA, compared to the uncoated and alginate-coated samples without EOs. Alginate coatings with 1.5% EO concentration maintained a brighter and more visually appealing carrot appearance than uncoated samples and at lower EO concentrations, which exhibited more noticeable color degradation over time. Microbiological analysis showed that CEO and LEO-enriched coatings kept total plate and yeast/mold counts below 6 log CFU/g after 21 days, while uncoated controls showed higher counts (>6 log CFU/g), confirming the coatings' effectiveness in preserving microbiological safety. Overall, while both active coatings extended the shelf life of minimally processed carrots, CEO proved to be the more effective additive. The study highlights the potential of EO-enriched alginate coatings as a natural, effective method for reducing food waste and enhancing the post harvest storage of fresh produce.

Keywords: alginate, carrots, cinnamon essential oil, edible coatings, lemongrass essential oil

Development and Evaluation of a Functional High-Protein Beverage for Adult Humans: Physiochemical and Sensory Properties Analysis Alongside Storage Assessment

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Abstract

The functional beverage market is rapidly expanding, particularly in promoting healthy aging among the elderly. This study aimed to develop a high-protein functional drink to meet the daily protein needs of adults using whey protein isolate (WPI), collagen hydrolysate (CH), and *ashwagandha* (*Withania somnifera*) root powder (ARP). The beverage was prepared in two forms: a ready-to-drink (RTD) version and a premix (PM). Both forms were tested with different *ashwagandha* root powder concentrations: PM had 0.57% (T1), 0.86% (T2), 1.14% (T3), and 1.43% (T4), while RTD had 0.1% (T5), 0.15% (T6), 0.2% (T7), and 0.25% (T8). The protein content was derived from WPI, CH, and full fat milk powder in PM, and from WPI, CH, and fresh milk in RTD, providing a protein concentration of 77.12% (w/w) and 3.5% (w/w) fat in PM, and 13.51% (w/v) and 1.2% (w/v) fat in RTD. Other ingredients included tricalcium phosphate, coffee flavor, guar gum, sucralose, and caramel color. Sensory evaluation showed that T2 in PM with 0.86% ARP and T8 in RTD with 0.25% ARP had the highest acceptability. The protein content met the standards for malted food drinks by the Sri Lankan Standards Institution. The RTD was stored at 4 °C for two weeks, with assessments of color, microbial counts, titratable acidity, pH, total solids, and viscosity on days 0, 3, 7, 11, and 14. The PM was stored at room temperature (29.4±1.45 °C) for two weeks, with microbial counts analyzed at the same intervals. During storage, RTD showed a decrease in color and pH, while titratable acidity and viscosity increased. Microbial counts remained were not significantly different ($p \geq 0.05$) for PM over the two weeks. This study demonstrates the potential for creating high-protein beverages with desirable sensory and functional qualities for adult humans.

Keywords: functional beverages, healthy aging, high-protein beverages, whey protein, *Withania somnifera*

Enhancing Yogurt Antioxidant Activity with Aqueous Extracts of *Zingiber officinale*, *Clitoria ternatea*, and *Coccinia grandis* Aqueous Extracts

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Abstract

Yogurt is a popular fermented dairy product that provides excellent nutritional benefits. Antioxidants are particularly noted for their ability to reduce health risks. Therefore, fortifying yogurt with antioxidants derived from various plants has become a significant trend in increasing the functional properties. This study investigated the total phenolic content by Folin-Ciocalteu reagent and radical scavenging activity by 2,2-diphenyl-1-picrylhydrazyl (DPPH), and 2,2-azino-di-3-ethylbenzothialozine-sulphonic acid (ABTS) assays of set-yogurts incorporated with 1% aqueous extracts of ginger rhizomes (*Zingiber officinale*), ivy leaves (*Coccinia grandis*), and blue butterfly pea flower (*Clitoria ternatea*) at 7-day intervals over 21 days of refrigerated storage. The significant difference between the means was evaluated by one-way ANOVA and post-hoc Tukey's test with a 95% confidence level ($p<0.05$). The results indicated that all the fortified yogurts showed significantly higher antioxidant activity (total phenolic content, DPPH, and ABTS radical scavenging activity) than unfortified yogurts throughout the storage period. On day one, the total phenolic content of the ginger, blue butterfly pea flower, and ivy leaf extract fortified yogurts were 64.09±0.10, 69.89±0.05, and 61.03±0.07 µgGAE/mL, respectively. Furthermore, on day one, ginger, blue butterfly pea flower, and ivy leaf aqueous extract fortified yogurts exhibited DPPH radical scavenging activity of 25.03±0.09, 26.70±0.02, and 25.30±0.09 µgAAE/mL, respectively, and ABTS radical scavenging activity of 61.62±0.26, 70.68±0.22, and 64.10±0.20 µg AAE/mL, respectively. Over the storage, all yogurts exhibited a significant increase in total phenolic content, DPPH, and ABTS radical scavenging activity. However, all the fortified yogurts were able to maintain significantly higher total phenolic content, DPPH, and ABTS radical scavenging activity until day 21 compared to the unfortified yogurt. In conclusion, aqueous extracts of ginger rhizome, blue butterfly pea flower, and ivy leaves effectively enhance the antioxidant activity of fortified set-yogurts.

Keywords: antioxidants, *Clitoria ternatea*, *Coccinia grandis*, fortified yogurts, *Zingiber officinale*

Development of Coconut Milk-Based Fruit Smoothie

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Abstract

Smoothies are semi-liquid, thick beverages made from fruit pulps or blends. In recent years, growing demand for dairy-free beverages has been driven by lactose intolerance and dietary preferences. However, fruits with strong acidity and astringency have limited appeal for direct consumption, leading to increasing demand for mixed beverages. This study aimed to develop a lactose free, vegan, and nutrient rich smoothie using coconut (*Cocos nucifera*) milk and tropical fruits. Six formulations of smoothie were prepared by using varying proportions (w/w %) of papaya (5 - 35) and pineapple (5 - 35), along with fixed amounts of coconut milk (40), banana (16.2), sugar (3.5), and carboxymethylcellulose (CMC) (0.3). The best formulation was selected by evaluating the sensory properties of the samples by 30 untrained panelists using 9-point hedonic scale. Proximate composition, physicochemical, and functional properties of the selected smoothie formulation were assessed. Further, to determine an optimal preservation technique, three treatments were prepared using the selected formulation: a fresh smoothie, a smoothie with 0.01% sodium metabisulfite additive, and a pasteurized smoothie (60 °C for 20 min). All samples were packed in pre-sterilized glass bottles and stored in a refrigerator at 4 °C, and microbial and physicochemical analysis of these samples were conducted over storage time. In the fresh smoothie, the moisture, crude fat, crude protein, crude fiber, carbohydrate, and ash contents were 78.36±0.53, 6.76±0.42, 1.78±0.04, 1.82, 10.62, and 0.66%, respectively. Properties in all treatments were pH (5.32 - 5.61), total soluble solids (14.8 - 15.1 °Brix), titratable acidity (0.20 - 0.21%), total solids (21.83 - 29.97%), total sugar (11.90 - 12.21%), antioxidants activity (51.01 - 61.40%), and viscosity (359 - 1655 cp). Pasteurization treatment effectively extended the shelf life of the smoothie to 6 weeks. It can be concluded that 40% of coconut milk, 30% of papaya, 10% of pineapple, 16.2% of banana, 3.5% of sugar, and 0.3% of CMC is the best formulation for coconut milk-based fruit smoothies.

Keywords: coconut milk, lactose intolerance, pasteurization, smoothies, tropical fruits

Development of Vegan Sausage Using Baby Jackfruit (*Artocarpus heterophyllus*) and Banana Floret (*Musa paradisiaca*) as a Meat Substitute

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Abstract

A vegan sausage was formulated using baby jackfruit and banana floret combinations, evaluated for texture, physicochemical, and sensory properties, and compared to commercial chicken sausages. The research aims to develop a plant-based vegan sausage mimicking traditional meat texture and structure. Three samples were prepared with varying ratios of baby jackfruit (*Artocarpus heterophyllus*), banana floret (*Musa paradisiaca*), and other ingredients (T1; 50 : 30 : 20), (T2; 40 : 40 : 20), (T3; 60 : 20 : 20), and control sample was using commercially available chicken sausages based on preliminary studies. A semi-trained panel of 30 individuals evaluated appearance, texture, flavor, odor, and overall acceptability using a 5-point hedonic scale. Data were analyzed with one-way ANOVA and Tukey pairwise comparison tests. According to sensory analysis, T2 (40% baby jackfruit, 40% banana floret) had the highest scores for appearance (3.97±0.93), texture (4.30±0.13), flavor (4.54±0.57), odor (4.24±0.73), and overall acceptability (4.57±0.57), making it the preferred formulation. The final product (T2) had a cooking yield of 99.98±0.03%, pH of 5.69±0.01, and moisture content of 70.96±0.07%. Texture analysis conducted for sample T2, included hardness (2,653±1.00 g), adhesiveness (0.1±0 mJ), cohesiveness (0.49±0.11), springiness (8.1933±0.11 mm), gumminess (1,267.7±1.53 g), and chewiness (1,064.7±1.53 g). Proximate analysis conducted for sample T2, using AOAC methods found moisture, total fat, crude fiber, and ash contents of 70.96±0.07%, 0.93±0.02%, 17.56±0.54%, and 2.51±0.07%, respectively. The vegan sausages underwent four weeks of refrigeration at -18 °C in vacuum packaging. During storage, moisture content significantly increased ($p<0.05$), and pH decreased ($p<0.05$). Value-added vegan sausages made from baby jackfruit and banana floret show potential for commercialization, especially as convenient food for busy consumers.

Keywords: baby jackfruit, banana floret, meat substitute, sensory evaluation, vegetarian sausage

Development of Beetroot (*Beta vulgaris*) Incorporated Blackcurrant (*Ribes nigrum*) Concentrate and Study the Acceptability of the Product

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Abstract

Fruit concentrates are popular among many age categories. Cost of those products is high because of the short post harvest life and seasonality. The excess production of vegetables led to a new global trend of combining fruits with vegetables in fruit concentrate production. This research aims to develop blackcurrant concentrate by incorporating beetroot extract. Nine samples prepared by varying the concentrations of beetroot pulp in 80, 60, and 40 mL, and sugar solution under three ranges. Pulp percentage and the chemical composition of samples were analyzed in terms of total soluble solids content, pH, and titratable acidity. Sensory evaluation conducted using a 9-point hedonic scale with 40 untrained panelists. The sample with 100 mL blackcurrant pulp, 60 mL beetroot extract, and 230 mL sugar solution was the best sample based on the control. Selected sample had 2.9 pH, 67.4% total soluble solids, 2.4% titratable acidity, and 41% pulp. That was further analyzed for volatile components, phenolic content, antioxidant activity, sedimentation index, and color (L*, a*, and b*) compared to the commercial blackcurrant concentrate (control). The sample containing 167.5 ppm total phenolic compounds did not indicate significant differences in the volatile compounds and antioxidant activity. Sedimentation index was 55 and color parameters were L*=26.83, a*=0.84, and b*=-0.63. Also, total soluble solids, pH, titratable acidity, yeast, and mold count are analyzed to determine the shelf-life under ambient temperature. Shelf-life test results were in acceptable range. Selected sample had more than 65% total soluble solids, pH 2.3 - 3.3, titratable acidity 2.3 - 2.5, and no yeast or mold growth. Therefore, this combination of beetroot and blackcurrant provides a quality outcome which is more similar to the blackcurrant concentrate. Furthermore, this research helps to demonstrate the potential of commercializing vegetable incorporated fruit concentrates.

Keywords: antioxidant activities, beetroot extract, blackcurrant concentrate, fruit concentrate, sedimentation index

Comprehensive Analysis of Crack Formation in Soft Dough Biscuits

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Abstract

Unexpected cracks were observed at specific period during the day, causing huge losses to a prominent biscuit manufacturing company in Sri Lanka. Therefore, multiple trials were conducted, involving variations in ingredient sources, adjustments to oven temperature settings, and replacement of cutter mold to establish a definitive solution. However, crack formation was studied with the environment temperature and observed that the temperature fluctuations during the afternoon directly affect on crack formation. Time intervals were recorded at 7.00 a.m. to 7.00 p.m. in two-hour increments throughout the daytime, monitoring the environmental temperature, moisture content of the biscuit dough, and visual assessments of baked biscuit texture. Elevated environmental temperature raised the dough temperature, shows excessive drying and moisture variation from 11.3 to 10.34%, resulting in uneven moisture distribution in the biscuit dough. This phenomenon led to the pressure generation inside the biscuit while baking and caused crack formation. Therefore, the uniformity of moisture distribution in the dough confirmed the mitigation of the crack formation. The solution was proposed by deriving an equation to calculate the volume of water to be pre-mixed into the dough, compensating for the moisture loss during drying. The additional volume of water required should be determined by considering the time, batch size, and the initial moisture content of the biscuit dough. Following the proposed approach reduced crack formation by 80%, effectively addressing the issue and improving production outcomes.

Keywords: cracks, environmental temperature, heat generation, moisture, soft dough

Non-Destructive Screening of the Presence of Cowpea Weevil (*Callosobruchus spp.*) in Red Cowpea Grain Using Near Infrared Spectroscopy

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Abstract

Weevil infestation is a significant threat to the quality and market value of red cowpea (*Vigna unguiculata*) grains, both externally and internally. In agricultural settings, traditional techniques such as manual sampling, probes, and traps have been employed to detect and treat the presence of weevil (*Callosobruchus spp.*) infestation. Currently, these methods are inefficient and time consuming. Addressing this concern, this study presents a fast, non destructive and chemical free method to identify insect infestations in red cowpea grains using near infrared spectroscopy (NIRS). Insect-infected and non-infected seed samples were obtained from five small scale farms located in the Anuradhapura district of the North Central province in Sri Lanka and the total number of 200 samples were tested with 20 replicates. A total of 1600 reflectance spectra were obtained NIRS (FQA-NIR GUN) as 4 spectra from each replicate in 2 storage times. Results showed that the soft independent modelling of class analogy (SIMCA) model, enhanced with variance scale pre-processing and second derivative mathematical transformation, maximized the distinction between infected and non-infected samples, with the near 100% accuracy. The important wavelength variable influencing this superior classification model was identified as 858.7239 nm. Furthermore, the SIMCA model with mean-center pre-processing and second derivative math transformation maximizes the class distance to assess the influence of farmers' location on the intensity of insect infections, and the most important wavelength variable involved in the best classification model is 941.6613 nm. The SIMCA model of mean-center, second derivative was selected as the best model to assess the influence of storage time on the intensity of insect infections. This research demonstrated the potential possibility of developing NIRS as a screening tool for weevil infestation (*Callosobruchus spp.*) in red cowpea grains. By successfully bridging the gap between technological advancement and agricultural quality control, this study paves the way for enhanced preservation and marketability of red cowpea grains.

Keywords: manual inspection, NIR spectroscopy, non-destructive, red cowpea, soft independent modelling of class analogy (SIMCA)

Development of Grain-Based Carbonated Beverage Using Sprouted Green Gram (*Vigna radiata*) and Red Rice (*Oryza sativa* L.)

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Abstract

Carbonated soft drinks pose significant health risks. Grain combinations provide ample amounts of nutrition. This study aims to identify the feasibility of incorporating cereals and pulses for carbonated soft drinks. MI 1 green gram and red *nadu* rice varieties were used. Taguchi's L9 orthogonal array experimental design was employed. There were 5 factors (red rice flour, sprouted green gram flour, sugar syrup, guar gum solution, and treated water) and 3 levels in each factor. Twelve samples were screened according to the sedimentation, pH, Brix, and titratable acidity results. Three sensory evaluations were conducted using a 9-point hedonic scale. Forty untrained panelists participated in each session. Results were analyzed using five sensory attributes (color, aroma, flavor, consistency, and overall acceptability). The selected sample was treatment 10 (T10), which consisted of 10 g of red rice flour, 5 g of sprouted green gram flour, 35 g of sugar syrup, 30 g of guar gum solution, and 10 g of treated water. Inverted Brix, appearance, odor, taste, e-nose analysis, total bacteria count, yeast, mold, and shelf-life analysis were conducted. Market available carbonated soft drink product, which consisted of artificial flavoring, water, carbon dioxide, sugar, citric acid, and sodium benzoate was taken as a control. Results revealed a significant variation in control and T10. Aromatic compounds such as broad-methane and sulfur-organic were highly available in the control. The T10 consisted with low inverted Brix value than the control and 48.45% moisture content (wet basis), relatively 2.85% mineral content, higher protein (10.20%), and fat content (1.47%). Also, that comprised 0.92% fiber and 35.97% carbohydrate content. The major drawback of the T10 was lower microbial stability. The optimum physical, chemical, and biological characteristics were retained until the second week under refrigerated conditions (4 °C). Further experiments should be conducted to introduce T10 with prominent features and strengthen the national economy.

Keywords: carbonated soft drinks, red rice, sensory evaluation, shelf-life analysis, sprouted green gram

Investigate the Potential Application of *Keren Koku* (*Acrostichum aureum*) Leaf Extract as a Binding Agent for Sausages

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Abstract

High import costs and health concerns are led sausage manufactures to find alternatives for modified tapioca starch as primary binding agent. This study explored the potential application of *keren koku* (*Acrostichum aureum*) (KK) leaf extract as binding agent in sausage production. Sausages were formulated using three different concentrations (2, 4, and 6% w/w) of KK leaf extract to replace 4% tapioca starch (control). The study evaluated the physicochemical, sensory, and microbial properties of the developed sausages, as well as their shelf life over four weeks at -18 °C. There were no differences in color, taste, and aroma between KK leaf extract-added sausages and the control, whereas texture and overall acceptability were significantly favored for the 6% KK leaf extract-added group. Sausages of all experimental groups showed a decreasing pH trend throughout the storage. Notably, 6% KK leaf extract added sausages showed significantly lower water holding capacity values compared to the control during the storage. Sausages with 2% KK leaf extract had significantly lower cooking loss compared to the control while those with 6% KK leaf extract had significantly higher cooking loss. Texture profile analysis exhibited that KK leaf extract addition significantly reduced the chewiness compared to the control while the 6% KK leaf extract group showed the lowest chewiness. The hardness of all KK leaf extract-added sausages was significantly higher compared to the control. The total aerobic bacteria count of all experimental groups remained within the safe limit during the storage. These findings revealed that, addition of KK leaf extract up to 4% offers the best water holding capacity, yield, and chewiness without compromising the sensory properties. Higher concentrations of KK extract (6%) improve texture, however, negatively affect other quality attributes. These findings suggest that incorporation of KK is a viable alternative to commercial binding agents in sausages.

Keywords: binder, *keren koku* (*Acrostichum aureum*), plant-based binder**s,** sausage, substitute

Development and Evaluation of Lactose-Free Coconut Milk Chocolate Incorporated with Dates

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Abstract

Chocolate is one of the popular food products worldwide, known for its diverse range of different flavors. The key ingredients of many chocolate formulations are cocoa *(Theobroma cacao)*, sugar, and milk. In recent years, the food industry has been developing a range of plant-based milk alternatives to bovine milk for people with lactose intolerance. Coconut milk is a plant-based alternative with high nutritional content making it an excellent substitute. The study aimed to develop and evaluate lactose-free chocolate using cocoa, dates *(Phoenix dactylifera)*, coconut milk powder and sugar as primary ingredients. The ingredients were selected for their natural sweetness and suitability for individuals with lactose intolerance. Coconut milk chocolate was prepared by first making the cocoa mass, then blending it with all the other ingredients, moulding and cooling. Three samples were prepared by varying ratios of cocoa, coconut milk powder, dates, and sugar: T1 (60 : 10 : 10 : 20), T2 (60 : 20 : 10 : 10), and T3 (60 : 10 : 30 : 0), and a control sample was prepared using cocoa, milk powder, and sugar. Thirty semi-trained panelists were involved in evaluating consumer acceptance on attributes like appearance, color, texture, aroma, taste, after taste, mouth feel, and overall acceptability using 7-point hedonic scale. Sensory attributes were analyzed using the Tukey pairwise comparison test (one-way ANOVA). Sample T2 received the highest ratings for appearance (6.17±0.91), color (6.17±0.98), texture (5.77±1.16), odor (5.90±1.18), taste (6.47±0.81), and overall acceptability (6.60±0.81). The proximate analysis conducted for sample T2, showed fat (37.15±0.17%), moisture (1.23±0.14%), ash (2.90±0.03%), fiber (6.57±0.06%), protein (8.12±0.28%), and carbohydrate (34.44±0.49%). The shelf life analysis conducted for sample T2, showed no microbial growth during the 4-weeks storage period, with a decrease in moisture content and an increase in the pH. The study successfully developed a lactose-free product with reduced sugar content, desirable sensory properties and enhanced nutritional value.

Keywords: chocolate, coconut milk powder, dates, healthy, lactose intolerance

Utilization of Brewer's Spent Yeast to Develop a Cattle Protein Concentrate

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Abstract

Brewer's spent yeast, a by-product of beer production, is rich in protein, B vitamins, and minerals. This study aimed to develop a cattle protein concentrate from brewer's spent yeast under optimal processing conditions, by evaluating its nutritional value and sensory properties. Twelve samples were prepared under different autolysis and drying temperatures with and without debittering process. The best treatment was selected through a sensory evaluation for parameters like fermented, rancid musty odors, and bitterness, comparing it to a control sample, which is spent brewer's yeast. The optimal sample was produced by debittering with 2 N NaOH at pH 10, at 50 °C for 30 minutes, followed by autolysis at 50 °C for 24 hours and oven drying at 50 °C or 5 - 6 hours. The results revealed that the moisture, total ash, crude fat, crude protein, crude fiber, and carbohydrate contents of the optimal feed sample were 8.36±0.29, 6.43±0.30, 0.66±0.07, 46.68±0.19, 6.59±0.17, and 31.28±0.43%, respectively that most of these parameters were higher compared to the control sample. However, there was no significant difference ($p>0.05$) in total ash and crude fat between the two samples. The results indicate that debittering, autolysis, and oven drying improved the nutritional composition of the cattle feed. Fourier transform infrared analysis confirmed the presence of functional groups, such as hydroxyl groups of lipids, amide groups, peptide bonds of proteins, and C-O stretching of nucleic acids and carbohydrates in the best feed sample. Chemical analysis of the best feed sample using the electronic nose has shown the highest relative response to S6 sensor which reveals short chain alkanes such as methane. The other significant relative response of the electronic nose was by the S2 sensor for the control sample where it is sensitive to nitrogen oxides. Based on nutritional parameters, the developed feed meets the Sri Lanka Standards for compound feeds for dairy cattle and buffalo. This research shows the potential for creating a sustainable feed source while reducing spent yeast waste.

Keywords: autolyzed yeast, brewer's spent yeast, cattle feed, cattle protein concentrate, electronic nose, FTIR

Enzymatic Hydrolysis of Yellowfin Tuna Proteins Using Extracted Papain Enzyme from Papaya Latex

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Abstract

There is a growing interest in utilizing fish waste-based protein substitutes for direct human consumption. This study aims to evaluate the proximate characteristics of fish protein hydrolysate extracted from the skin of yellowfin tuna (*Thunnus albacares*) using a locally prepared papain enzyme derived from papaya latex. Therefore, the cost of purchasing papain enzymes should not be considered. The papain enzyme was extracted from fresh papaya latex, followed by purification through a dialysis process. Milk-clotting test was conducted to determine the enzyme activity. Hydrolysis of yellowfin tuna protein was done using papain enzyme concentrations of 3% (treatment 3), 2% (treatment 2), 1% (treatment 1), and 0% (control sample). According to the results, the highest yield of papain enzyme from papain latex was extracted using the optimal ratio of ammonium sulfate to papain enzyme of 1 : 3. Moreover, the results revealed that 3% of this extracted enzyme concentration is suitable to obtain the highest percentage of fish protein hydrolysate (87.52±1.27%) and the milk-clotting results showed 3% of papain enzyme showed the highest enzyme activity. Furthermore, proximate analysis of the oven-dried fish protein hydrolysate produced using 3% of papain enzyme showed mean contents of 87.52±1.27% protein, 7.3±0.7% moisture, 2.2±0.2% ash, and 0.1±0.0% crude fat. Overall, the findings revealed that the concentration of the papain enzyme influences the protein content during the hydrolysis process. As the enzyme concentration increases, the hydrolysis process becomes more effective. In conclusion, based on the protein content, the fish protein hydrolysate developed from yellowfin tuna skin meets the proximate requirements. Therefore, fish protein hydrolysate can be a valuable protein substitute to use in snacks, juices, or animal feeds to enhance their protein content.

Keywords: dialysis process, fish protein hydrolysate, oven drying, papain enzyme, yellowfin tuna skin

Enhancing the Probiotic Viability, Textural, and Sensory Attributes of Yogurt through the Incorporation of Pectin Extracted from Fruit Peels

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Abstract

This study investigates enhancing the functional and sensory properties of set yogurt by incorporating pectin extracted from mango (*karathakolomban*) and banana (*kolikuttu*) peels at varying concentrations (0.1, 0.5, and 1% w/w) and 1% of gelatin, adding same amount of ABY 10 probiotic starter culture. Pectin was extracted from peels by heating at 60 °C at pH 2, and 96% alcohol precipitation followed by oven drying at 100 °C. A control yogurt without pectin was prepared. The pH, syneresis, probiotic count, shelf life, and sensory attributes were evaluated on days 1, 7, 14, 21, and 28 of storage. Incorporating 1% mango and banana pectin significantly reduced the pH of the yogurts respectively to 4.3 and 4.4, compared to pH 4.5 in the control ($p<0.05$) from the first day of storage. This is likely due to the microbial fermentation of the pectin. Moreover, the 1% mango peel pectin yogurt showed a significantly reduced syneresis (1.83%) compared to other treatments, and the control (2.93%) ($p<0.05$) as per the funnel method. After 14 days of storage, all yogurt variants were analyzed on MRS agar. The *Lactobacillus spp.* survival in the yogurt with 1% mango peel pectin significantly higher level ($9.5\pm0.31\times10^4$ CFU/g) compared to all treatments and the control ($7.0\pm0.29\times10^4$ CFU/g), ($p<0.05$). Total plate count indicated that all yogurts with pectin maintained a shelf life of 28 days, similar to the control. One percent mango peel pectin yoghurts significantly reduced sensory acceptability ($p<0.05$), while 1% banana peel pectin produced yogurts with sensory properties similar to the control. In conclusion, incorporating 1% mango peel pectin improves the viability of yogurt's probiotic bacteria and syneresis. However, it reduces the sensory appeal. Conversely, 1% banana peel pectin offers benefits while maintaining similar consumer acceptability as of the control, making it more suitable to produce probiotic yoghurts compared to mango peel pectin.

Keywords: banana peel, mango peel, pectin, probiotics, syneresis

Evaluation of Fermentation Dynamics and Volatile Compound Profiles of Probiotic *Lactobacillus* spp. Inhabiting| Tender Coconut Water

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Abstract

Lactic acid bacteria fermentation of tender coconut water creates a beverage with enhanced probiotic and biopreservation properties. This study examines the potential fermenters with a preferred volatile profile among four indigenous lactic acid bacteria inhabiting tender coconut water: *Lactiplantibacillus plantarum* CWJ3, *Lacticaseibacillus rhamnosus* CWKu-12, *Lacticaseibacillus paracasei* CWKu-14, and *Lacticaseibacillus casei* CWM15. The lactic acid bacteria strains were cultured in de Man, Rogosa, and Sharpe broth, and inoculated into pasteurized tender coconut water. Their fermentation characteristics were monitored over 48 hours at 37 °C, and volatile profiles were analyzed using gas chromatography-mass spectrometry coupled with solid-phase microextraction (GCMS-SPME). In all samples, pH and residual sugar levels consistently decreased, while viable cell counts increased during fermentation. *L. plantarum* CWJ3 exhibited the significantly lowest pH (3.86±0.26) and Brix (3.78±0.54) values while maintaining high cell viability (5×10^6 CFU mL^{-1}). This strain also demonstrated relatively stable viable cell productivity (78,194 to 102,950 CFU $mL^{-1}h^{-1}$), and a growth rate (0.0417 to 0.0516 h^{-1}), making it the most suitable strain for fermentation. GCMS-SPME analysis confirmed the production of acids, esters, ketones, lactones, and aldehydes during fermentation. *L. plantarum* CWJ3 produced the significantly highest amounts of acetic acid (13.12±1.21%), and acetaldehyde (1.25±0.23%), and the lowest ethanol levels (4.56±0.87%). Conversely, *L. rhamnosus* CWKu-12 produced elevated levels of ketones and lactones, such as 2-heptanone (8.15±1.02%) and 2,3-butanedione (4.16±0.81%), contributing to a unique volatile profile. Ethyl acetate was the primary ester produced by all strains, with *L. paracasei* CWKu-14 generating the significantly highest amount (7.65±0.54%). Notably, *L. plantarum* CWJ3 was the only strain to produce ethyl isobutyrate. The volatile compounds from *L. plantarum* CWJ3 and *L. rhamnosus* CWKu-12 contribute to a fruitier flavor, while their increased acetic acid and reduced ethanol levels enhance the product's biopreservation.

Keywords: fermentation, GCMS-SPME, lactic acid bacteria strains, probiotics, volatile profile

Sorption Efficiency of Calcium Ions by Green Leafy Vegetables

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Abstract

Calcium, which exists as a salt of calcium ion (Ca^{2+}), is the most abundant mineral in the human body. When green leafy vegetables (GLVs) are consumed along with calcium-rich foods, the oxalate ions ($C_2O_4^{2-}$) present in GLVs combine with the Ca^{2+} and form calcium oxalate (CaC_2O_4), which is an insoluble salt and cause the formation of kidney stones. In this study, the calcium sorption efficiency of the GLVs were evaluated using *Ipomoea aquatica* (*kankung*), *Alternanthera sessilis* (*mukunuwanna*), *Asparagus falcatus*; (*hathawariya*), *Sesbania grandiflora* (*kathurumurunga*), and *Centella asiatica* (*gotukola*) while changing the Ca^{2+} concentration and contact time. A 10 g portion from each GLV was soaked in 25 mL of standard calcium solutions (20, 40, 60, 80, and 100 ppm) separately for one and two hours. In the kinetic study, the GLVs were soaked with 25 mL of calcium-rich foods such as milk, yoghurt drink, tofu, curd, and salmon water by varying the contact time. For the calcium detection in the GLVs, dry and wet ashing processes were carried out separately on vegetable samples and calcium-rich foods, respectively. Prepared samples of each were used to measure Ca^{2+} concentrations through atomic absorption spectroscopy. The sorption efficiency of GLV increased to a certain level depending on the Ca^{2+} concentration and contact time. *Asparagus* increases up to only 40 ppm, and *Alternanthera* increases up to 60 ppm in both one-hour and two-hour sorption. The kinetic study proved that GLVs being able to bind with Ca^{2+} when they are consumed together. The Ca^{2+} concentrations *of Alternanthera* and *Centella* were increased, and the Ca^{2+} concentrations of selected calcium-rich foods were decreased with time. Sometimes, the equilibrium reached after 15 min, while salmon water shows the opposite behavior. This study revealed that consumption of selected GLVs and calcium-rich foods within two hours can affect calcium absorption in the body and there is no formation of CaC_2O_4.

Keywords: calcium-rich foods, calcium sorption, green leafy vegetables

Assessment of Phytochemical Content and *in vitro* Antioxidant Activity of *Pouteria Campechiana* (*Kaha Laulu*) Fruit Pericarp Extract: An Underutilized Fruit in North Central Province of Sri Lanka

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Abstract

Pouteria campechiana (*kaha laulu*) has been recognized as an underutilized fruit in Sri Lanka and hence, its nutritional content remaining undiscovered. The present study was aimed to assess the phytochemical content and antioxidant activity of unripen fruits of *P. campechiana*, which were collected from different locations of North Central province in Sri Lanka. Dried fruit pericarp was extracted in ethanol by maceration, and the dried crude extract was subjected to solvent partition with hexane and ethyl acetate. Residual aqueous phase was freeze-dried, and all the fractions were subjected to estimate total phenolic content (TPC) and total flavonoid content by the Folin-Ciocalteu method and aluminum chloride method, respectively. A concentration gradient (0.0625, 0.125, 0.25, 0.5, and 1.0 mg/mL) of crude extract, and the fractions were screened for antioxidant activity by 2,2-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS), 1,1-diphenyl-2-picrylhydrazyl (DPPH), and nitric oxide (NO) radical scavenging assay. The TPC in 1 mg/mL concentration were 230.4±2.3, 199.2±4.7, 234.7±0.9, and 214.9±7.7 mg GAE/100 g of extract for crude extract, hexane, ethyl acetate, and aqueous fractions, respectively. The total flavonoid content in 1 mg/mL concentration of crude extract, hexane, ethyl acetate, and aqueous fractions were 231.0±6.4, 187.3±30.1, 205.6±11.5, and 163.9±4.6 mg QE/100 g of extract, respectively. Compared to the crude extract and other fractions, ethyl acetate fraction showed a significantly higher antioxidant activity in 1 mg/mL for ABTS, DPPH, and NO assays (99.17±0.4, 60.42±1.1, and 63.83±1.6%, respectively). The results of the present study revealed that ethyl acetate fraction of *P. campechiana* fruit pericarp exerts promising antioxidant activity reflecting its suitability for the development of antioxidant food supplements.

Keywords: antioxidant activity, *Pouteria campechiana*, underutilized fruits

Development of a Moringa Powder (*Moringa oleifera* Lam.) Incorporated Rice Paper Snack

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Abstract

In Sri Lanka, children consume snacks between meals, but there are a few healthy snacks available in the market. This creates a demand for healthy snacks that support children's growth. This study was carried out to develop a moringa powder incorporated rice paper snack. *Moringa oleifera* Lam. leaf powder and red rice flour are incorporated into this snack, which contains higher nutritional and medicinal properties. Rice paper snacks were prepared from rice papers. To prepare the rice papers, three methods were evaluated (1st method: red rice flour, 2nd method: cooked red rice, and 3rd method: red rice flour with guar gum). To prepare the rice paper snacks, frying and baking methods were evaluated. Moringa powder incorporated rice paper snack was studied with three moringa percentages (2.5, 5.0 and 7.5%) and two flavors (spicy and sweet flavor). Sensory evaluations were conducted to select the best moringa powder percentage and best flavor. Further, proximate composition and antioxidant activity were evaluated for the best product compared to the control (snack sample without adding moringa powder). Based on the results, the 3rd method and the frying method were selected as the most suitable method to prepare rice papers and rice paper snacks, respectively. Based on the sensory evaluation results, sweet flavor 2.5% moringa powder incorporated rice paper snack was selected as the best product. According to the analytical results of the best product, protein, ash, fat, crude fiber, and carbohydrate contents were 6.13±0.09, 1.50±0.01, 15.24±0.77, 0.76±0.00, and 76.37±0.87%, respectively. Total polyphenolic content, total flavonoid content, DPPH radical scavenging activity, and oxygen radical absorbance capacity were 0.23±0.01 mg Gallic Acid Equivalents/g, 0.02±0.00 mg Quercetin Equivalents/g, 14.94±1.09 mg Trolox Equivalents/g, and 14.23±1.46 mg Trolox Equivalents/g, respectively. In conclusion, the sweet flavor 2.5% moringa powder incorporated rice paper snack sample is considered as the best product according to the analytical results. It has higher nutritional value and antioxidant activity compared to the control.

Keywords: antioxidant activity, leaf powder, *Moringa oleifera* Lam., proximate analysis, rice paper snack

Development of Food Consumption Monitoring System for Tracking and Analyzing Pre-Packaged Fast Food Intake to Promote Healthier Eating Practices

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Abstract

Fast-foods, often called "junk food" is typically characterized by their low nutritional value and high caloric content, primarily from fats, carbohydrates, salts, preservatives, and additives. Its consumption can have a substantial negative impact on physical and mental health, particularly in children, who are more susceptible due to their tendency to choose foods based on appearance and taste. Existing food intake monitoring systems generally rely on vision-based methods, which can be classified into active and passive modes. We have developed a food consumption monitoring system to track, and analyze an individual's pre-packaged fast-food consumption without requiring expensive equipment or tools. Food consumption monitoring enables consumers to identify the ingredients, nutritional content, and portion size of their food, helping them make informed decisions when purchasing pre-packaged fast foods. This system employs a convolutional neural network using TensorFlow and Keras along with libraries for data handling and visualization. It is trained on sample data through training and validation modules, allowing it to accurately recognize and display the ingredients, and nutritional information of captured food items. Users are required to capture an image of the item and manually input the portion size consumed. This data can be stored and retrieved, enabling users to review their consumption patterns, ingredients, and nutritional information over time. Food consumption monitoring needs model training using more pre-packaged fast food images to ensure accurate identification of items. Future enhancements could include more detailed ingredient identification, and more accurate measurement of portion size. It is anticipated that this approach could improve public health by reducing the prevalence of non communicable diseases, and enhancing overall physical and mental well-being, contributing to achieving nations' sustainable development goals.

Keywords: consumption, fast food, monitoring, non communicable diseases

Use of Cheese Whey as a Substitute for Skim Milk in the Standardization Process of Yoghurt Production

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Abstract

Whey is a major by-product of the cheese industry and its disposal is a huge challenge for the dairy sector, resulting in huge protein wastage as well. This study evaluated the effective utilization of liquid sweet whey to replace skim milk in the standardization process of yoghurt production. Initial physicochemical characterization (titratable acidity, pH, fat, moisture, and non-fat solids) of sweet whey and skim milk was carried out to identify potential compositional differences affecting yoghurt production. The control group used standardized whole milk with skim milk, while the treatment group used standardized whole milk with liquid sweet whey. The proximate analysis was performed for the control group and the treatment group. The shelf life study monitored changes in pH, titratable acidity, syneresis index, and microbial characteristics in the treatment and control groups stored under refrigerated conditions (4 °C) over 21-days at one-week intervals. The findings highlight that whey is a viable alternative, optimizing the gelatin content is essential to achieve the desired gel texture in yoghurt. Over 21-days storage period, the pH of the treatment group significantly decreased from 4.43 to 3.83 staying within the Sri Lanka Standards (SLS), maximum of pH 4.5 for yogurt. Initial titratable acidity level of the treatment group was 0.75%, increasing to 0.84% by day seven, within the SLS level of 0.7 - 0.85%. Syneresis was significantly higher in the treatment group, increasing from 42.04 to 48.14%, than in the control group, which increased from 40.32 to 45.78%. The treatment group had significantly higher moisture content (76.9%) than the control group (74.05%), while other compositions remained similar. The treatment group yoghurt met the SLS for microbiological characteristics throughout 14-days of refrigerated (4 °C) storage. These findings show that sweet whey can successfully replace skim milk in yoghurt production, offering potential cost savings and reduced environmental impact.

Keywords: cheese whey, replacement, standardization, yoghurt

Role of Curcumin as a Food Eco-Preservative and its Effect on Shelf-Life Prolongation of Fresh Fish

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Abstract

Extending the shelf-life of perishable fish products is crucial for minimizing waste and ensuring the availability of safe, fresh fish rich in essential nutrients. This study investigates the microbial, biochemical, and organoleptic stability of frozen sardines (*Sardinella longiceps*) treated with the natural preservative curcumin. Fish samples underwent a dip treatment with curcumin, with benzoic acid and potassium nitrate serving as positive controls and triple-deionized water as a negative control. Curcumin was extracted using a column-based technique with PAD 950 resin. Microbial stability was assessed by analyzing aerobic, anaerobic, psychrotrophic, proteolytic, and enterobacteria counts. Organoleptic quality was evaluated using the quality index method, and biochemical stability was measured through total volatile basic nitrogen (TVB-N) and hydrogen peroxide determinations. All tests were conducted in triplicate, with pre-tests performed at day 0 and post-tests at days 3 and 7 of preservation. The acceptable limit for TVB-N is 35 mg N/100 g; however, samples treated with 2% curcumin showed a TVB-N value of 7 mg/100 g on day 7. For peroxide values, which should not exceed 10 meq oxygen/kg fat, the 2% curcumin-treated fish recorded a value of 7.53 meq oxygen/kg on day 7. The treatment with 2% curcumin significantly reduced ($p<0.05$) counts of aerobic, anaerobic, psychrotrophic, proteolytic, and enterobacterial bacteria, demonstrating its potential as a preservative compared to benzoic acid and potassium nitrate. Organoleptic analysis, which included assessments of skin appearance, slime, eye cornea, pupil, gill appearance, odor, texture, and body stiffness, indicated significantly lower quality index scores ($p<0.05$) for curcumin-treated samples. Curcumin treatment effectively reduced lipid oxidation, hydrogen peroxide levels, and TVB-N rancidity. In conclusion, 2% curcumin is suggested as an effective preservative to inhibit bacterial spoilage and prolong the shelf-life of fish, thereby maintaining the freshness of raw fish.

Keywords: curcumin, preservation, sardines, shelf-life extension

Early and Middle Stage Anti-Glycation Activities of Whole Grains of Selected Wild *Oryza* Species in Sri Lanka

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Abstract

Wild relatives of rice, belonging to the genus *Oryza*, present significant opportunities for enhancing cultivated rice species. In Sri Lanka, there are five wild *Oryza* species, yet research into their health benefits remains extremely limited. This study was conducted to evaluate the anti-glycation potential of wild *Oryza* species from Sri Lanka in relation to diabetes complications management. Freeze-dried seventy percent ethanolic extracts of whole grains of *Oryza nivara* (Chenkaladi, Batticaloa), *Oryza rufipogon* (Thihagoda, Matara), *Oryza eichingeri* (Waulpane, Embilipitiya), and *Oryza granulate* (Walakada, Matara), which were collected from their natural habitats were used in the study. The anti-glycation activity of selected species was evaluated using early stage [Bovine Serum Albumin (BSA)-glucose] and middle stage [BSA-methylglyoxal (MGO)] glycation models *in vitro* (n=4 each). The results showed that all the selected wild *Oryza* species had both BSA-glucose and BSA-MGO anti-glycation activities in a dose dependent manner. Significant differences ($p<0.05$) were observed among the studied species in both glycation models tested. The IC_{50} values of BSA-glucose and BSA-MGO anti-glycation activities were in the range of 11.51±1.59 to 36.37±0.44 µg/mL, and 187.47±27.71 to 380.11±7.10 µg/mL, respectively. Among the studied species, *O. eichingeri* (11.51±1.59 µg/mL) exhibited significantly high ($p<0.05$) BSA-glucose anti-glycation activity while *O. eichingeri* (187.47±27.71 µg/mL) and *O. granulate* (197.85±15.64 µg/mL) showed the highest ($p<0.05$) BSA-MGO anti-glycation activity. It is concluded that both early and middle stage anti-glycation activities were observed in the studied wild *Oryza* species in Sri Lanka, and *O. eichingeri* is the best species in terms of both anti-glycation activities tested. Therefore, *O. eichingeri* may have the potential to utilize in rice breeding program in developing anti-diabetic cultivated rice species in the country.

Keywords: anti-glycation activity, BSA-glucose anti-glycation, BSA-MGO anti-glycation, wild *Oryza* species in Sri Lanka

Geo Resources, Geo Environment, and Geotechnics

Borehole Injected Biochar for *in situ* Contaminant Remediation: Effect of Particle Size in Treatment Efficiency

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Abstract

Soil contamination with hydrocarbons is a pressing environmental issue, particularly near industrial sites like service stations, fuel stations, and garages. Traditional remediation methods often need to be revised, necessitating innovative solutions. This research explores the effectiveness of biochar in removing hydrocarbons from contaminated soil. This experiment is the first to test injecting boreholes and treating them using biochar, as no prior research has addressed this approach. Using a specially created glass tank to simulate the real ground conditioning of the contaminated land area and facilitate the treatment of contaminated soil from using the model. We conducted sieve analysis and hexane extractable material tests on nineteen samples, including initial soil, modeled soil, modeled biochar, and a water sample from the model. The findings demonstrated that biochar absorbed 75 - 85% of hydrocarbons, significantly reducing contamination levels over 20 days. Minimal hydrocarbons were detected in the water sample, indicating that biochar effectively prevents leaching. However, challenges remain, such as separating fine soil particles and understanding the slight hydrocarbon loss during testing. This study demonstrates biochar's potential as a sustainable remediation agent, highlighting its capacity to clean contaminated soil and protect groundwater, paving the way for further research and practical applications.

Keywords: soil remediation, hydrocarbons, environmental sustainability, borehole injection, hexane extractable material (HEM)

Estimation of Uniaxial Compressive Strength and Elastic Modulus of Metamorphic Rocks using Schmidt Hammer Test

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Abstract

Engineers widely use the uniaxial compressive strength (UCS) and elastic modulus (EM) of rock in designing surface and underground structures. Although the methods used to measure UCS and EM are relatively simple, it is time consuming and expensive and requires well prepared rock cores. Therefore, indirect tests are often used to predict the UCS and EM, such as the Schmidt rebound hammer test, point load test, impact strength, and sound velocity. The Schmidt rebound hammer test is very easy to carry out, because it requires less or no sample preparation, and the testing equipment is less sophisticated. It can also be easily performed in both field and laboratory conditions compared to UCS and EM tests. Many studies had been carried out to develop the correlation between Schmidt rebound hammer test results and UCS of rocks found in different regions of the globe, but there is no standard relationship developed yet between UCS, EM, and rebound hammer test for Sri Lankan metamorphic rocks. So, this study aimed to develop a relationship by performing the Schmidt hammer test, UCS, and EM for metamorphic rock samples collected from Sri Lanka and analyzing the obtained results through regression by the least squares method. Developing a correlation between UCS, EM, and Schmidt rebound hammer value would be beneficial for engineers in tunneling and deep foundation construction in Sri Lanka, enabling them to assess the strength of rock at the site with reduced sample preparation and time consumption.

Keywords: metamorphic rocks, uniaxial compressive strength, elastic modulus, Schmidt hammer test

A Slope Stabilization and Erosion Control Proposal with Waste Tyres and Plants: Design and Simulation Results

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Abstract

The escalating issue of waste tyre disposal, because of their large volume and resistance to decomposition, poses significant environmental challenges. Given the difficulties associated with recycling rubber, repurposing waste tyres in geotechnical engineering offers a viable alternative. Traditional slope stabilization techniques such as gabions, concrete walls, and geosynthetics are often costly and environmentally taxing. This study investigates the use of waste tyres as a sustainable, cost effective solution for slope stabilization and erosion control. By incorporating waste tyres and fast growing plants like lemongrass and vetivergrass, the study addressed two pressing issues: the need for affordable slope stabilization methods and the environmental impact of waste tyre accumulation. The research methodology involved a literature review, soil sampling and testing, design and simulation of a slope stabilization proposal, and a pilot study incorporating selected plants for erosion control. Numerical simulations offered a platform to trial a few different solutions to optimize the design parameters. Once the design parameters were decided, then the model was further checked with current industry practices and updated. Then, the effect of plants on slopes with waste tyres were studied and current practice guidelines were analyzed and selected the more useful plants to be planted as per local weather conditions. Our approach provides a practical, environmentally friendly alternative to traditional stabilization methods, contributing to both effective waste management and enhanced soil conservation.

Keywords: slope stabilization, tyre reuse, environmental geotechnics, nature based ground engineering solutions

An Enhanced Piling Project Management Web Application with Portable Accessibility

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Abstract

In the ever changing world of construction project management, digital solutions have become a necessity to combat the pitfalls of outdated manual processes. This study aimed at improving mobile access to piling projects through a newly developed web-based application. By moving paper-based work into the digital realm, this solution creates a single point of truth for task management, data transfer, and storage, ensuring greater accuracy and efficiency, while providing an easily accessible record of past activities. The web application which has no any limitations with any devices or operating systems provided project managers as well as assistant engineers the ability to monitor construction of piles beyond just one site, allowing real time tracking of the pile construction. The system's ability to efficiently handle data input and retrieval was evaluated by simulating the entry of dummy project data, including pile details (e.g., pile number, coordinates, and ground level), bentonite test results (e.g., density and viscosity), and process logs (e.g., tool used, depth, and time) makes this web application more efficient. Moreover, 2-dimensional pile graph visualization shows the location of piles for a better way to make major decisions accurately and improve the functioning of the project. This study highlighted the importance of data collection by piling staff, working together and validating data; this allowed the help-seeking process to be turned into an easier and friendlier user interface, which improved data management and allowed the user to use it anywhere and anytime on other devices around the world.

Keywords: piling, project management, simultaneous users, data entry, 2D visualization, data-driven insights

Experimental Analysis of the Effect of Cyclic Wetting and Drying on the Mechanical Characteristics of Rocks from Ambuluwawa Mountain

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Abstract

The mechanical properties of rocks are critical in determining the stability and safety of engineering structures, particularly in regions with complex geological conditions such as Ambuluwawa mountain, located in Sri Lanka's highland complex. This study aims to investigate the effects of cyclic wetting and drying on the mechanical characteristics of rocks from this region, which experiences significant seasonal moisture variations. Understanding the degradation in rock strength and durability under cyclic moisture conditions is vital for infrastructure projects, including the planned cable car system at Ambuluwawa. The research involves collecting rock samples from key locations on Ambuluwawa mountain and subjecting them to controlled wetting-drying cycles. Uniaxial compressive strength and point load tests are performed on the samples pre and post wetting drying cycles to assess changes in their mechanical properties. The cyclic wetting-drying process is simulated in the laboratory with samples undergoing four cycles of wetting and drying. The results provide insights into the impact of moisture fluctuations on the strength, brittleness, and fracture toughness of these rocks. This study offers critical insights into the long term behavior of rocks under fluctuating moisture conditions, contributing to the development of safer, more durable engineering practices in moisture sensitive regions. These findings are critical for infrastructure projects like the Ambuluwawa cable car, where fluctuating environmental conditions pose challenges to rock stability and durability.

Keywords: cyclic wetting-drying, uniaxial compressive strength, point load test, rock mechanics

Mitigation Techniques for Controlled Landslide Risk in Karandagolla: Comparative Analysis and Recommendations

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Abstract

The Uma Oya multipurpose development project in Sri Lanka, designed to enhance irrigation and hydroelectric power generation through river diversion, involves extensive tunneling and dam construction in the geologically complex Badulla district. Since its inception, the project has faced several challenges, including water leakages, structural damage to local homes, and the drying of wells, adversely impacting nearby communities. Of particular concern is the Karandagolla region, situated 2.5 km from the project's tunnel, where heightened landslide activity has been observed. Residents suspect these landslides result from changes in groundwater flow caused by underground operations, raising significant concerns about the project's long term effects on geotechnical stability. This study investigates the landslide risk in Karandagolla, focusing on identifying the most critical areas of instability through a multi-layered analysis. Initially, digital elevation models, groundwater classification, fracture mapping, human impact assessment, and vegetation analysis will be combined to pinpoint zones with high landslide potential. Soil and geological characteristics will be analyzed and overlaid to designate the area with the greatest vulnerability. For the identified critical zone, slope stability simulations will be conducted to calculate the factor of safety, providing insights into the likelihood of slope failure under current conditions. Data from existing geotechnical and geophysical investigations will support a detailed understanding of subsurface stability. By reviewing and assessing current mitigation strategies, the study will offer additional recommendations, including drainage control, reinforcement structures, and vegetation restoration to prevent future landslides. Community engagement initiatives for early monitoring will also be proposed. This comprehensive approach aims to propose effective and sustainable mitigation techniques tailored to the Karandagolla region's unique geotechnical conditions, with implications for similar projects in landslide-prone areas.

Keywords: disaster management, landslide mitigation, geotechnical risk assessment, impacts of tunneling

Emerging Trends in Disaster Management with Concern to Artificial Intelligence: With Special Focus on Landslides

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Abstract

Landslides pose significant threats globally, necessitating efficient disaster management strategies. Traditional methods often lack timeliness and efficacy, prompting exploration into artificial intelligence (AI) solutions. Leveraging AI, particularly machine learning and remote sensing, enhances landslide prediction accuracy and aids in disaster response and recovery. The objective of the study investigates the integration of AI into landslide disaster management, focusing early warning, risk assessment, and decision making. The problem clearly highlights the AI's potential in landslide susceptibility mapping and real time monitoring, alongside challenges like data availability and model interpretability. Mixed research methodology which was applied in the study employed historical data of landslide disaster management using AI technologies. As of the past landslide management data, the landslides have been managed using AI in early warning systems which applied in western Ghats in Munnar Kerala and Himalayas in Chandmari, Sikkim in India. The articles and e-books were used for collecting data. By leveraging Microsoft Azure services such as "Azure Site Recovery" organizations can create a well-defined plan to early warning and recovery by databases to minimize disaster risks. The applications of digital technologies in landslide disaster management should gradually be used to help the affected people by disasters like landslides. The study reviews the state of latest technology and addresses the future trends of research and provides support for scientists and decision makers involved in landslide disaster management. In conclusion, the research shows that AI revolutionizes landslide disaster management by improving early warnings and post-disaster recovery methods, despite the challenges in data availability and ethics.

Keywords: artificial intelligence, disaster management, landslides, technologies

Information Systems/Applications and IS Strategies

Factors Associated with the Identification of Software Quality Assurance Practices Towards Waterfall and Agile Information Systems Projects of BOI Registered Software Companies in Sri Lanka

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Abstract

Delivering high quality products has become essential in the rapidly evolving software industry, and software quality assurance (SQA) practices plays a significant role in ensuring dependability, functionality, and user satisfaction throughout the software development lifecycle. Unfortunately a large number of companies fail to achieve their project objectives due to poor SQA practices. In this context, the study aims to identify SQA practices towards Waterfall and Agile information systems (IS) projects of BOI registered software companies in Sri Lanka. It identifies three key factors: project, stakeholder, and company culture, with the endpoint of determining their relationship to the dependent variable of SQA practices towards Waterfall and Agile IS projects through a comprehensive analysis. The study employed a positivist philosophy, utilizing a deductive approach and a mono-method, quantitative research strategy. An online survey was conducted among a sample of 63 BOI registered software companies in Sri Lanka, selected using Morgan's method of sample calculation out of a target population of 75. The data were analyzed using SPSS, employing descriptive and inferential statistical methods, including linear regression analysis. The study highlights strong positive correlations between the identified key factors and SQA practices, with correlations of 0.936, 0.927, and 0.908 for "Project," "Stakeholder," and "Company culture," respectively, in Waterfall IS projects, and 0.904, 0.859, and 0.542 in Agile IS projects. Linear regression analyses indicated that these independent variables accounted for 87.6, 85.9, and 82.4% of SQA practices in Waterfall IS projects, and 81.8, 73.8, and 29.4% in Agile IS projects, with all models significant (p value<0.05). The results reveal an intensive correlation between the independent and dependent variables, as evidenced by linear regression analysis, indicating substantial relationships between them. The study extends on existing literature by highlighting key factors in identifying SQA practices, while being able to identify SQA practices, identifies challenges, and provides recommendations.

Keywords: Agile, BOI, information systems projects, software quality assurance practices, Waterfall

Exploring the Impact of Evolution and Maintenance on Software Architecture: A Study Based on Startups and a Large Scale Organization

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Abstract

Software is a dynamic entity that continuously evolves to meet changing requirements and technological advancements. This study investigates the impact of software evolution and maintenance on architecture stability and integrity within three Sri Lankan companies: IFS, an established organization, and two startups, Sanmark Solutions and Kodez. Through structured interviews with senior and operational staff, we identified key practices employed for managing architectural evolution, including modular design, continuous integration/continuous delivery (CI/CD), version control, and comprehensive documentation. The findings reveal that, while all companies utilize these practices, their implementation varies significantly based on company size and maturity. Challenges such as integration issues, technical debt accumulation, and balancing innovation with legacy codebases were common across all organizations. This research contributes to the understanding of software architecture maintenance by highlighting best practices and the complexities faced in different organizational contexts. The insights gained from this study underscore the importance of proactive maintenance strategies to enhance architectural quality and ensure long term software sustainability.

Keywords: software maintenance, software evolution, software architecture

Relativity Assessment on Lehman's Law on Software Quality Evolution Context in Sri Lanka

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Abstract

In the dynamic landscape of technology, the evolution and quality management of software systems play a crucial role. Lehman's laws offer valuable insights into the dynamics of software evolution, emphasizing the necessity for continuous adaptation to meet evolving demands. However, understanding how these laws impact software quality across various types of systems and companies poses a significant challenge. This research seeks to address this gap by examining how Lehman's laws influence software quality and evolution in diverse contexts, including large scale enterprise applications, embedded systems, and open source projects. Specifically, this study conducts a comparative analysis between small, medium, and large scale companies within the Sri Lankan context, with categorization based on factors such as revenue, employee count, and project complexity. A qualitative approach is used to conduct surveys and case studies across three prominent IT companies in Sri Lanka, enabling a comprehensive understanding of the relationship between Lehman's laws and software quality through detailed insights. The findings of this research reveal indirect, yet significant adherence to Lehman's laws within these companies, influencing their approaches to software development, adaptation to changing technologies, and quality management practices. The ensuing discussion highlights the practical implications of Lehman's laws in shaping software evolution strategies, particularly in the context of different organizational scales. The conclusions emphasize their enduring significance in contemporary software engineering practices. By recognizing and understanding Lehman's laws, organizations can effectively navigate the complexities of software evolution, ensuring continuous adaptation and innovation in a dynamic technological landscape.

Keywords: Lehman's laws, software quality, evolution, IT companies, software maintenance

Materials Engineering and Process Technology

Determination of Mechanical Properties of Chitin Nanofiber Based Dermal Applications for Rapid Increase of Skin Rigidity

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Abstract

Chitin nanofibers are gaining popularity in dermatology because of their distinct qualities, which include biocompatibility, and the ability to increase skin strength. These nanofibers can be combined with cyclopentasiloxane, glycerol, and polyvinyl alcohol to generate an effective formulation for dermal applications focusing on the rigidity of aging skin in particular. This study analyzed the mechanical properties of a chitin nanofiber-based formulation. Incorporating polyvinyl alcohol (PVA), glycerol, and cyclopentasiloxane into chitin nanofiber films significantly enhanced tensile strength, increasing it from 2.41±0.86 to 15.57±0.56. The enhancement was particularly notable when utilizing the spraying technique rather than casting. The result reveals that the presence of chitin nanofiber influences the increase in bending length of the film's flexibility or rigidity. Improved flexibility and versatility are indicated by the higher bending length of the film, which allows for superior conformity to facial shapes and movements. The increase in bending length after applying glycerol, PVA, cyclopentasiloxane, and chitin nanofiber shows a stronger, more rigid film structure when using the spraying method over the casting method. Time-to-retraction research showed that lax pig skin treated with particular formulations exhibited a significant recovery in skin elasticity. Improved recoil efficiency was demonstrated by the treated skin (3.00±0.41), which retracted to its original form more quickly than the untreated samples (10.75±0.62), ($p<0.05$). This improvement is due to chitin nanofibers and the formulations' particular characteristics, which promote skin stiffness. The AFM images show a considerable decrease in the roughness of the pig skin with the application of chitin nanofiber-based formulation, indicating that these comprehensive formulations are extremely effective at reducing the impact of wrinkles and sagging. In conclusion, this study demonstrates the effectiveness of chitin nanofiber-based formulations for enhancing skin rigidity and improving a variety of film properties.

Keywords: chitin nanofiber, mechanical, rigidity, skin

Textile Fibre Incorporated Natural Rubber Latex Foam for Acoustic Applications

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Abstract

Acoustic insulation panels enhance productivity and comfort by preventing sound transmission between adjacent spaces, thereby maintaining privacy. Constructing a panel using high ammonia natural rubber latex (HA-NRL) and a cellulosic regenerated textile waste 5 - 25 w/w% through the Dunlop foam method, with pure HA-NRL foam as a control. FTIR analysis confirmed the presence of the textile fiber molecules and SEM micrographs clearly shows that the foam has an open cell structure where the fibers are uniformly distributed in it and all the fibers were rubberized. The undisturbed cell structure and absence of coagulation in the foam matrix show that the fiber filler does not affect the foam stability during processing. The maturation time of 2 hours and curing time of 1 hour was sufficient, while foam stability can be sustained for nearly 2 hours providing sufficient time for molding and processing in industry scale. Higher porosity correlates with lower density, similar to the control sample. As fiber concentration increases, foam density rises, decreasing porosity, and sound absorption coefficient (α). The fiber incorporated natural rubber latex foam (F-NRLF) showed a higher density with a higher α value compared to neat natural rubber latex foam. Due to proper rubberization of fibers, the morphology of the foams were unaffected and an open-shell morphology was retained in F-NRLFs. The F-NRLF samples with 22.5 w/w% fiber concentration have the highest α, which reaches nearly 1 across the tested frequency range. Increasing sample thickness increases α, indicating that higher fiber concentrations and thickness enhance α values.

Keywords: natural rubber latex, foam, textile fiber, sound absorbing materials

Design of a Foldable and Portable Motorbike Helmet

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Abstract

As per the department of motor traffic of Sri Lanka, around 4,850,000 motorcycles are currently in use. More than two deaths due to motorbike accidents are reported in Sri Lanka each day. One of the major reasons for motorbike related injuries is riding without a helmet. Many bike riders and bike passengers are reluctant to carry helmets due to the inconveniences caused by their relatively large size. Often storage of the helmet becomes a challenge during office hours and while utilizing public transportation. This innovation is a prototype of a biomimetic, foldable, and portable helmet design that reduces the size for convenience. The prototype was made with plastic materials mimicking the actual product. In the actual helmet design, the exterior shell made from polycarbonate, fiberglass, and thermoplastic materials, is divided into three parts. These parts can be folded and secured together using a screw system, allowing the helmet to be reduced in size by 60% without the need for specialized tools. The inner padding is made from expanded polystyrene foam. The foam layers and integrated safety shield provide additional comfort, while maintaining safety. This compact size enables users to easily carry, hang or store the helmet in a limited space. The biomimetic helmet prototype mimics the biological designs of pangolin scale structure in the organism and behavioral levels. This prototype can be used as a model to develop foldable and portable motorbike helmets for urban commuters seeking convenience without sacrificing safety.

Keywords: helmet prototype, biomimicry, foldable and portable helmet, polycarbonate shell, screw assembly system

Development of Natural Rubber Latex-Based High Density and Low Height Foam Sheet via Dunlop Method

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Abstract

There is a constant demand for foam sheets as they offer unique properties that result in widespread use across multiple industries, such as cushioning, insulation, and protective sectors. Reducing the thickness of the sheets while retaining high density has been a tricky task, as there is less material to support the cell walls inside the pores. Therefore, this study demonstrates the formulation of a suitable process and the raw materials involved in making high density and low height foam sheets by using natural rubber latex (NRL) foams, thereby addressing an alternative approach to non-biodegradable polyurethane foams. The experimental approach involves optimizing the processing parameters of raw latex, such as mechanical stability time, zeta potential, compression set, and density, and correlating them over the maturation time of raw latex. Further, optimum conditions for foam sheet production were investigated by varying the curing time of the foam under variable compounded latex maturation times (0, 2, 4, 8, and 16 hours). The low density foam sheets prepared via the Dunlop method have increased the density using a compression technique. Half cured NRL foam sheet was placed between two plates and compressed using constant force. The foam sheet was kept under force for variable times. After compressing the foam sheet for shape stabilization, it was cured at 100 °C which offered the best density increment. The morphology study by scanning electron microscope showed that the bottom and upper layers retain their open cell structure. The middle section compressed their cell structure. The curing achieves this morphology based on its heat profile. Hence, a suitable processing condition and methodology for high dense, low height NRL foam sheet preparation was proposed.

Keywords: natural rubber, latex foam, foam sheets, compression molding

Characterization of PEO-Based Stretch Film with *Artocarpus heterophyllus* (Jackfruit) Latex as a Green Packaging Solution

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Abstract

Numerous researches are focused on developing innovative stretch films due to their advantages as packaging solutions. However, the materials commonly utilized in producing these films tend to be costly and environmentally harmful. A novel stretch film has been formulated by combining poly(ethylene oxide) (PEO) with *Artocarpus heterophyllus* latex (AHL), commonly referred to as jackfruit latex, which is a by-product that shares similarities with natural rubber in its composition, as a solution for expensive and environmentally harmful stretch films. This blend was produced by dissolving PEO and raw AHL without any purification in toluene and heating up to 95 °C. The stretch film was prepared by solvent casting technique in a petri dish and allowing it to dry in a vacuum oven at 40 °C for 2 hours. The film was characterized by Fourier transform infrared spectroscopy (FTIR) in ATR mode and X-ray photoelectron spectroscopy (XPS). By comparing the FTIR spectra of Toluene and AHL dissolved in Toluene solutions, extra peaks appear at 1365, 1325, 1230, and 2970 cm^{-1} corresponding to represent C-N stretching, S=O stretching, C-O stretching, and the N-H stretching, which were identified as being due to AHL. Similarly, by comparing the FTIR spectra for the thin films made by only PEO and PEO/AHL polymer blend extra peaks appear 1708 and at 2866 cm^{-1} corresponding to C=O stretching and N-H stretching appear for PEO/AHL polymer blend and the S=O stretching disappears which was characteristic for the additional AHL. Further, the XPS analysis confirms the existence of nitrogen as an additional element in the polymer blended material. This additional nitrogen element is due to the incorporation of AHL. Both FTIR and XPS analyses of polymer-blended stretch film reveal that the absence of sulfur present in AHL is due to the heating process while synthesizing the material.

Keywords: *Artocarpus heterophyllus* latex, poly(ethylene oxide), polymer-blended material, composition, stretch film

Development of Seawater-Based Primary Battery through Electrode Design and Materials Selection

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Abstract

Conventional primary batteries, which use chemicals like potassium hydroxide, manganese dioxide, and zinc chloride are costly and environmentally harmful upon disposal. This research introduces an innovative approach to sustainable energy storage by utilizing readily available seawater as an electrolyte. Seawater, being abundant, renewable, and free, offers a promising alternative. This research focuses on the fabrication of cathode electrodes using copper sulfide (CuS)-coated copper iodide (CuI), and CuS-coated graphite electrode materials and investigates the feasibility of utilizing pure seawater as an electrolyte and AZ31 magnesium alloy as an anode in the development of a primary battery. Experimental results indicate that an AZ31 magnesium alloy anode combined with a CuS-coated CuI activated cathode significantly enhances battery efficiency compared to batteries with CuS-coated graphite and pure graphite cathodes. The optimal performance was achieved in a battery cell assembled with a CuS-coated CuI cathode (CuS-coated CuI : graphite : ethyl cellulose in a 0.8 : 0.3 : 0.08 ratio) and an acid-washed anode electrode. This cell exhibited a discharge voltage of 1.14 V with a constant current of 0.75 mA, a specific capacity of 18.23 mAh/g, and an energy density of 20.78 Wh/kg. Batteries assembled with acid-washed anodes demonstrated superior performance compared to those with non-acid-washed anodes. This research contributes to the development of seawater-based primary batteries, offering a cost effective and efficient energy storage solution through innovative electrode design and material selection.

Keywords: primary battery, seawater electrolyte, CuS-coated CuI, magnesium alloy

Recent Advancements of Intelligent Packaging Materials in Fruits and Vegetables Manufacturing Industry, Limitations, and Future Perspectives

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Abstract

Empowering fruit and vegetable manufacturers to enhance product quality, extend shelf life, and secure food safety, the application of intelligent packaging materials has evolved into an important advancement in this industry. Intelligent packaging systems, which typically include sensors, indicators, and radio frequency identification (RFID) tags, provide real time information on the freshness, ripeness, and presence of hazardous microorganisms of the packed product. These technologies are particularly crucial for perishable goods, such as fruits and vegetables, since microbial growth and physiological changes may allow deterioration to occur rapidly. Experimental research has demonstrated the benefits of various intelligent packaging techniques. For instance, freshness indicators that depend on pH sensitive dyes have demonstrated a good association with the real freshness of fruits, including bananas and strawberries, with color changes in the indicator corresponding to the beginning of rotting. The packaging of tomatoes employed RFID-enabled smart labels equipped with gas sensors to effectively identify increased amounts of ethylene gas, a hormone that promotes ripening. This allowed for prompt action to avoid excessive ripening. Despite all of these advances, several obstacles prevent intelligent packaging from becoming prevalent in the sector. Significant obstacles remain, such as high production costs, constrained scalability, and problems with customer acceptability. In addition, major infrastructure modifications and investments are needed to integrate these materials into the current supply chains. Looking forward, the future of intelligent packaging depends on the development of more cost effective, sustainable, and user friendly solutions. To increase the sensitivity and specificity of sensors, apply them to a wider variety of products, and investigate edible and biodegradable packaging materials, further study is required. Artificial intelligence could potentially be integrated into intelligent packaging to further develop its applications as qualitative indicators of the food enclosed by the packaging and create more customized and adaptable packaging solutions.

Keywords: intelligent packaging, fruits and vegetables, applications, limitations, future perspectives

Physicochemical Properties of Cross-Linked Cassava Starch Polymer with Trisodium Phosphate

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Abstract

Recently, the manufacture of natural biodegradable polymers from natural sources has emerged as a significant research topic. One of the most promising raw materials for the creation of biodegradable polymers is starch, a natural renewable polysaccharide found in several crops. Chemical treatments involve the introduction of suitable functional groups into the starch molecule via derivatization reactions such as etherification, esterification, crosslinking, and grafting, or decomposition reactions such as acid or enzymatic hydrolysis. Chemical modification is commonly used to improve the properties of starch to meet the requirements of particular applications. Crosslinking is one of the most often used strategies to alter starch, intended to add intra- and inter-molecular links at random places of a starch molecule. Glycerol acts as a plasticizer, and when added to polymer synthesis, it improves the flexibility, elasticity, and handling properties of the polymers produced. Acetic acid was commonly added to starch to aid in the breaking down of branched amylopectin molecules into straight chain amylose molecules. This study investigated the effects of trisodium phosphate crosslinking on cassava starches' structural, water solubility, biodegradability, and tensile strength properties. Furthermore, the polymer films were characterized using a scanning electron microscope and infrared spectroscopy to investigate the surface morphology and the chemical modifications of polymer films, respectively. The proportions of glycerol, trisodium phosphate, and acetic acid were changed from 10 to 50% w/w. The water solubility (25.88%) and moisture content (18.20%) decreased when increasing the trisodium phosphate. The addition of cellulose increased the tensile strength (3.325 MPa) due to the strong interaction between the starch and trisodium phosphate. The results indicated that the biodegradable polymer composed of 20% w/w trisodium phosphate has the maximum tensile strength of 3.33 MPa, lowest water solubility of 25.88%, moisture content of 18.20%, and biodegradability of 28.38%, making this polymer a potential replacement for single use plastics.

Keywords: biodegradable polymers, crosslinking, trisodium phosphate

Preparation of Nanocellulose Reinforced Cassava Starch-Based Biodegradable Polymer Composites

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Abstract

Petroleum-based polymers significantly pollute the environment by generating toxic emissions and persisting as non-biodegradable waste in ecosystems. Microplastics cause serious threats to human health and ecosystems due to ingestion by marine life and bioaccumulation in food chains. To address this problem, coordinated efforts are needed to reduce plastic pollution, improve waste management, and create environmentally friendly plastic alternatives. Biodegradable polymers help minimize waste, protect ecosystems and contribute to a greener future. In this study, biodegradable polymer composites were prepared using cassava starch and nanocellulose extracted from the cellulose of the invasive plant species *Panicum maximum*. Cellulose was extracted through alkali treatment with NaOH (6%) followed by bleaching with a solution containing NaOCl (1.7%). Nanocellulose was produced by hydrolysis of cellulose fibers in 50% concentrated sulfuric acid. During the preparation of biodegradable polymer composites, the amounts of starch, glycerol, acetic acid, and citric acid were kept constant. While the nanocellulose content was varied at 5, 10, 15, and 20%. Citric acid was used as a crosslinking reagent, and glycerol served as a plasticizer. The water absorption capacity, water solubility capacity, biodegradability, moisture content, dry matter density, and tensile strength of the polymer composites were determined. Increasing the amount of nanocellulose enhanced the tensile strength of the polymer composites due to the high strength and flexibility of nanocellulose. The composite with 20% nanocellulose exhibited an effective tensile strength of 4.15 MPa, a moisture content of 15.91%, and biodegradability rate of 62.39% over 30 days. Nanocellulose was further characterized using a nanoparticle size analyzer, with dynamic light scattering results indicating that nanocellulose particle sizes were within the nanoscale range, yielding a value of 254.6 nm. Additionally, the cellulose, nanocellulose and polymer films were characterized using scanning electron microscopy and infrared spectroscopy. Biodegradable nanocellulose-starch-based polymers offer strong barrier properties, providing sustainable solutions for packaging.

Keywords: biodegradable, nanocellulose, cassava starch, nanoparticle size analyzer, scanning electron microscope

Multimetallic Silica/Polymer Nanohybrids for Self-Sterilizing Synergistic Antifungal Applications

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Abstract

Recent advancements in nanotechnology have led to the development of multimetallic nanohybrids integrated into nanofiber mats, which exhibit synergistic antifungal activity and represent an innovative approach for enhancing the quality of healthcare. In this study, a novel antifungal material with promising self-sterilizing capabilities has been developed. It integrated metal doped silica nanoparticles (silver, copper, and cobalt) into a polymer-based membrane to create a functional antifungal layer. The nanohybrids were reinforced to the polymer matrix using the electrospinning technique. Then nanofiber mats were analyzed using Fourier transform infrared spectroscopy, X-ray diffractograms, and Raman spectroscopy to confirm the successful incorporation of metallic silica nanohybrids into the polymer matrix. Scanning electron microscopy and transmission electron microscopy techniques were employed to determine the mean fiber diameter, which recorded the lowest diameter (30 nm) by the trimetallic silica/polymer mat. Atomic absorption spectrometric analysis quantified the metal incorporation levels in the nanofiber mats. Evaluation of the band gap energies of the cellulose acetate mats indicated their activation under visible light, with the multimetallic silica nanohybrid demonstrating the lowest band gap energy at 2.84 eV, affirming its self-sterilizing capability. Additionally, the DPPH assay confirmed the highest radical scavenging activity (91.77±0.88%) in the nanofiber mat incorporating the multimetallic silica nanohybrid. The antifungal activity was assessed by the disc diffusion assay by using the fungal strains *Trichophyton rubrum, Microsporum gypseum, Aspergillus niger*, and *Candida albicans*. The highest inhibition zones against all tested microorganisms exhibited by multimetallic silica nanohybrid incorporated nanofiber mat. Ultimately, the most effective nanofiber mat was electrospun onto a commercially accessible diaper and a wound dressing, demonstrating the practical application of the research. Based on the findings, this self-sterilizing mat is expected to serve as a dual barrier; physical and biological, offering protection against a wide spectrum of fungi (yeast type and filamentous fungi), supported by its accessibility, cost effectiveness, and biodegradability.

Keywords: antifungal action, electro spinning, multimetallic nanohybrids, nanofibrous mat, self-sterilization

Caryota urens Fiber/HDPE Composite for Non-Structural Applications

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Abstrac

Global plastic production significantly contributes to pollution and long term sustainability challenges. Although plastics such as polyethylene, offer essential applications and advantages, they cause significant risks to human health and the environment. This research focuses on *Caryota urens* (CU) fibers (*kithul* fibers), as reinforcement for high-density polyethylene (HDPE) composites for non-structural applications. *Kithul* fibers offer specific benefits that make them especially suited for blending with HDPE. To enhance the fiber adhesion to HDPE, the fibers were treated with an alkaline solution followed by silane treatment; these steps effectively increase fiber-matrix adhesion, leading to improved mechanical properties. These treated fibers were then incorporated into the HDPE matrix at 2, 5, 10, 15, and 20 wt% loadings, with fiber lengths varying between 5, 10, 15, and 20 mm for each loading. These composites were compared with a control sheet made from waste HDPE material. The hot press fabrication process was used to make composite sheets. The mechanical properties increased as fiber loading and fiber length increased. The CU/HDPE composite with 20 wt% fiber at 20 mm length achieved the highest tensile strength of 18.9 N/mm^2, flexural strength of 17.3 MPa, and impact strength of 61.0 kJ/m. Additionally, this composite exhibited the highest hardness of 97.5 Shore A. In contrast, the control sample exhibited the highest density value of 1.06 g/cm^3. This lower density offers advantages in applications where lightweight, yet durable materials are required. The study demonstrates this composite is best-suited for non-structural applications such as automotive interior components, panelling, and decorative items. The study presents the systematic evidence towards *Caryota urens* fiber as a sustainable reinforcement for polymer composites which can be an eco-friendly alternative in polymer industries.

Keywords: *Caryota urens* fiber, HDPE, polymer composite, non-structural applications, mechanical properties

Development of Cellulosic Fibre/Polylactic Acid Based 3D Printable Acoustic Panels with Improved Acoustic Properties

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Abstract

Noise pollution is an environmental issue that arises from myriad sources including construction, industrial, automobile, and other household appliances. 3D printing is one of the revolutionary techniques in the field of manufacturing. This research introduces cost effective, 3D printable acoustic panels to address the issue of noise pollution. Two series of composite filaments were prepared by varying the weight percentage of two types of cellulosic fibers with polylactic acid (PLA) as the matrix via hot press method. These filaments were then successfully 3D printed to form acoustic panels. Thermogravimetric analysis indicated that the prepared composites are thermally stable up to ~350 ℃. Differential scanning calorimetric analysis confirmed the semi-crystallinity of the panels with melting ~160 - 170 ℃. Fourier transform infrared spectroscopy identified the presence of cellulose, hemicellulose, and lignin groups in the panels. Acoustic tests evidenced improved sound absorption coefficient (α) with higher fiber loading and thickness of the two types of panels, with respect to neat PLA, the control. The highest sound absorption coefficient (~0.98) was achieved by hybridizing the highest fiber loaded (10 wt%) panels at high frequency range. Even though the tensile strength and toughness decreased with increased fiber loading in the 3D printed panels, the achieved tensile strengths were comparable to that of the commercial acoustic absorbers. Moreover, scanning electron microscopy proved the porous nature of the acoustic panels. These low cost and environmentally friendly acoustic panels would be promising candidates for walls and ceilings to negate high frequency noises.

Keywords: cellulosic fiber/PLA, 3D printing, acoustic panels, biodegradable thermoplastic

Determination of the Optimal Firing Temperature Range for the Porcelain Tile Production

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Abstract

Porcelain tiles are known for their excellent strength, high durability, low water absorption, and low porosity. The porcelain tiles produced by the Lanka Tiles PLC manufacturing site at Ranala, Sri Lanka are made from a mixture of potash feldspar, ball clay, kaolin, dolomite, silica sand, and talc. This mixture is fired at high temperatures around 1200 °C to achieve vitrification. This study aims to understand the impact of firing temperature on porcelain tiles. Limited studies have been conducted on how the various firing temperatures affect porcelain tiles. Conducting this study helps reduce gas consumption in the kiln, increase production efficiency, and improve the final product quality. Physical properties such as shrinkage, loss on ignition, water absorption, and mechanical properties such as acid-base resistance, thermal shock resistance, and abrasion resistance of porcelain tiles were evaluated after the firing process. The firing process was performed at different firing temperatures ranging from 1121 to 1220 °C using the temperature gradient kiln. Our results indicate that the tiles exhibit minimal water absorption when firing above 1220 °C; however, the shrinkage is higher. Considering color, excellent thermal shock resistance, high abrasion resistance, and high acid-base resistance the porcelain tiles achieve the best quality in the temperature range of 1200 - 1210 °C.

Keywords: porcelain tiles, firing temperature, temperature gradient kiln, green tiles

Fabrication of Ceramic Engobe Using Low Cost Raw Materials Available in Sri Lanka

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Abstract

There are three main types of tile production in Sri Lanka, divided according to their water absorption ability, vitrified (water absorption percentage below 0.5%), porcelain (water absorption percentage 0.5 - 3.0%), and ceramic (water absorption percentage 3 - 6%). In this way, the water absorption capacity of the tiles is controlled by changing the temperature at which the tiles are fired. Glazes are applied on green tiles made in this way. The first glaze layer to be used is the engobe glaze layer. An engobe glaze layer is a high clay slurry that balances the stress and color differences between the tile body and glaze layers of ceramic tile production. Major raw materials of the engobe layer are currently imported, incurring a high cost. The main objective of this research is to use low cost materials in Sri Lanka to manufacture ceramic engobe. Glaze raw materials can be divided into four parts; glass former (quartz), fluxing materials (potassium feldspar, calcite, and dolomite), white colorant (zirconium silicate), and refractory agent (kaolin). Feldspar, calcite, and dolomite were obtained from mines in Matale, Sri Lanka while kaolin from Balangoda, Sri Lanka. Ceylon Minerals and Chemicals (Pvt) Ltd. supplied quartz and zirconium silicate. After making the engobe, water absorption, river stain, whiteness, and coefficient of thermal expansion were measured. The high content of feldspar and calcite in the engobe decreased water absorption. The mineralogy of each material was determined using X-ray diffraction analyses, which confirmed the mineral composition of minerals. After comparing above results, it can be confirmed that engobe glaze can be made using only Sri Lankan raw materials. The price of a research engobe of 1 kg made from raw materials commonly available in Sri Lanka is 50% lower than commercially available engobe composite.

Keywords: glaze, engobe, coefficient of thermal expansion, water absorption, linear shrinkage

Harnessing Agricultural Waste: Synthesis of Mesoporous Silica Nanoparticles from Rice Husk for Sustainable Applications

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Abstract

Mesoporous silica nanoparticles (MSNs) were successfully fabricated from rice husk using a simple thermo-chemical treatment, offering an environmentally and economically beneficial value-added product. This study aims to optimize the synthesis of MSNs by performing pyrolysis at 700 °C for 4 hours, followed by calcination at 550 °C for 5 hours, using sodium silicate solution derived from rice husk ash (RHA). Silica nanoparticles were synthesized using the sol-gel method, and mesopores were formed through a soft-templating approach with a cationic surfactant with a yield of 57%. The fabricated materials were characterized by SEM, FTIR, and XRD. SEM analysis of MSNs showed the presence of uniformly distributed silica nanoparticles with agglomerated spherical shape. Notably, FTIR analysis revealed the presence of siloxane and silanol groups at 1076 and 964 cm^{-1}, respectively, confirming the silica formation, while XRD confirmed the amorphous nature of both RHA and MSNs at 22.12°. In conclusion, the results of this study demonstrate the potential of rice husk-derived mesoporous silica nanoparticles for various applications as a renewable material, offering a sustainable alternative to conventional chemical precursors, which are high in costs, complex production, and energy intensive requirements. Moreover, the wasteful disposal of rice husk can be minimized by utilizing it for valuable applications like nanomedicine, environmental remediation, and food packaging.

Keywords: cationic surfactant, renewable material, soft-templating, sol-gel method

Development of a Natural Antimicrobial Deodorized Rubber Composite for Shoe Insoles Using Lemongrass Powder

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Abstract

Footwear hygiene remains a critical concern due to persistent odor and the potential growth of microbes on foot skin. To address this issue, industries explore novel approaches by incorporating various chemicals into footwear materials to impart antimicrobial properties. However, synthetic materials pose health risks or are prohibitively expensive. Consequently, there is a growing demand for natural antimicrobial solutions as alternatives. This study focuses on developing a natural antimicrobial rubber composite for shoe insoles using lemongrass (*Cymbopogon citratus*) as the antimicrobial agent. Lemongrass powder was integrated into the natural rubber composite at concentrations of 5, 10, 15, 20, 40, and 60 parts per hundred rubber (phr). The antimicrobial efficacy of the composites was assessed using the disc-diffusion method against *Pseudomonas*, *Escherichia coli*, and *Candida spp.* isolated from used shoe insoles. Results indicated that antimicrobial activity increased with higher lemongrass content, reaching maximum inhibition (13 mm) at 60 phr. However, only the *Pseudomonas* species contributed to microbial inhibition among the other three species. Also, mechanical properties such as tensile strength, tear strength, and hardness began to degrade significantly beyond 40 phr. Based on mechanical testing (ASTM standards), the optimum composite was identified at 40 phr, with a hardness of 74 Shore A, tear strength of 47.8 N, and tensile strength of 4.7 N/mm^2. These findings would contribute to the development of safer and more effective antimicrobial solutions for footwear, promoting foot health and comfort. Moreover, microencapsulation techniques are warranted to further enhance antimicrobial properties.

Keywords: antimicrobial, *Cymbopogon citratus*, natural rubber composite, shoe insole

Comparison between Fourier-Transform Infrared Spectroscopy-Based Transmission IR and Attenuated Total Reflectance Mode Characterization of Epoxidized Natural Rubber

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Abstract

Epoxidized natural rubber (ENR) is an important raw material prepared by partial epoxidation of the *cis*-1,4-polyisoprene chains in natural rubber (NR). Due to introduction of the oxirane rings, ENR becomes polar, hence, increases the resistance to oil and solvents, gas permeability, thermal stability, and ozone resistance of the NR. The application of ENR in different rubber-based products vary depending on the extent of epoxidation making the accurate characterization of the ENR vital. More accurate quantitative determination is usually done using NMR techniques which are expensive. In this study, NR and ENR were characterized using Fourier-transform infrared spectroscopy in both transmission IR and attenuated total reflectance (ATR) modes were compared to identify the most precise method for ENR quantitative analysis. The epoxidized natural rubber used for the analysis was synthesized using high ammonia natural rubber and peracetic acid. For the transmission mode, ENR samples were prepared by casting on potassium bromide disks, and in ATR mode the dried epoxidized natural rubber sample specimen was analyzed as it is. The samples analyzed on transmission mode, distinct peaks were observed at 870 and 1249 cm^{-1}, attributed to the asymmetric and symmetric stretching of the epoxide ring, respectively. However, in the ATR mode, the above mentioned characteristic peaks appeared in less intensity, compared to *cis*-1,4-polyisoprene chain. The ^{1}HNMR spectra of the ENR samples have characteristic peaks at 2.7 and 1.3 ppm for methine and methyl protons of the epoxide group, respectively. Quantitative epoxide concentration analysis is carried out by the peak intensity ratio between 2.7 characteristic methine peak and 5.1 peak corresponding to the proton of CH_3 group of isoprene units. The epoxide concentration calculated from ^{1}HNMR spectra was 66%. The epoxide concentration calculated by ATR mode using the peak intensity ratio between 870 and 835 cm^{-1} was 41% and in transmission IR, it was 62%. The epoxide concentrations for 25% showed a similar variation. Hence, the transmission FTIR provided more accurate and reliable quantitative determination of epoxide concentration compared to the ATR mode.

Keywords: epoxidized natural rubber, characterization, FTIR, ATR mode, transmission IR

Mechatronics, Robotics, and Automation

Automated System for Optimized Motorcycle Parking in Urban Environments

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Abstract

This study proposes an optimized parking system considering the increasing demand for efficient and secure motorcycle parking solutions in rapidly urbanizing areas. Traditional parking methods often suffer from inefficiencies, leading to congestion, wasted space, and heightened risks of theft or damage, necessitating the development of innovative systems to address these challenges. The primary objective of this project is to design and implement an automatic motorcycle parking system that utilizes advanced robotics to automate the parking process, thereby enhancing space utilization, reducing time, and improving the security of parked motorcycles. A 1 : 10 scale prototype, including structural and functional aspects, was developed to validate the system's functionality, with SolidWorks utilized for design optimization and simulation under criteria, such as space efficiency, structural stability, and operational fluidity. Extensive testing procedures were conducted, focusing on performance metrics like parking accuracy, speed, user interaction, and environmental adaptability across various scenarios. Materials, such as acrylic (plexiglass), were used in the prototype to balance durability with cost efficiency. The robot's autonomous motorcycle handling process is structured to optimize space utilization while streamlining retrieval and storage operations, addressing limitations in existing parking methods. Test scenarios included various parking densities, user command responsiveness, and reliability under simulated urban conditions, indicating the system's effectiveness in minimizing manual effort, reducing parking time, and optimizing space utilization while ensuring secure storage. The system demonstrated consistent reliability and effectiveness across various test scenarios, underscoring its potential for real world deployment in urban settings. The significance of this project lies in its potential to alleviate urban parking challenges, thereby contributing to smarter, more sustainable city infrastructures. By integrating this system into broader urban planning initiatives, this project provides a scalable and adaptable solution that is suited to diverse environments. This advancement not only contributes to the field of automated parking systems but also enhances urban mobility.

Keywords: automated parking systems, urban mobility solutions, robotics in parking, space optimization, motorcycle security

Real Time Machine Vision-Incorporated Coordinate Estimation System for Selective Compliance Articulated Robot Arm Operations in Printed Circuit Board Manufacturing

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Abstract

Selective compliance articulated robot arm (SCARA) robots are widely recognized for their fast movements and relatively simple mechanical structure, making them essential to industries such as healthcare, electronics, and automotive. Their high speed capabilities, coupled with precision, make them ideal for tasks involving material handling and assembly, particularly in production lines. However, modern industrial applications demand even higher levels of accuracy and repeatability, especially when dealing with small scale components in printed circuit boards (PCBs). Traditional approaches to improving SCARA robots' performance have largely focused on refining control algorithms and mechanical designs. In contrast, this study introduces a real time, closed loop visual feedback system to enhance the precision significantly. The proposed system integrates image-based visual servoing to estimate object coordinates along the X and Y planes, while a simplified laser triangulation method is used to determine the depth (Z-axis) accurately. This integrated approach provides precise coordinate estimation, achieving an overall accuracy of 99%. The system's ability to self-correct its positioning during repetitive tasks minimizes cumulative error, a common issue in industrial automation particularly in PCB manufacturing, where precision is critical. Additionally, the system operates using a single camera and two laser lights for triangulation, making it both cost effective and efficient.

Keywords: SCARA, object tracking, real world coordinate estimation, visual servoing, depth perception

Portable Fully Automatic Wire Stripping and Crimping Machine

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Abstract

The wire stripping and crimping process is crucial in the automation industry, as wires are essential for power transmission and communication. Ensuring high quality and efficiency in this process is vital. Manual methods are common but often lead to quality issues and are time consuming, especially in mass production. Fully automatic machines for this purpose exist but are typically bulky, unportable, and expensive, limiting their practicality. This project aims to develop a portable, time efficient, and cost effective wire stripping and crimping machine. By focusing on 22 AWG wire size, a standard used by many companies, the machine enhances portability and reduces costs. The redesigned structure further improves portability. The current prototype is compatible with JST crimp terminals and can be adapted for lug crimping by changing the crimping die. The machine design includes rollers to guide the wire to the stripper, with two blades: one for the outer core and one for the inner core. A pneumatic powered crimp die is used for crimping. The machine can strip and crimp a wire or perform each task individually. Testing involved precision, performance, and user interface (UI) assessments. In precision and performance testing, 20 samples were tested, with 18 yielding positive results and 2 negative due to slippage, demonstrating a 90% accuracy rate. Improvements are expected to achieve up to 98% accuracy. UI testing with two workers from a private company provided positive feedback. Future enhancements will expand compatibility to include 16 - 22 AWG wire gauges and lug crimping capabilities. Integrating internet of things (IoT) technology will allow remote access and operation via mobile devices or PCs, offering greater flexibility and efficiency. This innovation promises to significantly improve the quality and efficiency of wire stripping and crimping processes in the automation industry, providing a valuable tool for various applications. By addressing the limitations of existing machines, this project offers a novel solution that is both portable and cost effective.

Keywords: portable machinery, wire stripping, crimping, IoT, automation, cost effective

Assessing the Feasibility of Existing Devices for Monitoring Lower Limb Recovery

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Abstract

The feasibility of remote patient monitoring devices designed for the rehabilitation of lower limb conditions is evaluated in this paper, as these conditions are prevalent due to various medical issues such as stroke and Parkinson's disease. Remote monitoring technologies, particularly wearable devices and internet of things (IoT) systems, are gaining popularity due to their ability to provide continuous, real time feedback, minimize disruptions to patients' daily lives, and allow for timely intervention in emergencies on lower limb function during rehabilitation. The study aims to identify the effectiveness and usability of current monitoring technologies that leverage wearable devices and IoT systems, providing continuous gait analysis and facilitating timely interventions. A systematic literature review was conducted, and relevant studies on remote patient monitoring systems were gathered from multiple databases. A qualitative analysis of these devices focused on parameters such as accuracy, patient compliance, comfort, usability, and their capacity to support multiple conditions. A weighted scoring system was employed to rank the devices based on their performance metrics. The findings indicate that certain devices achieved high accuracy rates, particularly those incorporating inertial measurement units and force sensitive resistors, while others excelled in user comfort but faced challenges in clinical applicability. Notably, two systems emerged as the most feasible solutions, capable of effectively monitoring patients with diverse lower limb conditions. However, significant barriers regarding patient comfort, compliance, and the practicality of integrating these systems into daily life were highlighted. It is concluded that while remote patient monitoring devices present substantial potential for enhancing rehabilitation outcomes, further development is necessary to improve ergonomics, reduce costs, and ensure long term usability. Recommendations include the exploration of more comfortable designs, integration of biofeedback mechanisms, and conducting longitudinal trials to validate patient adherence. The outcomes of this study contribute to the ongoing discourse on advancing rehabilitation technologies for improved patient care and recovery.

Keywords: patient monitoring, lower limb rehabilitation, gait analysis, remote monitoring

Advanced Sensor Fusion Based Smart Vehicle Navigator for Enhanced Driving Safety

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Abstract

The smart vehicle navigator is a modular, real time automation and safety system designed to address critical driving challenges, including obstacle detection, lane recognition, driver fatigue monitoring, and emergency response. This compact, portable system can be easily mounted on various vehicle types. Leveraging the processing power of a Raspberry Pi controller, the system integrates advanced sensors and algorithms to enhance vehicle safety and provide seamless hands-free operation. The configuration includes a 360 degree LiDAR sensor for long range obstacle mapping up to 12 m, ultrasonic sensors for short range detection, and a stereo camera for lane and stop sign recognition. This combination improves obstacle detection accuracy by 20% over earlier models, with reduced latency and enhanced depth perception. An accelerometer detects sudden impacts, triggering the GSM module to send GPS-based emergency alerts within 5 seconds. Driver fatigue is monitored using an infrared-based sensor, providing alerts when drowsiness is detected. The integration of natural language processing enables voice control, allowing the driver to execute commands hands-free with a recognition accuracy of 92%. This seamless interaction minimizes distractions and enhances user experience. Prototype testing validated the system's effectiveness across various real world driving scenarios, achieving a 95% lane recognition rate and an 80% success rate in stop sign detection. The system's modular design supports future upgrades, including AI-enhanced obstacle prediction and cloud diagnostics, providing a scalable platform for vehicle safety advancements. By combining multiple sensor technologies and real time processing, the smart vehicle navigator establishes a versatile and cost effective foundation for future autonomous driving systems, demonstrating that sensor fusion and open source processing can drive impactful and adaptable vehicle safety solutions.

Keywords: sensor fusion, vehicle automation, real time obstacle detection, driver fatigue monitoring, emergency response system

Development of Wearable Devices for Visually Impaired People in Sri Lanka

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Abstract

Visually impaired people lead a challenging life in navigating their environment safely. They cannot function independently and face many difficulties in leading a normal life. Existing assistive devices have limitations related to cost, complexity, or adaptability to specific environments. This research proposes a wearable device that translates real time visual information into audio cues to aid obstacle detection, providing a novel approach to enhance navigation for visually impaired in outdoor settings. Nearly 5,538 images were collected surfing through the internet and manually taking photos under nine objects classes. Then data annotating and labelling were done in Roboflow. A total of 13,310 images were generated after augmentation of initial data set. The model was trained in TensorFlow framework using TensorFlow SSD MobileNet V2 FPNLite 320 and later converted to tflite format to be implemented in Raspberry Pi. The mAP value of this model is 76.3% which is within the range of 74 - 80% as most models trained by the above framework. The user's environment is captured in real time using a camera, embedded into the wearable device. Obstacle identification and localization are carried out by the trained model by utilizing the real time video feedback. This information is translated to audio by means of earphones attached in the wearable device. Preliminary tests demonstrated successful detection even in low-light conditions, with the aid of a flashlight in dark. The novelty of this study lies in the selection of object classes tailored for outdoor urban navigation and adaptation of deep learning models for efficient processing on compact, wearable hardware. In essence, this device functions as an aiding device for the user to assess his environment and avoid potential danger, by incorporating an object detection model to run on a Raspberry Pi with a simple camera and headphones setup.

Keywords: TensorFlow, tflite, wearable device, object detection, deep learning

Technology Education and Management

Differences in the Learning Environment: The Successful Use of Online Learning Platforms in Higher Education

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Abstract

The purpose of this work is to use a systematic quantitative analysis to evaluate the effectiveness of online education platforms for learning in higher education institutions. The aims of this study consider a number of different factors, including student interaction, involvement, academic performance, accessibility and technology opportunities, and barriers in online learning settings. Using online structured surveys, record examination of institutional data and qualitative interviews, the study samples participants using a stratified random sampling technique with the aim of achieving a variety in the participants' field and diversity of population. Students with certain learning difficulties need special attention in order to address accessibility and inclusion problems. The suggested instrument is applied in a case-based manner as part of the participatory study to assess the accessibility and usefulness of several learning management systems, to look into technology problems and potential fixes. When institutions with effective online learning implementations are reviewed, successful methods and difficulties in online learning become evident. The study highlights the benefits of using interactive materials and the outcomes of ongoing evaluation through the use of discussion boards and quizzes, for example. In order to improve student accessibility, the current study focuses on an analytical aspect of advocating universal design for learning. Additionally, it talks about how cutting-edge technology like virtual reality and artificial intelligence could enhance interactive learning. Lastly, it is essential to understand that, although there are apparent benefits when it comes to flexibility and accessibility of the online learning platforms, some technological and inclusivity issues must be solved in order to enhance effectiveness. The research calls for plans for constant trainer continuing professional development, the use of information communications technology and formative assessment methods tailored to the evolving needs of both learners and educators.

Keywords: continuing professional development, learning management systems, universal design for learning, virtual reality

Evaluating the Impact of Kahoot! on Chinese Language Acquisition in Sri Lankan University Classrooms

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Abstract

With the increasing importance of Chinese globally, integrating technology into language education is crucial. This study examines the impact of Kahoot! a game-based learning platform, on Chinese language acquisition among university students in Sri Lanka. This research employed a mixed-methods approach, using both quantitative data from pre- and post-tests and qualitative insights from surveys and focus group discussions to assess how Kahoot! influences Chinese language learning. The participants, 25 students aged 21 - 25 years from the University of Kelaniya, Sri Lanka had already passed the Chinese proficiency test HSK level 2 and were enrolled in Chinese proficiency test which is called HSK level 3 Chinese language classes. Over six weeks, Kahoot! quizzes were integrated into the curriculum to reinforce vocabulary, grammar, and reading comprehension. The findings show that Kahoot! significantly improved students' language proficiency, with post-test scores indicating better vocabulary retention, grammar comprehension and reading skills. The platform's interactive features, such as leaderboards, points, and multimedia integration boosted student engagement and motivation, making learning more enjoyable. Students reported increased participation and motivation, attributing their positive learning experiences to the gamified environment. Additionally, the real time feedback provided by Kahoot! enabled both students and teachers to monitor progress and address learning gaps. Despite these advantages, the study identified challenges such as limited access to technology and the need to manage competitive dynamics in the classroom. However, the overall impact of Kahoot! was positive, fostering collaboration and enhancing learning outcomes. This research provides valuable insights into the potential of gamified learning tools like Kahoot! in Chinese language education, offering practical recommendations for educators and policymakers aiming to integrate educational technology in diverse cultural settings.

Keywords: Chinese language acquisition, educational technology, game-based learning, Kahoot! student engagement

Can GenAI Replace Academics in Evaluating Complex Assignments in Higher Education?: A Comparative Analysis of ChatGPT-4o and Gemini 1.5 Pro

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Abstract

This study was conducted to explore the possibility of utilizing GenAI platforms (ChatGPT-4o and Gemini 1.5 Pro) in evaluating undergraduate assignments (reports), focusing on application of operations management concepts/practices. A rubric was developed and validated using weighted Cohen's Kappa, and the GenAI systems were then employed to assess the reports. Results revealed inconsistencies and patterns among marks generated for the reports by the two platforms, raising the doubt of accuracy indicating that the chosen GenAI platforms cannot fully replace human judgment, particularly in complex and nuanced assessments. The study highlights the limitations of GenAI platforms in understanding context, reasoning capabilities and providing coherent criteria-wise feedback. It concludes that GenAI can serve as a valuable tool for educators, but human mediation and critical thinking remain essential in ensuring accurate and comprehensive evaluation. Future research should focus on replicating the current methodology making variations in the type of assessments and the type of course modules. Converging efforts to explore the likelihood of entrusting the GenAI platforms with the full responsibility of evaluations in education is also encouraged.

Keywords: assignment evaluation, ChatGPT-4o, Gemini 1.5 Pro, GenAI, higher education

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