CISIR

6th Biennial Research Symposium

International Research Symposium 2023

Advance Research, Development and Innovations towards the Fourth Generation Industrial Development

PROCEEDINGS

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International Research Symposium 2023

Advance Research, Development, and Innovations towards the Fourth Generation Industrial Development

Abstracts

7th – 9th November 2023

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Message from the Honourable Minister of Industries and Minister of Health

I am delighted to extend my warmest greetings through the pages of this Research Symposium Conference Book for the 6th Biennial International Research Symposium hosted by the Industrial Technology Institute (ITI). The theme "Advance Research, Development, and Innovation Towards the Fourth Generation Industrial Development," encapsulates the very essence of innovation and progress, making this symposium a notable platform.

In a rapidly evolving world where innovation and progress are paramount for economic growth and global competitiveness, this symposium is a vital platform for fostering transformative ideas, cultivating collaboration, and advancing research that is instrumental in shaping the future of industrial development.

I commend the dedication and expertise of the researchers, scientists, academics, and industry leaders who have gathered here. Your work not only advances our grasp of new technologies but also fosters new enterprises that align with the government's vision for a technology-driven society and the realization of a "Smart Nation" well within our reach.

The government is fully committed to supporting research and development and innovations to drive national growth and competitiveness. We will continue to invest in research and education, institutions, and innovation hubs to empower our talented researchers for transformative contributions to society.

In the coming days, I hope this symposium serves as a fertile ground for the exchange of ideas, and knowledge, and the creation of a vision for the future. Together, we can harness the power of research and innovation to address the challenges of our time and pave the way for a more prosperous and sustainable future.

Once again, I extend my warmest congratulations to the international experts, organizers and presenters of the 6th Biennial Research Symposium. I offer my best wishes for a productive and enlightening symposium.

Dr. Ramesh Pathirana (M.P.)

Minister of Industries and Minister of Health

November 07, 2023

Message from the Secretary of Honor, Mrs. J. M. Thilaka Jayasundara of the Ministry of Industries

I take great pleasure in conveying this message on the occasion of the 6th Biennial Research Symposium and International Research Symposium 2023, hosted by the Industrial Technology Institute (ITI). The thematic focus of this symposium, "Advance Research, Development and Innovation towards the Fourth Generation Industrial Development" provides a platform for the exchange of novel ideas and knowledge, fosters innovation, and collaboration between diverse fields of expertise and a forum to deliberate on strategies that will shape the future of technological progress.

In a rapidly evolving global landscape, marked by technological disruptions and the continual transition towards the Fourth Generation of Industrial Development, research and innovation have emerged as the key player of progress. As a premier Scientific and Industrial Research Institution in the country, the ITI has consistently delivered significant contributions through pioneering research and development initiatives and the provision of globally competitive research and technical services spanning diverse scientific domains.

As the Ministry subject in charge, we remain fully committed to supporting research and development and innovation, specifically focusing on technology transfers, technology adaptation, and the development of innovative technologies. These endeavors will undoubtedly accelerate industrial development for the betterment of the people of Sri Lanka.

I want to extend my gratitude and admiration to the Chairman, Director General and the dedicated organizing committee of the ITI for their commendable work in successfully organizing the 6th Biennial Research Symposium and International Research Symposium 2023 for the sixth consecutive year.

I also extend my best wishes to all the participants for a productive, enlightening and inspiring symposium. May your deliberations lead to innovative breakthroughs that shape the future of industrial development and contribute to the betterment of society

Mrs. J. M. Thilaka Jayasundara
Secretary, Ministry of Industries

Message from the Executive Director COMSATS

The Commission on Science and Technology for Sustainable Development in the South (COMSATS) felicitates its esteemed Centre of Excellence in Sri Lanka, the Industrial Technology Institute (ITI) for holding its 6th Biennial Research Symposium. The theme of the event 'Advance Research, Development and Innovations towards the Fourth Generation Industrial Development' is important and pertinent to achieving Sustainable Development and the objectives of COMSATS.

The Fourth Industrial Revolution – characterized by a range of technologies that are fusing the physical, digital and biological realms, has a huge impact on all disciplines, economies and industries. Developments under Industry 4.0 are undeniably fast and many, however, the emerging and fast-evolving challenges of this day and age, necessitate greater emphasis on R&D and innovation for solving current and future global challenges. Therefore, it is incumbent upon nations to introduce and enact strategies and policies, for availing the advantages brought forth by the Fourth Industrial Revolution. The holding of this symposium is, therefore, a necessary step, which would provide a platform for the scientists, technologists, and researchers of ITI to share their research progress and to collaborate with relevant organizations in the realm of COMSATS.

Being an intergovernmental organization of 27 developing countries, COMSATS is a proactive proponent of South-South and Triangular Cooperation in science and technology for providing tech-based solutions to global challenges. The organization's recent initiatives pertain to data analytics, artificial intelligence, software quality assurance & IT training, precision agriculture, renewable energies, chip circuit designing, genomics, Electric Vehicles (EV), and digitalization.

The Democratic Socialist Republic of Sri Lanka is a founding Member State. COMSATS' scientific and technological strength comes from its Network of International S&T Centres of Excellence, which comprises 25 reputed centres/universities of science and technology. ITI is playing a commendable role in promoting S&T-led development in Sri Lanka and is an active member of the COMSATS Network.

I wish the desired outcome of the Research Symposium.

Dr Mohammad Nafees Zakaria

Executive Director, Commission on Science and Technology for Sustainable Development in the South (COMSATS)

Message from the Chairman

It is with immense pleasure I pen the Chairman's message for the proceeding of the 6th Biennial Research Symposium of Industrial Technology Institute (ITI).

Knowledge creation and dissemination is a mandated function of ITI as of the Science and Technology Development Act No. 11 of 1994. As a fulfilment of the mandate, this Research Symposium was introduced in 2013 as a biennial function of ITI during my period as the Director General of ITI. Thus, I'm contented and elated by being a patron of ITI Biennial Research Symposia from its inception, first as the Director General, then as the Ex-Director General, and now as the Chairman of the Governing Board of the Industrial Technology Institute.

Minister Dr. Ramesh Pathirana, during his visit to ITI as the Minister In Charge, requested to extend this symposium to an International event of the National Science & Technology Week happening in line with the World Science Day celebrations. Therefore, starting from the 6th Biennial Research Symposium, this national event of ITI will be an International Research Symposium where International S&T experts share their expertise in nationally and globally recognized topics of next-generation sciences and technologies for national S&T and Industrial development.

As the Center of Excellence in Sri Lanka for the Intergovernmental Commission on Science & Technology for Development of South (COMSATS), speakers from COMSATS centers of excellence in member states will speak at this event. On my invitation Prof. Zhaohui Lin, Director of the International Centre for Climate and Environment Sciences (ICCES), Institute of Atmospheric Physics, China's Center of Excellence of COMSATS will deliver the Keynote speech at this event as an expert in Atmospheric Physics and climate change events. Many international speakers will deliver plenary speeches on current topics of mutual interest in their respective disciplines of expertise making this event a grand international event aligning with the theme of the symposium "Advanced Research, Development and Innovation Towards the Fourth Generation Industrial Development".

I wish to thank all international dignitaries who accepted our invitation to deliver plenary speeches including the Keynote speaker Prof. Lin Zhaohui from the International Centre for Climate and Environment Sciences, China, and all invitees who accepted to grace the occasion. I send my heartfelt gratitude to all those who are behind the success story and congratulate all those who are receiving awards for their S&T achievements and who deliver technical presentations over the two days of the symposium.

I also wish the Director General, the organizing committee, and fellow Scientists, Engineers, Technologists and other Staff of ITI a very successful event.

Prof. Sirimal Premakumara
PhD, CChem, CBiol, FIBiol, FIChemC, FNAS
Chairman - Industrial Technology Institute (CISIR)
Former Director General & Research Professor - Industrial Technology Institute (CISIR)

Message from the Director General

The Industrial Technology Institute (ITI) proudly marks sixty-eight years of excellence in Research, Technology, and Innovation driving sustainable growth of industry in our nation. Our unwavering commitment supports industries through research and development, consultancy, contract projects, technology transfer, training, and the provision of testing and calibration services fostering industrial technology development.

It is with great pleasure and anticipation, that I extend a warm welcome to the 6th Biennial Research Symposium and International Research Symposium 2023, organized by ITI which will be held from the 7th to 9th of November 2023.

Under the theme of "Advance Research, Development and Innovations towards the Fourth Generation Industrial Development", the Research Symposium highlights our unyielding dedication to pioneering progress and innovation. This theme holds immense significance in our rapidly evolving technological landscape characterized by interconnected technologies, artificial intelligence, sustainability, and digital transformation.

We are honoured to announce the distinguished lineup for our research symposium, Honorable Dr Ramesh Pathirana, Minister of Industries will inaugurate the event as the Chief Guest, and Ms J. M. Thilaka Jayasundara, Secretary of the Ministry of Industries will be gracing the occasion as the Guest of Honour. We are also privileged to host the Ambassador Dr Mohammad Nafees Zakaria, Executive Director of COMSATS as a Special Guest. We are privileged to have Professor Zhaohui Lin, Director of the International Center for Climate and Environment Sciences, Institute of Atmospheric Physics, Chinese Academy of Sciences, delivering the keynote address.

Over three days, distinguished professionals from Australia, China and India will deliver plenary lectures and our ITI Researchers will present their research findings through paper presentations. This symposium promotes the exchange of knowledge, and experience, fostering collaborations among diverse foreign and local participants.

We extend our appreciation to international experts, the Chairman, the Board of Management, the Symposium Chairperson, the organizing committee and Researchers for their vital contributions to making the 6th Biennial Research Symposium a successful and memorable event. I wish all of you a most enjoyable and interactive symposium.

Professor J K R Radhika Samarasekera
Director General/CEO

Message from the Symposium Organizing Chair

I am deeply honored and privileged to serve as the organizing chair of the 6th Biennial Research Symposium and International Symposium of the Industrial Technology Institute (ITI). I warmly welcome the respected International and local invitees, scientists, engineers, technologists, academia, policymakers, industrialists, entrepreneurs and colleagues from my institute who have joined the event. Science, Technology & Innovation (ST & I) are key drivers of the economic growth of a country. Therefore, it is impo rtant to give more attention to innovations and scientific findings which could be effectively utilized for industrial development and find solutions for the prevalent economic recession of the country. Hence, this year we geared ourselves under the theme of 'Advance Research, Development and Innovations towards the Fourth Generation Industrial Development'. Being a leading multidisciplinary R&D institution in the country that provides technological solutions and technical support to industry, the Biennial Research Symposium is the most significant scientific event organized by the institute to showcase its valuable discoveries and innovative technologies developed through public funds. The 6th Biennial Research Symposium, which will be held from 7-9 November 2023, in line with the 'World Science Day' will be a good scientific platform for ITI researchers to disseminate the key findings of their research done in multidisciplinary sciences. This year's symposium is open for our international collaborators and this will be a valuable forum to share, discuss and debate scientific outcomes with a wider audience connecting local and international students, researchers, academia, industrialists, policymakers and entrepreneurs. I take this opportunity to wish all my fellow research scientists, engineers and technologists a successful future, leading to further scientific inventions and innovations to uplift the economy of the country. As the symposium chair, I wish to extend my gratitude to the Ministry of Industries, the Chairman & Board of Directors of ITI, the Director General, symposium secretaries and all staff who contributed in numerous ways to the success of this event. I would like to extend my sincere thanks to all the distinguished international and local invitees for joining us to enlighten the audience with their insightful speeches. I greatly appreciate the financial and other assistance given by our sponsors to glamour this event.

Professor Ilmi G. N. Hewajulige
Organizing Chair and Additional Director General R&D

Keynote Address

Drought variation and changes under a warming climate and its future projection

Prof. Zhaohui Lin,

Director, International Center for Climate and Environment Sciences, Institute of Atmospheric Physics, Chinese Academy of Sciences

Abstract

In recent decades, hydro meteorological extremes have increased significantly and have threatened regional and global socio-economic development. As one of the most important natural disasters, drought and its impact are of great concern to many developing countries, because they are intertwined with the water resources, agriculture and energy productions that contribute considerably to the economy and livelihood of the region's demography. Therefore, strong evidence-based scientific information on drought characteristics and its future change is desirable for effective disaster risk management and adaptation interventions.

Using the meteorological observation datasets, the historical drought variations and the corresponding mechanisms over South Asia and East Africa region have been investigated, and the projected future changes of drought characteristics are also demonstrated using the CMIP6 model projection results. Taking the Mahaweli River Basin (MRB) as the representative study domain in South Asia, it's suggested that both the Indian Ocean Dipole (IOD) and Nino3.4 index are important drivers for the variability of Southwest Monsoon (SWM) rainfall over the MRB. Moreover, interdecadal change of drought characteristics during 1985-2015 can be found in the wet region of MRB, with more frequent, severe and persistent drought events occurred during the 2000-2015 period, especially for medium and long-term drought. This interdecadal enhancement of drought can be largely attributed to the drought changes in the SWM season, which is coherent with the interdecadal weakening of the SWM rainfall since 2000.

Over East Africa, an overall weak long-term drying trend in the spring season exists for most parts of the region from 1901-2020. An increase in drought areal extent after the 1980s could be ascribed to the increase in potential evapotranspiration (PET) and is consistent with the negative trend in SPEI value over the 6 sub-regions. The apparent increase is mainly attributed to an increase in moderate and severe drought areas rather than extreme drought areas. It is further revealed that inter-annual drought variability could be associated with the critical role of El Niño in the tropical Pacific in driving the drought variations in East Africa. Based on the CMIP6 multi-model simulation and projection results, it is found that the mean rainfall shows an increasing trend over most of East Africa and the projected change is particularly enhanced and shows strong model agreement. East Africa broadly shows an increase in average Standardized Precipitation Index (SPI) values with higher magnitude under a 2 °C rise in contrast to a 1.5 °C warming level. The population exposure to drought under different emission scenarios has further been discussed.

Plenary Lectures

Agribusiness 4.0: Technology, Innovation and Digitalization

Dr Jairo Andres Villamil-Diaz

International Senior Technical Specialist, United Nations Industrial Development Organization -UNIDO

Abstract

The rapid development and adoption of ICT technologies are leading to a transformation in the way production is conducted across all sectors of the economy and society. In the era of the 4th Industrial Revolution (4IR), the Agrifood sector can accelerate its advancement by integrating both physical and virtual modern technologies. This lecture explores how the 4IR is enhancing the efficiency and sustainability of the Agrifood sector, offering a context relevant to Sri Lanka.

University 4.0: Gearing up to meet the 4th Industrial Revolution- Our experience at JSS AHER

Dr. T.M. Pramod Kumar

Dean, Faculty of Pharmacy & Principal, JSS College of Pharmacy, JSS Academy of Higher Education & Research, Mysore, India

Abstract

- According to one of the surveys, more than 50% of the existing jobs across the world will not exist in the next 25 years. Courtesy: Industry 4.0.
- The central challenge of industrial 4.0 is for universities, students and their families to come together to create an energetic learning ecosystem, one, that ensures that the graduate can thrive in the constantly changing world (VUCA World).
- Yet most students and many universities do not know what employers of today are looking for which means they will not be ready for the fast-changing world of industrial revolution 4.0.
- Rapidly evolving technologies, including digitisation, automation, artificial intelligence and machine learning are going to disrupt the workplace in untold and dramatic ways.
- There is a huge emphasis on the advancement in genomics, AI, robotics, material and manufacturing technologies.
- India announced the creation of the Centre for the Fourth Industrial Revolution at the World Economic Forum, annual meeting in 2018.
- The fourth industrial revolution will change how we produce, how we consume, how we communicate, and even how we live, says World Economic, Forum founder and Executive Chairman, Klaus Swab.
- The challenge for universities and students is to enter the world of constant change where jobs you are being trained for might not be there anymore, where you might have to create your job or become an entrepreneur while in University and team up with friends to create an Enterprise.
- The following are a few ways that graduates can thrive in Industry 4.0.
- Be a lifelong learner
- Demonstrate wisdom and common sense
- Gain good collaboration and friendship skills
- Gain, crossword, understanding and skill sets
- Become outstanding communicator
- Be a team-based problem solver
- Build self-reliance and resilience

At JSS Academy of Higher Education and Research, Mysore India, we are carrying out 360-degree grooming of the students so that they are future-ready. We are merging the fields of health science with engineering disciplines to nurture an interdisciplinary research culture. We are embracing AI and ML in our Research projects and are working with L&T and Google to support our initiative. Our drug testing laboratories are NABL accredited, hospital is NABH accredited. We have established a university sophisticated instrumentation center (USIC) in the pharmacy college, which has NMR, confocal microscopy, HRMS, NIR Spectroscopy, and Schrödinger complete suite software for Drug Discovery to name a few. Central Animal House facility has state of art Equipment and instrument for pre-clinical testing. JSS Hospital has a center of excellence for clinical trials which has conducted several national and international clinical trials.

It may be concluded that JSS AHER is taking all necessary steps to prepare the next generations of students who are future-ready and employable in fourth-generation industries.

Scientific Approaches in the Designing and Development of Natural Personal Care Products

Dr. Ashok B.K., Senior Manager

AYUSH & Scientific Affairs, Himalaya Wellness Company, Bengaluru, India

Abstract

Since ancient civilizations herbs and other natural ingredients were used by humans as cosmetics and a supplement for enhancing and maintaining human beauty preparations used to improve beauty that provides additional health-related functions. Also, the application of cosmeceuticals is a common phenomenon among all races of humans without any difference in geographical territory and time of history. In the recent past as well, natural ingredients are everywhere and are continually gaining popularity due to their multi-functionality and diverse benefits. Further, the use of plant extracts in cosmetic formulation is on the rise and researchers have been focused on plants to investigate their efficacy and safety in the cosmetics field. It is interesting to note that consumers are increasingly demanding natural ingredients and additives in cosmetic products, because of their skin friendliness and lack of side effects giving them an advantage as "greener or safer" compared to conventional products.

Generally, cosmetic products are formulated using various regulatory permissible cosmetic ingredients to provide cosmetic advantages only. However, over the years cosmetic formulations have evolved significantly and are no longer viewed merely as beauty-enhancing products. Rather, they are expected to deliver additional benefits to the skin that positively affect the skin health and serve many purposes for consumers, namely delay in skin aging, protection against acne and ultraviolet rays, hydration improvement, reduction in hyperpigmentation and wrinkles, skin elasticity and firmness improvement, scar reduction, hair-loss reduction, dandruff treatment, etc. through their skin conditioning, healing, moisturizing, anti-oxidant, anti-bacterial etc. properties. Hence it is appropriate to term these products as "Personal Care" products rather than a mere cosmetic.

It is important to note that natural products are a complex mixture of many phytochemical compounds that can greatly influence the aesthetic value, stability, safety, and efficacy of the finished product. Further, many times a few natural ingredients are even responsible for the development of adverse reactions of the skin including irritation, contact dermatitis, and photosensitization. Hence scientific studies aiming at the development, evaluation, and application of natural ingredients in cosmetic formulations that simultaneously meet consumer concerns are a challenge. To overcome these factors adopting evidence-based research which includes standardization of herbal raw materials and final products is very important. In short, evidence-based research includes the selection of time-tested ingredients, ingredient authentication, process standardization, stringent quality tests, and stability studies, specific clinical studies for safety and efficacy, optimum packaging, and compliance with global and local regulatory guidelines to ensure optimum, stable, safe, and efficacious products. Additionally, a main requirement of Cosmetic Good Manufacturing Practices (ISO 22716) needs to be adopted for herbal cosmetic/personal care product-producing processes. These procedures can be an asset to ensure the safety of consumers who choose to use natural products and, consequently, the acceptability of the marketed product.

Specifically, evaluating personal care products for their efficacy and safety is critical during product development. They should be thoroughly researched and tested for mildness, biodegradability, low toxicity, cleansing ability, moisturization, skin appearance, feel, fragrance, lubrication, and other target therapeutic benefits. The *in vitro* cytotoxic potential of extracts should be performed in several human cell lines before use in humans and the irritant potential of cosmetic formulations can be screened. Further, innovative dosage forms, novel packaging approaches for proper storage, shipment, and delivery of the products, and, suitable sustainability/eco-friendly practices to support the environment we inhabit are very important aspects to ponder.

Fungi and the Future: Pioneering a sustainable industrial revolution

Dr. Dhanushka Wanasinghe

Center for Mountain Futures, Kunming Institute of Botany, Chinese Academy of Sciences, Honghe 654400, China

Abstract

Fungi, with their diverse and intricate roles, act as vital keystones within various ecosystems, playing a significant part in shaping and driving the complex web of biological processes that sustain life on Earth. Their contributions extend beyond familiar realms of decomposition and nutrient cycling. However, the key contributions of fungi to Earth's ecological and biological processes often go unnoticed. In consideration of rapid habitat degradation and the rising challenges of climate change, gaining a deeper understanding of the global diversity and distribution of fungi is more essential than ever before. Despite their widespread presence, a comprehensive grasp of fungal taxonomic diversity, molecular phylogeny, ecological interactions, and global distribution remains elusive. This knowledge gap not only poses challenges to conservation initiatives but also limits the ability to harness the full potential of fungi in reshaping industrial paradigms. By employing methods such as comprehensive fungal sampling, thorough land cover examination, advanced microscopy, and DNA sequencing, we can reveal essential relationships. These methods spotlight the intricate relationships between fungal communities and various environmental factors, encompassing land use patterns and vegetation structures. Such revelations pave the way for a multitude of innovative strategies, positioning fungi at the forefront of sustainable industrial solutions. Amid the contemporary global setting characterized by rapid technological shifts, disruptions in supply chains, escalating environmental concerns, evolving consumer tastes, competitive innovation, and the move towards a circular economy, fungi rise prominently. They are not mere observers in this narrative but bring forth a spectrum of opportunities aligned with sustainable and environmentally conscious practices. As the globe stands on the tip of a significant industrial shift, fungi emerge as indispensable partners. They offer more than just a connection between the natural world and industry and are set to guide us towards a sustainable and ecologically balanced industrial era.

Food Safety in South East Asia

Prof. Daniel Tan

The University of Sydney, Sydney Institute of Agriculture, School of Life and Environmental Sciences, Faculty of Science, NSW 2006, Sydney, Australia.

Abstract

There is an increasing awareness of food safety issues in Southeast Asia and many Southeast Asian countries have introduced Food Safety Acts mainly focussing on microbial food safety. Fruit and vegetables are implicated in a disproportionate number of food safety incidents, and these can be caused by chemical, physical and microbial contaminants. In Southeast Asia, pesticide residue contamination is more challenging as crops including rice, fruits and vegetables are mostly produced by smallholder farmers. This paper discusses the need to understand the motivations of smallholder farmers and input sellers in the use of pesticides and proposes the use of mobile applications and training of government regulators, input sellers and smallholder farmers in integrated pest management to reduce the incidences of pesticide residues being detected above the maximum residue limit.

Technical Session

Assessment of current scenario and challenges related to fresh fruit and vegetable safety in Sri Lanka with reference to pesticide and heavy metal contamination

Poornima, W.V.D.S[1]., Liyanaarachchi, G.V. V[1*]., Somasiri, H.P.P. S[1]., Hewajulige, I.G.N[1]., Tan, D. K.Y[2]

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[2]*The University of Sydney, Sydney Institute of Agriculture, School of Life and Environmental Sciences, Faculty of Science, NSW 2006, Sydney, Australia*

Abstract

Modern agricultural practices heavily rely on the use of pesticides to control pests and diseases, and this has resulted in the accumulation of residues in food crops. In addition, the use of heavy metals in agrochemicals has also led to their accumulation in soil and subsequent uptake by plants. Since fruit and vegetables have traditionally occupied a prominent place in the majority of human diets, and the residues of pesticides and heavy metals accumulated in them could cause adverse health effects to consumers, such as developmental disorders, cancer, and neurological damage, it is important to assess the sources and levels of contamination in fruit and vegetables compared to the standard maximum residue limits (MRLs) or maximum permissible limits (MPLs). The objective of this review is to provide an overview of the local studies conducted on the level of contamination of fruit and vegetables by pesticides and heavy metals and evaluate the levels with the standard recommendations and similar studies in other regions of the world. Based on those, Chlorpyrifos, Profenofos, Tebuconazole, Diazinon, and Fipronil were the most commonly detected pesticides in Sri Lanka. Further, in comparison to other countries, a relatively, lower prevalence of persistent organic pollutants (POPs) was observed in Sri Lanka. Investigations into the presence of pesticide and heavy metal residues originating from both local and international sources demonstrated a similar trend, featuring increased susceptibility of leafy vegetables to such residues compared to other agricultural products. The majority of authors have emphasized the need of continuous monitoring studies and enforcement of stringent regulations on pesticide and heavy metal use. The review further recognized the requirements need for statistically sound studies as well as the establishment of MRLs and MPLs locally since chronic kidney disease of unknown aetiology (CKDu) and detection of nationally prohibited pesticides in local produce remain unsolved. Promoting Good Agricultural Practices (GAP) and organic farming practices were also effective with collaborative and sustained efforts from all stakeholders to reduce threats to human health.

Acknowledgement: Financial assistance from University of Sydney, Australia through the FRESH, CGIAR project (FP 138)

Microbial community composition analysis of Sri Lankan milk microbiota for different lactation phases

Udara, M. A[1]., Fernando, S.P.C[1]., Rajawardana, D.U[2*]., Hewajulige, I.G.N[2]., Nanayakkara, C.M[1]

[1]Department of Plant Sciences, Faculty of Science, University of Colombo, Sri Lanka
[2]Food Technology Section, Industrial Technology Institute, 503 A, Halbarawa Gardens, Thalahena, Malabe, Sri Lanka

Abstract

The cattle lactation cycle refers to the period from one calving of a dairy cow to the next. There are four main phases in a single lactation cycle: early lactation phase, mid-lactation phase, late lactation phase, and dry lactation phase. These lactation phases are primarily distinguished by the level of milk production and the overall dry matter intake of cows. In general, research that studied the milk microbiota considering cattle parameters in countries in South Asia is lacking. For the first time in Sri Lanka, the Industrial Technology Institute conducted a 6S rRNA gene sequencing on 82 Sri Lankan milk samples collected from 18 different farms. The data generated in this study were utilized to evaluate alpha diversity, beta diversity, as well as the abundance and distribution of the most prevalent known pathogenic species throughout the various lactation phases. The dry lactation phase data were excluded from the study due to the limited number of available samples. According to the alpha diversity plots, the diversity of the microbiomes of the mid and late lactation phase seemed to be slightly higher than the microbiome of the early lactation phase. There was a significant difference in the microbial diversity of the samples collected from cattle in early and mid-lactation phases in the Shannon and Simpson indices as suggested by the results of Wilcoxon rank sum tests. In all three lactation phases, the most abundant phylum found in raw milk microbiota was *Firmicutes*. The most prevalent genera varied with the lactation phases: *Streptococcus, Elizabethkingia*, and *Macrococcus* were the most abundant in early, mid, and latelactation phases, respectively. Regarding pathogenic bacteria, *Staphylococcus saprophyticus* is highly prevalent in the mid and late lactation phase, while *Streptococcusagalactiae* was the most common in early lactation phase. *Rothia nasimurium* was foundin both early and late lactation phases, while *Enhydrobacter aerosaccus* was only present in the early lactation phase.

Acknowledgement: Financial assistance by National Science Foundation (FP 120) and Treasury Research Grant (TG15/117)

Mycotoxin, yeast and mould contamination and physico-chemical quality of non-branded coconut oils sold in Western province of Sri Lanka

Madhushani K.D[1]., Silva J.S. G[1]., Samarathunga O[2]., Karunaratne S.H.S[2]., Dasanayake M.R.P[3]., Mubarak M.N.A[2*]

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Abstract

Coconut oil, mainly obtained from copra, accounts for 15 - 20% of the fresh coconut harvest each year and it is widely used in Sri Lankan cuisine. The quality of coconut oil can be expressed using physicochemical parameters such as free fatty acid content (FFA as Lauric acid) and peroxide value (PV). Further, low fungal contamination (Y&M) is a sign of food hygiene and may or may not indicate the contamination of mycotoxins which are harmful secondary metabolites produced by certain filamentous fungi. Coconut kernel and the extracted oil can be contaminated with mycotoxins during the process of drying, storage, extracting the copra and during transportation and storage of extracted coconut oil. Commonly reported mycotoxins in edible oil are aflatoxins B1(AFB1), B2(AFB2), G1(AFG1), G2(AFG2), deoxynivalenol (DON), fumonisins B1(FB1), B2(FB2), zearalenone (ZER) and ochratoxin A (OTA). The Sri Lanka Standards Institute has stipulated maximum permissible levels (MPLs) for aflatoxins, FFA, PV and Y&M in coconut oil under SLS 32:2017 standard. The present study covered 32 non-branded coconut oil samples collected from large-scale/bulk distributors (BD) and small-scale vendors (SV). Mycotoxin levels were quantified using Liquid Chromatography-Tandem Mass Spectrometry while FFA, PV, and Y&M were analyzed as per the methods given in SLS 32:2017. In each batch, the spike recoveries of all 9 mycotoxins were greater than 70%, and thus the results were considered accurate. Aflatoxin B1 was detected either at 5 $\mu g\ kg^{-1}$ or above 5 $\mu g\ kg^{-1}$ in 20% of BD samples and 35% of SV samples. Total aflatoxins were detected above 10 $\mu g\ kg^{-1}$ only in 13% of BD and 18% of SV samples while OTA was detected above the limit of detection (LOD) in only nine samples. The highest level of total aflatoxins and OTA were detected in the same coconut oil sample which was collected from a BD. None of the samples were detected above the laboratory LOD for FB1, FB2, ZER, and DON. Further, Y&M were detected above the MPL 93% of BD and 94%of SV. More than 70% of the samples complied with the MPL for PV in both categories. Hence, oxidative rancidity has not been initiated in most of the oils. However, higher FFA content in the BD indicated the initiation of hydrolysis of triglycerides leading to hydrolytic rancidity. The possibility of detecting Aflatoxins higher than the MPL was greater in SV than in BD. However, the variance of both sample populations was insignificant for both aflatoxins and PV while significant for FFA, and the Y&M in both categories. Therefore, it can be concluded that the quality of non-branded coconut oil at both BD and SV was not satisfactory from the hygienic perspectives and 20% may may contain aflatoxins above MPLs.

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Development and validation of a multi residue QuEChERS method for analysis of pesticide residues in tea using liquid chromatography-tandem - mass spectrometry

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Abstract

Tea, the globally consumed beverage sourced from *Camellia sinensis* (L.) Kuntze, is world renowned for its health promoting attributes, and plays a pivotal role in economies like Sri Lanka. With the global demand, tea also faces the concern of pesticide residue contamination due to the extensive use of pesticides in agriculture. Exceeding tolerance limits of pesticides in human dietary intake can result in severe health complications has led to the enforcement of stringent maximum residue limits (MRLs) to ensure the safety of tea consumption. Therefore, establishing reliable and accurate analytical methods for detecting and quantifying pesticide residues in tea is crucial to assure its integrity and the well-being of consumers. During method development for the analysis of ten pesticide residues in tea, a modified quick, easy, cheap, efficient, rugged, and safe (QuEChERS) method was employed for sample extraction, followed by purification using a combination of primary and secondary amines (PSA), C18, and graphitized carbon black (GCB). Liquid Chromatography- TandemMass Spectrometry (LC-MS-MS), using electron spray ionization (ESI) in positive polarity,was utilized as the technique of detection and the specificity for each pesticide in MS-MS detection was confirmed through the application of multiple-reaction monitoring (MRM), which assesses the ratios of peak areas between the qualifier and quantifier mass fragments. The method was validated for an array of pesticides, including acetamiprid, azimsulfuron, bifenthrin, difenoconazole, flufenoxuron, hexythiazox, malathion, methidathion, propargite, and tolfenpyrad, and all the evaluated method performance characteristics complied with the requirements of the internationally established SANTE guidelines recommended for pesticide residue analysis. The recovery percentages spanned from 70% to 120%, across the spiking levels of 0.040 mg kg^{-1}, 0.100 mg kg^{-1} and 0.250 mg kg^{-1}, representing the low, mid, and high concentration levels of the working range respectively, indicating the accuracy of the method. The percentage relative standard deviation (% RSD) values below 20% in repeatability and reproducibility studies verified the precision at the aforementioned three fortified levels. Limit of detection (LOD) and limit of quantification (LOQ) of the method were 0.001 mg kg^{-1} and 0.005 mg kg^{-1} respectively for all the stated pesticides and exhibited a wide linear working range from 0.005 to 0.300 mg kg^{-1}, with regression coefficient (R^2) values greater than 0.995, obtained using eight calibration levels. In conclusion, the validated modified QuEChERS extraction approach coupled with LC-MS/MS detection can be considered an accurate and precise method which is applicable for quantitative analysis of the aforementioned pesticide residues in tea.

Development of soybean milk by enhancing processing techniques with acceptable organoleptic properties

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Abstract

Soybean (*Glycine max* Linn.) milk, an economical and nourishing protein source, has encountered challenges due to off flavors and undesirable odors. This study focuses on enhancing soymilk processing to reduce trypsin inhibitor and lipoxygenase activity while achieving appealing organoleptic qualities. The study aimed to address reducing grassy and beany flavors, yielding a smooth, well-textured milk with favorable color and aroma, and assessing its potential for both laboratory scale and industrial applications. Further, assays to quantify anti-nutritional factors are pending which extends the possibilities for enhanced soymilk utilization. Soybean milk was prepared by subjecting soybeans to soaking, blanching, dehulling, grinding with water, filtering through cheesecloth, homogenization, pasteurization and bottling. The developed method successfully improved the soybean milk characteristics. The resulting milk displayed absence of grassy flavors, bitterness, or unusual odors. Its texture was appropriately smooth and thick while its color remained visually appealing. The addition of flavors further enhanced its sensory properties. The method also maintained a suitable pH level within an acceptable range. Soy milk samples prepared using six different methods were subjected to sensory analysis. The milk produced by the method six had superior qualities across parameters such as texture, taste, aroma, and overall acceptability. However, further studies are needed for the analysis of trypsin inhibitors, tannins, phytates, and total phenolic content. The developed processing method has shown substantial potential in enhancing soybean milk characteristics. By addressing off flavors and undesirable attributes, developed method contributes to make soy milk more palatable and versatile. The utilization of food grade natural food additives, strategic blanching and careful processing temperatures underscore its effectiveness. This research demonstrates the potential for producing soy milk with improved organoleptic properties, impacting both consumer preferences and the food industry at large.

Microbial quality assessment of Ceylon cinnamon from small and medium-scale entrepreneurs

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Abstract

Ceylon cinnamon is a spice in the global market, valued for its extensive culinary use across various cuisines, owing to its recognized nutritional and medicinal attributes. Thus, this study was carried out to evaluate the microbiological quality of commercially available, processed Ceylon cinnamon in Sri Lanka. Furthermore, it explores the potential significance of water dipping tanks as critical entry points for coliforms and *Escherichia coli* contamination in the cinnamon processing industry. A total of 14 Ceylon cinnamon samples were randomly collected from small and medium scale entrepreneurs in Sri Lanka, while an additional eight water samples were aseptically collected from the water dipping tanks located within eight cinnamon production areas in the Galle district, Sri Lanka. All the cinnamon samples were analyzed for the presence of total aerobic mesophilic bacteria, yeasts and moulds, coliforms, *E. coli*, and *Salmonella* Spp. Water samples were analyzed only for coliforms and *E. coli*. Out of 14 cinnamon samples, only seven samples and two samples were positive for coliforms and *E. coli*, respectively. All the samples were negative for *Salmonella* spp. and positive for aerobic mesophilic bacteria and yeasts and moulds. The highest recorded counts were 4.2×10^8 CFU/g for aerobic mesophilic bacteria and 4.1×10^7 CFU/g for yeasts and moulds. However, out of all the analyzed cinnamon samples, 85.7% met the existing SLS specifications for microbiological quality. Moreover, among the eight water tank samples, all the tested samples were found to be free of *E. coli*, with only three samples showing the presence of coliforms. Based on these results, sources of *E. coli* other than water dipping tanks are to be identified as entry points for coliform contamination. The present study emphasized the value of good hygienic practices throughout the Ceylon cinnamon production to ensure microbiological quality, with a special focus on critical entry points of food pathogens.

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Development of radio frequency powered dielectric barrier discharge rotary plasma reactor and evaluation of the performance using native bacteria, fungi and *Bacillus cereus* inoculums

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Abstract

Decontamination of spices using non-thermal sterilization has become a sensible topic targeting conserving organoleptic properties. Cold plasma is an emerging non-thermal technology and different cold plasma design configurations are being tested globally for spices. It has been recognized as a surface treatment and therefore, penetration of plasma to a bulk spice powder or seeds limits the efficacy of inactivation. A conceptual design was made addressing to minimize the effects of extreme conditions of low pressure and gliding arc discharge atmospheric cold plasma systems. The study focused on evaluating the efficacy of cold plasma treatment by facilitating the rotation of particulates to expose every side of spice particle to maximize the plasma spice interaction to achieve a higher level of inactivation. Radio frequency power supply was selected since it owns a high ionization power than the 50 Hz alternating current. A prototype of a Radio Frequency (RF) Powered Dielectric Barrier Discharge (DBD) rotary plasma reactor was designed and fabricated using a cylindrical glass tube mounted in two Teflon supports and rotation was provided using a DC power supply. The air in the glass chamber was converted to plasma by connecting RF power to the perforated co-axial single electrode. The apparatus was placed in an RF-powdered low-pressure plasma chamber. Black pepper seeds were selected to test the performance of the reactor. The experiments were conducted in both rotating and stationery modes to evaluate the efficacy of killing naturally contaminated bacteria, fungi, and *Bacillus cereus* (ATCC 11778) inoculum. Treatment times were set as 5,10 and15 min. Log reduction of Aerobic bacteria was 1.57 and 0.92 in rotating and stationary modes respectively after 15 min treatment. Similarly, Y&M were reduced by 1.34 and 0.90. Inactivation of *B. cereus* followed a first-order kinetic reaction and decimal reduction times were calculated as 6.25 min and 12.15 min in rotary and stationary modes. After 15 min treatment time, 3.06 and 1.67 log reductions were obtained for the black pepper seeds with *B. cereus* inoculum.

Sensory evaluation results revealed no statistically significant changes to the selected sensory attributes after treatments in the developed reactor. Attenuated Total Reflectance, Fourier Transform Infrared spectroscopy revealed no changes in black pepper seed surface with respect to functional groups in Piperine. Results confirmed that the rotation of the reactor enhances the level of inactivation of microbes and the reactor has the potential for scaling up to set as a batch or continuous type reactor to reduce the microbial contamination levels.

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Microbial quality assessment of dried fish packed in two packaging types in Sri Lankan market

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Abstract

Dried fish plays a vital role in Sri Lankan diet serving as a rich protein source. Therefore, it is imperative to assess its microbial quality and the factors influencing microbial growth. Total number of 60 samples of sprats, baby shrimps, Sailfish, Queenfish, Skipjack tuna and Maldive fish were collected from markets and packed in two packaging types; vacuum-packed and polythene-packed. Considering the batch numbers in different brands, samples were analyzed in triplicates according to the relevant standard methods. Results revealed the absence of *Salmonella* spp. and *Listeria* spp. in vacuum-packed samples whereas *Vibrio cholerae* was detected in one Maldive fish sample. Halotolerant microorganisms were identified in one batch of Sailfish and Queenfish samples from the same brand while coliforms and *Escherichia coli* were absent in all vacuum-packed samples. *Staphylococcus aureus* was detected in only one batch of Queenfish samples. The total aerobic bacterial counts obtained ranged from 5.0×10^1 to 9.0×10^5 cfu g^{-1} and yeast and mold counts ranged from 1.0×10^1 to 6.2×10^5 cfu g^{-1} in vacuum-packed samples. Water activity values varied from 0.59 to 0.80 in polythene-packed samples and from 0.63 to 0.74 in vacuum-packed samples. Only one brand of polythene-packed Maldive fish sample exceeded the maximum acceptance limit for water activity. Moreover, *Salmonella* spp., *Listeria* spp. and *V. cholera* were absent in all polythene packed samples while halotolerant microorganisms were detected only in one batch of Queen fish and Skipjack tuna samples. Coliforms and *E. coli* were detected in one batch of Maldive fish in polythene packed sample. *S.aureus* was detected in one batch of polythene-packed Sailfish and Sprats samples. Total aerobicbacterial counts ranged from 1.6×10^2 to 7.0×10^7 cfu g^{-1} and yeast and mold counts rangedfrom <10 to 2.5×10^6 cfu g^{-1} in polythene-packed samples. Microbial contamination varied among the different batches of the same brand in both packaging types which revealed that 48.6% of polythene-packed and 28% of vacuum-packed samples did not comply with the standards. In conclusion, microbial quality of vacuum-packed samples was more acceptablethan that of polythene-packed samples.

Multi-residue extraction and cleanup method for analysis of 50 pesticide residues in bovine milk by chromatography coupled with tandem mass spectrometry

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Abstract

Due to irrational use of pesticides by the agricultural sector, there is a potential for locally produced milk to be contaminated with pesticides. Such harmful chemicals in milk even at low levels can cause significant health risks to consumers and thus need to be cautiously regulated. In par with the international regulatory guidelines such as SANTE/11312/2021 for the quantitative and confirmatory analysis, a quick, easy, cheap, efficient, rugged, and safe (QuEChERS) method was developed for the simultaneous extraction and cleanup of multi-class chemical residues in bovine milk. Milk samples were spiked with 31 pesticides in the range of 2.5 µg/L– 100 µg/L and 19 organochlorine pesticides (OCs) in the range of 5 µg/L – 120 µg/L, respectively. Both Liquid Chromatography - Tandem Mass Spectrometry (LC-MS-MS) and Gas Chromatography - Tandem Mass Spectrometry (GC-MS-MS) amenable compounds were simultaneously extracted followed by a cleanup prior to injection to the LC and GC systems separately. In LC-MS-MS, linear regression analysis showed a correlation (R^2) of ≥0.99 for all the pesticide compounds and the recovery ranged from 70% to 120% for 95% of the analyzed compounds. The remaining analytes showed recoveries in the range of 60% to 140%. A limit of quantification (LOQ) of 2.5 µg/L was achieved for all the analytes. The GC-MS/MS analysis of OC pesticides showed a linear regression correlation (R^2) >0.99 for all the compounds. A recovery ranges from 70% to 110% and a LOQ of 10 µg/L was achieved for 80% of the analyzed OC pesticides. A single extraction and cleanup procedure for both LC and GC amenable pesticides in milk was aimed at increasing the laboratory throughput and economic viability of multi-residue analysis. Further, the applicability of the method for different sample matrices needs to be further studied.

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A comparative study on physico-chemical, nutritional and antioxidant properties of Purple Yam (*Dioscorea alata* Linn) based pudding developed from cow's milk and coconut milk

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Abstract

Purple yam (*Dioscorea alata* Linn.) is an untapped natural source of nutrient-rich food ingredient available in Sri Lanka. To broaden the product diversity and provide reliableaccess, the present study aimed to transform purple yam into shelf-stable flour and to developa Ready-To-Cook (RTC) pudding mix. The edible portion of *D. alata* yams was blanched at80 °C for four minutes, dried at 45 °C for 24 h, powdered and sifted through a 300 µm sieveto process the yam flour. Formula standardization of RTC pudding mix was done through several trials. The four selected types of prepared pudding (purple yam: 10&12g; ground sugar 10&15g with coconut milk powder and carrageenan) were subjected to ranking on theirappearance, color, aroma, texture, taste, aftertaste, and overall acceptability through a trainedsensory panel using a 9-point hedonic scale. The net yield of the purple yam flour was 26.80±0.75%. The physico-chemical and sensory properties were measured and analyzed statistically using SPSS software. The moisture content, water activity and color of the RTCpudding mix were 3.98±0.30%, 0.40±0.01and L-36.10±1.00, a-3.28±0.10, b-0.16±0.00
respectively. The nutritional profile of the RTC pudding mix, pudding prepared with cow's milk and the pudding prepared with coconut milk were analyzed separately and resulted, 1.70±0.20%, 0.63±0.04%, 2.01±0.11% of ash; 4.27±0.09%, 2.55±0.15%, 0.91±0.07% of crude protein; 0.42±0.08%, 0.25±0.12%, 2.18±0.13% of crude fat; 0.88±0.03%, 0.36±0.04%,0.25±0.16% of crude fiber; 84.33±0.27%, 31.15±1.00%, 20.01±1.32% of carbohydrates and 433.94±0.09 kcal, 137.04±0.09 kcal, 103.17±6.35% kcal of energy on fresh weight basis while potassium (0.60±0.10, 0.23±0.01, 0.42±0.12 mg/kg) and calcium (0.07±0.04%, 0.08±0.00%, 0.17±0.08 mg/kg) as the major minerals in dry weight basis respectively. The antioxidant potential of TPC, TFC, DPPH and Anthocyanin of the purple yam, pudding mix with cow's milk and coconut milk were (3.78±0.10: 3.15±0.01: 1.78±0.04 of mg GAE/g), (2.17±0.32, 1.81±0.37: 0.96±0.14 of mg QE/g), (11.73±0.65,1. 41±0.10, 1.36±0.02 of mg TE/g) and (0.33±0.01: 0.13±0.00: 0.01±0.00 of c-3-gE mg/g) respectively on fresh weight basis. Although the pudding prepared with coconut milk showed the highest acceptability, the pudding prepared with cow's milk had better functional properties. In conclusion, *D. alata* yam flour containing natural purple color pigments could be used as a viable ingredient for the development of nutrient-rich functional food products.

Acknowledgement: Financial assistance by National Research Council (NRC 19/007)

Development of a probiotic whey-based functional beverage with *Cucurbita* species (Pumpkin*)*

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Abstract

Cheese whey is the largest volume by-product of the dairy manufacturing process. Although cheese whey retains nearly half of the nutritional value contained in milk, it is still a waste material in Sri Lanka. On the other hand, Sri Lankan pumpkins (*Cucurbita* spp.) are notable source of postharvest losses annually among vegetables. Therefore, the present study aimed to develop a sustainable utilization method for cheese whey and pumpkin. The cheese whey (acid whey) was prepared on laboratory scale by curdling fresh cattle milk. Blanched pumpkins and acid whey were subjected to a sequential process with the addition of permitted stabilizers and sweeteners to produce a beverage with enhanced sensory and nutritional attributes. The final formula was fermented with probiotic *Lactobacillus rhamnosus* which successfully delivered a satisfactory level of (> 10^6 CFU ml) viable probiotics after 28-day shelf life period. The flavor and nutritional value of the beverage were enhanced by incorporating five different natural fruit extracts (Mango, Pineapple, Passionfruit, Sri Lankan native Tangerine, and Sweet orange). The sensory evaluation (appearance, aroma, texture, taste, thickness, mouthfeel) was performed by trained panelists. The final formulation contained 40% cheese whey, 40% pumpkin juice, 10% fruit juice, 5% sugar, and a permitted stabilizer. Based on the overall acceptance, the mango flavored probiotic beverage was selected as the best to continue with further analysis (proximate composition, antimicrobial and antioxidant potentials, dietary fiber followed by an extended shelf life study). The study revealed that cheese whey which is considered an environmental pollutant can be turned into a highly nutritious functional beverage with additional health benefits.

Physico-chemical, nutritional, antioxidant and sensory properties of Canistel Fruit (*Pouteria campechiana*) incorporated beverage

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Abstract

Canistel Fruit (*Pouteria campechiana*) is an underutilized nutritious tropical fruit containing vitamin A and complex carbohydrates with a potential to attract consumer preference in Sri Lankan market. Present study has focused on the development of a novel fruit-basedbeverage incorporating canistel fruit. Starchiness of the fruit in beverage was remedied through α-amylase enzyme treatment by reducing complex carbohydrates into simple sugars.The base formula was prepared with the use of Canistel fruit pulp and coconut milk in the ratios of (4:8, 4:6 and 4:4 w/w) followed by incorporating sugar and stabilizers. The two- way preservation techniques of pasteurization (85 °C,15 min) and sterilizing techniques (110 °C,10 min) were used. Each sensory accepted formula of beverages from two techniques were analyzed for the physical properties, proximate composition, mineral content, vitamin content, fatty acid composition and antioxidants. The physical properties of pH, °Brix, viscosity, titratable acidity, water activity, specific gravity and color (L*A*B*) were (4.96±0.02; 5.68 ± 0.01), (6.96±0.12; 11.67±0.12), (459.0±2.5; 669.7±2.3 cP), (0.007±0.01;0.003±0.00%), (0.99±0.00;0.99±0.00), (0.95±0.00;0.95±0.00) and (30.65±0.39, 2.47±0.02, 15.45±0.13; 30.87±0.20, 4.46±0.09,12.79±0.17) respectively in pasteurized and sterilized beverage. A significant difference ($p<0.05$) was shown among pH, °Brix, viscosity and titratable acidity. Chemical parameters of moisture, total ash, crude fat, crude protein, crude fiber, and total sugars were (90.25±0.03; 86.19±0.02%), (0.35±0.03; 0.31±0.02%), (2.18±0.13; 2.29±0.30%), (0.51±0.09; 0.77±0.13%), (0.23±0.04; 1.50±0.25%), and (7.69±0.06; 10.83±0. 25%) respectively. There was a significant difference ($p<0.05$) observed between total sugars, crude protein and crude fiber of two treatments. The predominant fatty acid of Lauric acid (52.12 ± 0.55; 51.72±0.06%) was present in both beverages. The mineral contents (mg/kg) of sodium, potassium, calcium, and magnesium in pasteurized and sterilized beverages were (222±14.83; 181±10.56), (835±11.55; 855±9.11), (163±8.02; 198±7.56) and (83.4±5.31; 64.7±4.34) while vitamin A (mg/kg) (0.3±0.01, 0.2±0.01) respectively. The total phenolic content (TPC) and total flavonoid content (TFC) were (2.80±0.22; 1.71±0.19; 1.19±0.05 mg GAE/g) and (1.51±0.07; 0.89±0.01; 0.59±0.02 mgQE/g), for canistel fruit, pasteurized and sterilized beverages respectively in fresh weight basis. The present study showed a potential use for canistel fruit for consumption among the public in recognition of its nutritional value.

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Development of Adamant creeper (*Cissus quandrangularis* Linn.) incorporated crackers and evaluation of chemical and bio-active properties

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Abstract

The Adamant creeper (*Cissus quadrangularis* Linn.), known as "Heeressa" in Sinhala and "Pirandai" in Tamil, is a versatile medicinal plant with a history steeped in traditional remedies. This valuable plant is underutilized in Sri Lanka. Therefore, present study aimed to explore the food applications of Adamant Creeper Stem Powder (ACSP) and to harness the potential of developing crackers with the ACSP. The ACSP was collected from Kilinochchi district, Sri Lanka. Stems were cleaned, dried, powdered (0.25 mm particle size) and used for formulating the cracker. The cracker was prepared using margarine, water, baking powder, sugar, salt, garlic powder, ACSP with wheat flour and finger millet flour in different ratios. Crackers were baked in the oven at 180 °C for 10 minutes and analyzed for proximate composition, antioxidants and sensory evaluation. The crackers developed without ACSP were used as the control. Based on the results of the sensory evaluation, 7% ACSP with wheat flour was selected as the best cracker. The percentages of moisture, total ash, crude protein, crude fat, crude fiber and available carbohydrate in the composite crackers were 4.4±0.0, 7.8±0.2, 15.7±0.9, 15.4±0.3, 2.2±0.8, and 54.7±0.8 respectively. Percentages of moisture, total ash, crude protein, crude fat, crude fiber and available carbohydrate determined in the control crackers were 2.7±0.2, 4.3±0.0, 13.1±0.9, 14.2±0.2, 0.4±0.1 and 65.1±0.8 respectively. Both composite and control crackers exhibited similar water activity levels (0.4±0.01), however, there was a difference in the pH values (composite cracker, 8.5±0.2; control cracker, 6.2±0.2). The present study revealed that the composite crackers exhibited enriched nutritional content, showcasing elevated levels of potassium (1.7%), phosphorus (0.4%), and calcium (0.7%) compared to the control crackers. In addition, the total phenol content in the composite and control crackers were found to be 54.2±2.9 mg gallic acid equivalents (GAE)/g of dry matter and 49.0±1.4 mg GAE/g of dry matter respectively. Total flavonoid content in composite and control crackers were found to be 59.5±4.6 mg catechin acid equivalents (CAE)/g of dry matter and 30.8±0.2 mg CAE/g of dry matter respectively. The incorporation of ACSP enhanced the nutritional properties of the composite crackers compared to the control crackers. In conclusion, present study highlights the potential of ACSP as a valuable dietary inclusion in the form of composite crackers, showcasing its potential in offering health benefits.

Asparagus racemosus Willd instant porridge: Supplementary food development for diabetes mellitus patients

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Abstract

Herbal porridge is a nutritious, semi-solid breakfast meal that is usually consumed in Sri Lanka. *Asparagus racemosus* Willd (Family: Asparagaceae) has a wide range of therapeutic applications. The tuberous root of *A. racemosus* has been used to treat diabetes mellitus which is proven by animal studies. Herbal porridge with leaves of *A. racemosus* is available in the market while porridge with tuberous root is not common. Therefore, the aim of this study was the formulation, proximate composition analysis and shelf life study of an instant herbal porridge mixture prepared from the tuberous root of *A. racemosus*. The porridge mixture contained *A. racemosus* root powder, roasted red rice flour, coconut milk powder, garlic, onion, ginger, pepper and salt. All the ingredients were processed in the laboratory except coconut milk powder and salt which were purchased as raw materials. *A. racemosus* root, garlic, onion, ginger, and pepper were dehydrated at 50 °C and ground into a fine powder (<0.5 mm). Proximate analysis revealed that percentages of moisture, total ash, crude fiber, crude protein, crude fat and total carbohydrate in the porridge mixture were 7.8 ± 0.1 (w/w), 5.8 ± 0.0 (w/w), 4.1± 0.3 (w/w), 1.2 ± 0.0 (w/w), 5.6 ± 0.1 and 75.7 (w/w) respectively. The water activity of the dry sample of porridge mixture was 0.470 ± 0.002 and the pH of the porridge sample prepared by adding boiling water was 5.88 ± 0.04. Appearance, color, odor, taste and mouth-feel of the product were accepted by the screened and trained sensory panel of the Industrial Technology Institute. The shelf life of porridge was evaluated as eight months at 28 ± 2 °C.

Utilization of *Pentadesma butyracea* (African Butter Tree) butter for the development of nutrient-rich biscuits

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Abstract

Pentadesma butyracea (African butter tree) is an oilseed crop valued for its nutritious solid edible fat. High amount of oleic acid (53.1%), stearic acid (38.4%) and low amount of palmitic and linoleic acids present in the butter show that it is highly nutritive and oxidatively stable. It is enriched with stigmasterol (~45% of total sterol). Due to the unawareness, this tree remains underutilized and its applications are still not explored in Sri Lanka. This study aimed to explore the food applications of *Pentadesma* butter and to determine antioxidants, proximate composition, and physico-chemical properties of *Pentadesma* butter biscuit (composite biscuit). The biscuits were composed of flour, sugar, baking powder, and salt along with two types of butter (*Pentadesma* butter and normal butter), considering normal butter serving as the control. The moisture, total ash, crude fat, crude protein, crude fiber and carbohydrates of the control biscuit were 4.1±0.1%, 1.5±0.03%, 11.3±0.6%, 10.4±0.3%, 0.9±0.03% and 75.9±0.04% respectively while the values of the composite biscuit were 4.4±0.01%, 2.0±0.08%, 17.7±0.6%, 8.4±0.3%, 0.9±0.02% and 70.9±0.1% respectively. Both composite and control biscuits exhibited similar water activity levels (0.4±0.0), while there was a slight difference in pH values (composite biscuit: 6.5±0.01; control biscuit: 5.9±0.02). The ascorbic acid content was marginally low in the control biscuit (1.3±0.1) compared to the composite biscuit (1.6±0.03). The control and the composite biscuits contained total sugar (7.6±0.0 and 8.5±0.0) and reducing sugar (0.3±0.0 and 0.2±0.0) respectively. The total phenolic content and the total flavonoid content of the control and the composite biscuits were 53.3 mg gallic acid equivalent (GAE)/g, 67.5 mg GAE/g and 22.2 mg quercetin equivalent (QE)/g, 24.4 mg QE/g respectively. Sensory evaluation was conducted on both biscuits. The paired comparison test, using a 9-point hedonic scale, indicated a significant difference ($p<0.05$) in overall acceptability between the control and the composite biscuits. Composite biscuits were highly accepted by the panelists due to their specific aroma, flavor, color and taste and had higher levels of crude fat, crude protein, and total ash compared to the control. In conclusion, *Pentadesma* butter biscuits are highly nutritious particularly owingto their beneficial fats.

Development of Mella (*Olax zeylanica* Wall.) and Erabadu (*Erythrina variegate* Murr.) incorporated Cranberry flavored green tea blend and evaluation of its quality parameters

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Abstract

Green tea has gained popularity among consumers due to the belief in its numerous health benefits, attributed to its high levels of antioxidants and bioactive compounds. This study aimed to develop a green tea blend using a combination of supporting and activating herbs, namely Erabadu leaf and Mella leaf. The leaves of Erabadu and Mella were subjected to standard steam blanching, following the Japanese method used for production of common green tea. The resulting green tea blend was further flavored with cranberry granules and was packed into dip tea bags. The green tea blend was then analyzed for proximate composition, total polyphenol content (TPC), total flavonoid content (TFC), total caffeine content, 2,2-diphenyl-2-picrylhydrazyl (DPPH) scavenging activity and organoleptic characteristics using standard methods. The results revealed that percentages of moisture, total ash and crude fiber in the green tea blend were 4.5± 2.2, 7.0 ± 3.5 and 5.2 ± 2.6 respectively. The brew of the green tea blend depicted a pH of 6.04±2.01. The results revealed that total polyphenol, total flavonoid and caffeine contents in brew of the green tea blend contained 0.64 ± 0.01 mg gallic acid equivalents/ml, 0.12 ± 0.00 mg quercetin/ml and 40±0.02 mg/200 ml respectively. In addition, brew of the green tea blend revealed potent DPPH radical scavenging activity. The organoleptic evaluation indicated that the Erabadu and Mella-based green tea blend had good overall acceptability. In conclusion, green tea blend which consists of green tea (Fanning), erabadu, mella leaves, and cranberry flavor possesses potential antioxidant activity and it can serve as an alternative to commercial tea (*Camellia sinensis* L.), with various health benefits.

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Microbiological risk assessment of commercially available selected skin care products in Sri Lanka

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Abstract

Microbiological contamination of cosmetic products may cause spoilage of products and pathogenic contaminants may cause serious health issues for consumers. Present study mainly focused on the assessment of microbiological quality of selected commonly used creams and lotions of different categories, namely sunscreen, fairness, baby cream, moisturizer and herbal products. Branded imported products, branded local products and locally available non-branded products were selected for the study. A total of 183 products from 61 different brands were collected from the market in five different provinces. These samples were subjected to quantitative analysis of aerobic mesophilic bacteria (AMB), yeasts and moulds (Y&M) and qualitative analysis of four pathogenic microorganisms according to the Sri Lanka Standard for skin creams and lotions. A comparatively higher number of samples were contaminated (56%) in the North Western province than the other provinces. None of the sunscreen and baby creams/lotions were detected as contaminated. Out of fairness and moisturizing creams, 35 % of the products were contaminated with at least one of the two parameters tested. Twelve percent of each of those two categories were contaminated with AMB and 23% were contaminated with Y&M. Seventeen per cent of the herbal creams/lotions were contaminated with AMB whereas Y&M contaminations were not observed in the particular category. Results confirmed that, out of 61 products, 12% was contaminated with AMB and 20% was contaminated with Y&M. Overall, 25% of the tested samples were contaminated at least with one of these two parameters. *Staphylococcus aureus* was detected in three moisturizer samples while *Escherichia coli* was confirmed in two fairness creams. *Pseudomonas aeruginosa* and *Candida albicans* were not detected in any of the tested samples. Overall, 8% of the tested samples were contaminated with at least one of the pathogenic microorganisms. Therefore, the present study highlights the intense need to follow applicable and approved preventive measures to avoid microbial contaminations during the production process and regulation of the quality of cosmetic products to ensure consumer safety.

Formulation and characterization of pharmaceutically improved antacid tablets from freeze-dried extracts of *Desmodium triflorum* L. DC and *Pogostemon heyneanus* Benth

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Abstract

Freeze-dried powders obtained from aqueous extracts of plant materials possess a significant drawback in herbal-based pharmaceutical formulations as they tend to absorb water vapors from the atmosphere. In the present study, the hygroscopicity of a mixture of freeze-dried powder consisting of *Desmodium triflorum* and *Pogostemon heyneanus* aqueous extracts was altered using colloidal silicon dioxide (CSD) as the desiccant. Different concentrations of CSD were employed to formulate antacid tablets along with other excipients such as magnesium stearate, carboxymethylcellulose and lactose 200. Then the moisture contents of these tablets were evaluated. The physical characterization of the formulated tablets was performed according to the methods described in British Pharmacopoeia (2016). The acid-neutralizing activity of the formulation was also determined by *in vitro* acid-neutralizing effect assay and Vatier's artificial stomach model. When analyzing the results, the moisture contents of test formulations with 1:50, 1:20 and 1:10 CSD to freeze-dried powder were found to be 12.5% (w/w), 6.2% (w/w), and 4.0% (w/w) respectively. Hence, a weight ratio of 1:10 of CSD to freeze-dried powder was determined as the minimum effective composition for the formulation. The hardness of the tablet formulated using that ratio was 6.25 ± 0.38 N; friability was 0.98% (w/w) and disintegration time was 3.15 minutes. The same antacid tablets demonstrated *in vitro* transient acid neutralization for a duration of 4.23 ± 0.45 minutes in Vatier's artificial stomach model, which was significant ($p<0.05$) with relative to the activity of the placebo tablet (1.91 ± 0.38 minutes). The study demonstrates the effective use of CSD to overcome the hygroscopicity barrier in the herbal based pharmaceutical formulations thus enhancing the stability of such preparations by manipulation of the physical characteristics.

Use of amplicon length polymorphism in species discrimination of *Curcuma*

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Abstract

Curcuma is an important genus used in traditional medicine. Ayurvedic and folklore medicine utilize *Curcuma* species due to their potential pharmacological activities, including antimicrobial, anti-inflammatory and chemo-preventive activity. *Curcuma domestica* Valeton (Turmeric) is used as a spice, medicine or in the cosmetic industry. The chemical composition of *Curcuma* has been widely studied. However, attempts at species discrimination of Sri Lankan *Curcuma* using molecular methods are less reported. Amplicon length polymorphism has been applied to identify medicinal plants with success. The present study reports the potential of using the amplicon length polymorphism of plant barcoding genes *ycf* and *rbcL* in species discrimination of *Curcuma* species. Fresh leaf samples were collected from Ampara (*Zingiber zerumbet* Linn.), Yakkalamulla (*Curcuma zedoaria* Roscoe) and Narammala (*C. domestica* MT 23 and MT 32) specis. Standard CTAB method with modifications was used for the extraction and purification. Extracted DNA was quantified and amplified using universal primers for *ycf* gene and *rbcL* gene in chloroplast genome by PCR. PCR products were analyzed in 1% Agarose gel. The rbcL primers amplified about a 600 bp sized segment for Curcuma wild relatives *C. zedoaria, Z. zerumbet*, and *C. domestica* MT 23 and MT 32. The ycf1b primers amplified *C. zedoaria* (≈ 900 bp), *C. domestica* MT 23 (≈ 900 bp) and MT 32 (≈ 900 bp). The PCR product separation on 2% agarose gels revealed different sized PCR products for ycf1b primers in *C. domestica* MT 23 and MT 32 (≈ 900 bp each). Due to the improved performance of the *ycf* (having the highest species resolution in most cases rather than in specific cases) over *rbcL* gene (*rbcL* giving limited success in higher plants) as a plant barcode, the work under this study has contributed to the identification of *C. zedoaria and Z. zerumbet* using barcoding primers. Further, the two *C. domestica* plants MT 23 and MT 32 were able to be differentiated based on the amplicon length polymorphism of ycf1b primers on 2% agarose gel. Based on the above, amplicon length polymorphism could be further used as a relatively inexpensive method of species discrimination of *Curcuma* species.

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Chemical profile and *in vitro* immunomodulatory activity of *Citrus aurantium* Linn. leaf extracts

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Abstract

Citrus aurantium L. which is known as sour orange is important in traditional medicine as an anti-inflammatory and antiseptic agent as well as in aromatherapy, to relieve anxiety andpain. The conventional method of hydro distillation (HD) is used to extract volatile oils from aromatic and medicinal plants. This study investigated the chemical composition, total phenolic content (TPC), total flavonoid content (TFC) and the immunomodulatory activity of ethanolic and Essential oils (EO) extracted from the leaves of *C. aurantium*. The bioactivities were evaluated by performing an enzyme assay of 5-lipoxygenase (5-LOX) inhibition. The nontoxic concentration of extracted EO was determined by Sulforhodamine B (SRB) assay and inhibition of LPS-induced Nitric Oxide (NO) production was assessed by Griess assay using rat macrophages (RAW 264.7) cell line. The EO was analyzed for its chemical compositions using Gas Chromatography-Mass Spectrometry (GC-MS) to identify the chemical components potentially responsible for bioactivities. EOs of C. aurantium leaves resulted in 0.53 ± 0.07 % extraction yield and D-Limonene (42.30%) was identified as the major compound from the total of 69 compounds followed by Sabinene (21.43%) and Citronellal (5.36%). TPC and TFC values for the ethanolic extract and EO were 28.83 ± 0.45 and 3.93 ± 0.81 mg Gallic acid equivalent (GAE)/g and 33.41 ± 2.66 and 2.90 ± 0.67 mg Quercetin equivalent (QE)/g respectively. Extracts were dose dose-dependently inhibited 5-lipoxygenase enzyme giving the IC_{50} values of 8.40 ± 0.25 and 6.97 ± 1.47 µg /mL for ethanolic extract and EO respectively, compared to the positive control baicalein IC50 value 1.76 ± 0.15 µg /mL. The IC50 value for the NO inhibition was 130 ± 52.45 µg /mL compared to positive control NMMA (NG-monomethyl-L-arginine) 2 mM for ethanolic extract. Extracts were not cytotoxic for the RAW 264.7 cells at concentrations ranging from 500 to 1000 µg /mL. These bioactive compounds, mainly D- Limonene is known to reduce the inflammatory mediators thus results support the possibility of the use of *C. aurantium* extracts in the management of pain and inflammation thereby used in the development of anti-inflammatory drugs and pain management products.

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In vitro anti-amylase and anti-glycation properties of *Justicia adhatoda* L. (Malabar nut) leaf extract

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Abstract

One of the most demanding research areas in the discipline of drug discovery is focused on the pharmacological activities of medicinal plants targeting their health aspects. The present study demonstrates the bio-activities of *Justicia adhatoda* L. grown in Sri Lanka to management of diabetes mellitus. Phytochemical constituents, anti-amylase, antiglycation and antioxidant activities were investigated in ethanolic leaf extract of *J. adhatoda* using standard protocols. Phytochemical screening of the ethanolic leaf extract reflects the presence of alkaloids, tannins, flavonoids, phenols and terpenoids. Anti-amylase activity of the ethanolic leaf extract of *J. adhatoda* showed 50% inhibitory concentration at 215.40 ± 3.82 µg/ml, while Acarbose, the standard antidiabetic drug, showed 50% inhibitory concentration at 140.62 ± 2.40 µg/ml under the same conditions. Moreover, the antiglycation activity of the ethanolic leaf extract of *J. adhatoda* exhibited 50 % inhibitory concentration at 58.47 ± 4.55 µg/ml, while the Rutin standard drug showed 50% inhibitory concentration at 21.88 ± 2.82 µg/ml. The results revealed that the total phenolic content (TPC) and total flavonoid content (TFC) were 0.23 ± 0.02 mg gallic acid equivalents/g and 0.05 ± 0.00 mg rutin equivalents/g respectively. The obtained results exhibited that *J. adhatoda* has moderate antiamylase and antiglycation activity with compared to the respective standard drugs. It is suggested that further studies are required to identify the correlation between the antidiabetic activity and total alkaloid content, which is recorded as the main bioactive component of *J. adhatoda*. In conclusion, *J. adhatoda* is a potent candidate in relation to the management of diabetes mellitus.

Antioxidant potential of fruit powders developed from selected underutilized fruit species in Sri Lanka

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Abstract

Underutilized fruits inherited in Sri Lanka, contain a myriad of health advantages, and have been recognized since prehistoric times. Nevertheless, due to lack of scientific evidence about the nutritional and functional benefits, those fruits were very rarely consumed by the general public. The present study was carried out to explore the relationship between some bioactive compounds and antioxidant potential of four individual underutilized fruit powdersprepared by heat pump-drying method and their mixture with equal ratios (1:1:1:1 w/w). Methanolic extracts of selected fruits of *Cynometra cauliflora* L. *(Naminam)*, *Manilkara zapota* L. *(Sapodilla)*, *Flacourtia indica* L. *(Uguressa)*, and *Elaeocarpus serratus* L. *(Veralu)*were used for the study. Results obtained from different antioxidant assays (n=3) of total polyphenolic content (TPC), total flavonoid content (TFC), ferric reducing antioxidant power(FRAP), 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging assay and oxygen radical absorbance capacity (ORAC) were statistically analysed through correlation and regression analysis. Among the studied fruit powders, Uguressa exhibited the highest antioxidant potential for TPC (8.95±0.25 mg GAE/g), TFC (8.75±0.01 mg QE/g), FRAP (51.39±0.20 mgTE/g), DPPH (21.65±2.82 mgTE/g IC50) and ORAC (15.58 ±3.30 mg TE/g). Fruit powder mixture (1:1:1:1) had the highest mean value of TPC (12.54 ± 0.32 mg GAE/g). Pearson correlation analysis of TPC and TFC values with ORAC and FRAP values was found to be statistically significant with a positive relationship ($p<0.05$). Further, the multiple regression analysis of FRAP value with TPC and TFC had significant positive impact ($p<0.05$, $R^2 = 0.894$). Similarly, the ORAC value was significantly regressed ($p<0.05$, $R^2 = 0.724$) on predicting variables of TPC and TFC of the tested four fruit powders and powder mixture. According to the pearson correlation analysis, TFC had significant impact in predicting antioxidant activity of FRAP value ($p<0.05$; $r= 0.917$). Uguressa with the highest TFC value showed the highest antioxidant activity. The study concluded that underutilized fruit species could be used as a source of natural antioxidants for the development of new food products and nutraceuticals.

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Determination of gamma oryzanol content in selected Sri Lankan traditional rice varieties to develop a value added product

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Abstract

Rice grain contains several functional compounds. Among these, gamma oryzanol is one of the most important compounds owing to its biological role in human physiology. The present study was conducted to quantify the gamma oryzanol content in ten Sri Lankan traditional rice varieties using the reverse phase High Performance Liquid Chromatography (HPLC) method. Results revealed that the highest value of gamma oryzanol content was detected in Ran kumudu el (64.66 ± 0.02 mg/100g) while the lowest was detected in Dik vee (6.28 ± 0.03 mg/100g). When the individual components of gamma oryzanol were considered, 24-methylenecycloartanyl ferulate had the highest mean percentage of 30% while Sitosteryl ferulate had the lowest mean percentage of 21%. (Statistical variance = 153.78). Six types of cookies were made by incorporating Ran kumudu el rice flour and baked for three different temperatures at three different time periods (120 °C for 40 minutes, 150 °C for 30 minutes and 180 °C for 15 minutes) using a regular oven and an air fryer. The results showed that there was no significant difference ($P > 0.05$) in the gamma oryzanol content when baking the cookies using a regular oven or an air fryer. However, there was a significant difference ($P < 0.05$) in the sensory properties of the cookies baked in regular oven over the air fryer. According to the sensory results, the best cookie type was the one baked at 180 °C for 15 minutes in the regular oven. The total acceptability of cookie baked at 180 °C for 15 minutes in the regular oven was 6.8 ± 1.01 while the total acceptability of cookie baked at 120 °C for 40 minutes was 1.8 ± 0.77. In conclusion, Ran kumudu el is more suitable to develop cookies due to the high content of gamma oryzanol and baking technique/s and condition/s affects the sensory acceptability of the cookies.

Investigation of Sri Lankan rice varieties as potential sources for the management of iron and zinc deficiencies

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Abstract

Sri Lankan rice (*Oryza sativa* L.) varieties have global recognition owing to the physico-chemical and nutritional composition of rice grains, which create health-promoting and functional properties. Most rice producers practice different pre and postharvest treatments to increase the grain yield, demand and preference of the consumers without considering the nutritional properties of rice grains which could fulfil the nutritional requirement of the growing population. These treatments will directly affect the mineral levels which are more beneficial for a healthy diet since rice is used as the staple food in Sri Lanka. Therefore, this study was conducted to investigate the levels of Fe and Zn in twenty-six rice varieties including traditional and newly improved varieties of Sri Lanka using an intra-laboratory validated test method. Results indicated that the concentration range of Fe and Zn in tested rice samples were 18.6 ±1.1 to 44.0 ±2.6 mg kg^{-1} and 20.2 ±1.0 to 33.8 ±1.6mg kg^{-1} respectively. Significantly higher concentration of Fe was found in both traditional and newly improved rice varieties which exceeded (ranging from 12 - 15 mg kg^{-1}) the rice line developed by the International Rice Research Institute (IRRI) for the milled rice grains. Furthermore, it is confirmed that traditional and newly improved rice varieties can be used without bio-fortification as iron-rich sources. The calculated estimated daily intake (EDI) for Fe ranged from 5.6 to 12.9 mg/kg/day and the EDI for Zn ranged from 5.9 to 9.9 mg/kg/day. When considering the minimum levels of recommended daily allowance (RDA) and EDI for Fe and Zn, consumption of analyzed rice varieties can be fulfilled at least 70.0% and 73.8% of the daily recommended levels for Fe and Zn respectively.

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Development of a rice flour-based reference material for nutrients and minerals

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Abstract

Analysis of a reference material and participation in proficiency testing is a key requirement for testing and calibration laboratories as per the ISO 17025:2017. Simultaneous analysis of the reference material along with the samples helps to assure the accuracy of test results. The objective of this study was to prepare a rice flour-based reference material for cereal matrix, using a traditional rice variety "Madathawalu" as a candidate material and determine its homogeneity and stability. The international guidelines ISO 17034:2016, ISO 13528:2015, and the International Harmonized Protocol for the Proficiency Testing of Chemical Analytical Laboratories were followed throughout the preparation of the reference material and for the laboratory performance study. The raw rice sample was pulverized with a mill to pass through a 500 μm screen and packed in sealed plastic containers followed by nitrogen gas insertion. Moisture, ash, crude protein, crude fat, crude fiber, phosphorous, potassium, magnesium, calcium, sodium, copper, iron, and zinc contents of randomly selected rice flour samples were analyzed to study the homogeneity and stability. Moisture content wasanalyzed by oven drying method at 130±2 ^{o}C for two hours. Ash content was determined bydry ashing method at 550 ^{o}C for three hours. Crude protein content was determined by the Kjeldahl method. The diethyl ether extraction method was used to determine the crude fat content while acid base hydrolysis followed by fibertec system was used for the crude fiber determination. Phosphorous content of the sample was determined by following vanda-molybdo spectrophotometry using UV-visible spectrophotometer at 420 nm wavelength. Potassium content was determined using the flame photometry while magnesium, calcium, sodium, copper, iron, and zinc contents were determined by ICP-MS after microwave digestion of the samples. Sufficiently homogenized samples were used for the stability testing. Nutrients and minerals of samples were analyzed once in every two weeks for a period of 20 weeks. The significance of analytical and sampling variance with the time was analyzed using one-way ANOVA test at 95% confidence level. The mean ± SD of moisture, ash, crude protein, crude fat, crude fiber, phosphorous, potassium, magnesium, calcium, sodium, copper, iron, and zinc contents were 7.8±0.4%, 1.5±0.0%, 8.2±0.7%, 3.1±0.3%, 1.3±0.1%, 0.33±0.02%, 0.22±0.02%, 514.49±35.33 mg kg^{-1}, 132.23±9.65 mg kg^{-1},4.06±0.48 mg kg^{-1}, 2.66±0.35 mg kg^{-1},27.48±1.80 mg kg^{-1} and 34.14±2.30 mg kg^{-1} respectively. No significant difference was observed in the variation of samples with the time during the tested period ($p>0.05$). The prepared rice flour reference material was stable for 20 weeks. The stability analysis to be carried out continuously and stability would be analyzed using different packaging materials.

Comparison of volatile compounds identified by two different techniques in virgin coconut oil

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Abstract

Coconut oil represents the main source of edible oil used in Sri Lanka. Among the coconut oil types available in the country, virgin coconut oil (VCO) is the most immerging oil type due to its aroma and health benefits. Therefore, efforts were made to identify the constituents in the VCO via two different techniques; Headspace Gas Chromatography-Mass Spectrometry (HS-GC-MS) and Headspace Solid-phase Microextraction Gas Chromatography-Mass Spectrometry (HS-SPME-GC-MS) methods, enabling to select the most effective profile for identifying volatile content. Virgin coconut oil was prepared under laboratory conditions using 11 to 12 months (harvested after nut set) matured coconuts obtained from the Coconut Research Institute, Sri Lanka. The VCO was extracted from coconut meat without tesla, dried at 58±2 ^{o}C and expelled via a hand extruder. The volatile profile of the VCO was examined by the HS-GC-MS method and the HS-SPME-GC-MS method separately. The δ-Caprolactone, δ-Octalactonone, δ-Dealactone, Oxime-methoxy-phenyl, 2-Hepatone, and 2-Pentanone were identified by the HS-SPME-GC-MS method while only δ-Caprolactone and δ-Octalactonone were identified by HS GC-MS method. The SPME contained divinylbenzene / carboxen / polydimethyl siloxane coated fiber which is suitable to analyze more hydrophilic compounds. During the sampling headspace, volatile chemical compounds are bound to the SPME fiber by Vander Waal bonds and the entire sample was thermally desorbed to the GC inlet for the separation. However, in the HS-GC-MS method volatile headspace compounds collected into the syringe were directly injected into the GC for separation. SPME method has the capability to identify a greater number of compounds at low concentration levels as low as below 2 ppm. In conclusion, the HS-SPME-GC-MS method is more effective in the identification of volatile compounds in coconut oil.

Microwave-assisted hydro-distillation of essential oil from *Piper betle* L. leaf and quantification of safrole

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Abstract

Piper betle L. commonly known as betel vine is an economically significant medicinal plant belongs to the family Piperaceae. It is traditionally chewed in Southeast Asian countries. While widely cultivated in Southeast Asia, its chemical profile varies across regions leading to variations in the aroma and taste, primarily due to its essential oil constituent and other properties. In Chinese and Indian folk medicine, betel oil is used as a carminative, stimulant, and astringent against parasitic worms, conjunctivitis, and rheumatism. The present study focused on the extraction of betel essential oil using two different extraction techniques and quantifying the Safrole content which contributes to health risks. Essential oils (EOs) were extracted from *P.betle* leaves using microwave-assisted hydro-distillation (MAHD) and conventional hydro-distillation (HD) techniques. The EOs extracted from MAHD were compared with those of conventional HD regarding extraction time, extraction efficiency, and chemical composition. The EO was analyzed for its chemical compositions using Gas Chromatography-Mass spectrometry (GC-MS) to identify the chemical components. The volatile oil content of betel leaves was recorded at 0.114±0.002% for HD and 0.108±0.004% for MAHD. Even though the yield of MAHD is low, considering the lesser extraction time, the MAHD method is more efficient than HD. EOs of *P. betle* leaves contain Safrole as the major compound comprising 39.25% in HD and 52.18% in MAHD, with Eugenol and Eugenyl acetate, present at 14.27%, 6.27%, 5.98% and 14.24%, respectively. The EOs from HD and MAHD contain Safrole contents of 241.64 mg/ml and 217.29 mg/ml, respectively. These levels exceed the recommended Safrole content in food items, which is 0.02 mg/ml. Further research is required to evaluate the volatile oil profiles of Sri Lankan betel varieties, considering their geographical distribution, for a comprehensive understanding of the composition.

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The need for regulations to limit micro-plastics in compost in Sri Lanka

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Abstract

Microplastic (MP) in soil negatively alters the soil structure physically, chemically and biologically. The MP in compost has recently been identified as a pathway to introduce toxic trace metals and toxic organic contaminants to agricultural soils and thereby to the food chains. It is estimated that between 63,000-430,000 tons of MPs are added to the farmlands intentionally and unintentionally each year in Europe and 10% of the plastics found in agricultural lands is from compost. Compost is a neglected source of MP in soils, although MP addition to soil by littering has overridden the MP accumulation due to compost application. However, restriction of MP addition by littering or agricultural aids like plastic mulching is practically easier as immediate policies on those sources can directly mitigate the issue. The greatest risk of MP accumulation therefore retains in the neglected and indirect MP addition sources like compost. The positive effects on soil by applying compost automatically cause detrimental toxicity and soil infertility due to this hidden MP addition. More importantly, compost originating from municipal solid waste is believed to have a considerable amount of MP because of the malpractices in waste disposal and inefficiencies of composting raw material source segregations. Despite the requirement of immediate actions against the spreading of MP in compost, there is only one study that reveals the presence of MP in compost in Sri Lanka. Worldwide, the research in the area is emerging and MP in compost is limited by including MP in foreign matter of size >2 mm. Even Germany, being one of the countries with the strictest fertilizer regulations, allows foreign matter up to 0.4% of weight inclusive of MP and 1% of it is allowed to be non-degradable synthetic polymers. Therefore, there is a need to implement stricter policies and regulations to limit MP addition with compost, considering the hidden risk of MP spread and accumulation within soils with compost.

Chemical and physical quality of liquid organic fertilizer in Sri Lanka

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Abstract

The government of Sri Lanka encourages the production of liquid organic fertilizer (LOF) as it is considered a solution for recycling organic waste and reducing the use of chemical fertilizer for crop cultivation. As per the Sri Lanka Standard (SLS) 1702:2021 (specification for LOF), no baseline studies were carried out to evaluate the quality of LOFs in terms of chemical and physical requirements. Hence, commercially available LOF samples (n=30) were collected from randomly selected sellers in Sri Lanka and quantified the total nitrogen (N), phosphorous (as P_2O_5), potassium content (as K_2O), the sum of total primary nutrients ($N+P_2O_5+K_2O$), organic carbon content, pH and electrical conductivity (EC) to evaluate the quality of LOFs. Analysis of the above parameters of LOF samples was done as per the analytical methods given in SLS 1702:2021. The total N content of the analysed samples was varied from 0.2% to 23.4%. The total P_2O_5 content of the tested samples was varied from 0.01% to 12.0 %. The total K_2O content of analysed samples was varied from 0.05% to 44.0%. The total primary nutrients ($N+P_2O_5+K_2O$) of liquid fertilizer samples were varied from 0.01% to 60.1%. The organic carbon content of analysed samples was varied from 0.5% to 26.2 %. The pH of the tested LOF samples varied from 2.2 to 9.4. In tested LOF samples, the EC was varied from 1.10 to 56.6 dS/m. As per the SLS 1702:2021, the minimum N, P_2O_5, K_2O, total primary nutrients ($N+P_2O_5+K_2O$), and organic carbon of liquid fertilizer should be 1.0%, 0.5%, 0.5%, 2.0%, and 5.0% respectively. The requirement of pH and EC of LOF as per the SLS 1702:2021 was 6 to 8.5 and 20 dS/m (maximum) respectively. However, from the tested samples, 40%, 63.3%, 33.3%, 50.0%, 60.0%, 26.7%, and 36.7% did not comply with the SLS specifications for N, P_2O_5, K_2O, $N+P_2O_5+K_2O$, organic carbon, pH, and EC respectively. According to the findings, four samples did not contain N, P_2O_5, K_2O, or organic carbon. Overall, the N, P_2O_5, and K_2O, levels of the LOFs were significantly lower than that of chemical fertilizer and compost. As LOF contains nutrients in minute levels, it seems that LOF alone cannot cater to the demand for fertilizer requirement in mass-scale agriculture. In conclusion, it is essential to educate the LOF manufacturers about the chemicaland physical requirements of LOF. Since a significant percentage of LOF samples do not comply with the SLS specifications, it is vital to establish a regulatory mechanism to controlthe quality of LOF and develop a protocol for pricing LOF based on nutritional quality to prevent both misleading of end users and shortage in the harvest.

Overcoming challenges associated with matrix effect in electrospray ionization and tandem mass spectrometry

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Abstract

Liquid Chromatography-Tandem Mass Spectrometry (LC-MS-MS) is the preferred technique for quantifying thermally labile food and environmental contaminants in residue levels. Electrospray ionization (ESI) is the most widely used ionization method. The matrix effect (ME) is one of the challenges of the ESI technique, and the analyte signal can either be enhanced or suppressed. Matrix components co-extracted with the analytes cause signal suppression. There are several ways in which the ME can be overcome at different stages of the analytical process. This study evaluated dilution, the adaptation of analyte selective interference removal procedures, and the use of different modes in the ESI procedure. The analysis of aflatoxins was conducted in the positive mode of ESI, and solid phase extraction (SPE) and immune affinity cleanup (IAC) were used to reduce the co-eluants in the final extract. Chillie samples were spiked at 0.1 µg kg^{-1} of aflatoxins, and the analytes were extracted to acidify acetonitrile from spiked samples along with a blank control. The impurity removal was conducted using both SPE and IAC methods separately for the previously prepared sample extract, and the detection was done by LC-MS-MS. Chloramphenicol is a veterinary antibiotic that can be analyzed in both positive and negative ion modes. Therefore, a fish sample was spiked at 2.0 µg kg^{-1} of chloramphenicol, and the analyte was extracted using the QuEChERS extraction method, followed by dispersive solid phase cleanup with C18 from both blank and fortified samples. The purified samples were separated into two portions, and one set was further diluted with acetonitrile, then undiluted and diluted sets were injected into the LC-MS-MS. The spike recoveries of all aflatoxins in IAC demonstrated a 30% enhancement to the recoveries of the SPE method due to fewer signal suppression co-eluants presented in the final extract. Further, 5% and 10% increments of spike recoveries were observed in diluted samples compared to the undiluted samples in the negative and the positive ionization modes for chloramphenicol, respectively. Moreover, more than 75% enhancement of the recovery was observed by changing the ionization mode from positive to negative in chloramphenicol analysis with and without dilution. This enhancement indicates less competition for ionization in the negative mode compared to the positive mode. Therefore, dilution, adaptation of analyte selective interference removal procedures, and the use of negative ion mode for deprotonizable molecules in ESI can be successfully used to reduce the matrix effect in electrospray ionization used in LC-MS-MS.

Single laboratory validation of the method for analysis of Aroclors 1242, 1254, and 1260 in transformer oil using gas chromatography- electron capture detection

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Abstract

Polychlorinated biphenyls (PCBs) are a group of anthropogenic industrial chemicals, which are commercially available as Aroclors. The production and the use of PCBs are restricted and regulated under the Stockholm Convention on persistent organic pollutants (POPs), due to their adverse health effect on humans and animals. The study presents the validation of the method, developed for analysis of Aroclors 1242, 1254, and 1260 in transformer oil. The analysis was developed based on the ASTM D 4059 with few modifications. A matrix-matched calibration with an internal standard was used to compensate for the matrix suppression in transformer oil compared to the calibrators prepared in solvents. Therefore, transformer oil samples and certified reference standards in transformer oil were extracted using 2,2,4-trimethyl pentane; and subsequently, purified with deactivated florisil. The Aroclors were identified and quantified using Gas Chromatography with HP 5 (5% phenylmethyl siloxane) (30 m × 0.32 mm × 0.25 µm) capillary column with Electron Capture Detection (GC-ECD). The fitness of the method for quantifying individual Aroclors was evaluated by performing the method validation at three levels covering the working range following the EURACHEM guidelines, and the performance was evaluated by AOAC guidelines. Method accuracy was verified by monitoring the spike recoveries at 20 mg kg^{-1}, 45 mg kg^{-1}, and 90 mg kg^{-1}, and the recoveries were within the acceptable range of 80% – 110%. Further, the method demonstrated a linear response over a broad working range from 5 mg kg^{-1} to 100 mg kg^{-1}. The method also displayed repeatability and reproducibility with a percentage relative standard deviation below 5.3% throughout the entire working range. Further, with a low quantification limit (LOQ) at 5 mg kg^{-1}, the method enabled the susceptible trace level detection of Aroclors in transformer oils. The selectivity of the method was assured by employing non-overlapping characterized peaks for each set of Aroclor mixtures of 1242, 1254, and 1260. Therefore, based on the satisfactory performance characteristic parameters, the validated method can be recommended as a precise and accurate method to assess the distinguished presence of Aroclor 1242, Aroclor 1254, and Aroclor 1260 in transformer oil.

Evaluating the sugar profile in Sri Lankan made black tea using a validated HPLC method

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Abstract

Black tea (*Camellia sinensis* L.) is one of the main export-based agricultural products in Sri Lanka. Therefore, it is vital to ensure and maintain the chemical and microbiological quality of black tea in both export and local markets. Recently, the purity of black tea was affected by the adulteration of added sugars. As a result, the Sri Lanka Tea Board has introduced maximum permissible levels for sucrose, glucose and fructose in low-grown black tea as 19 mg/g, 16 mg/g and 14 mg/g respectively. Therefore, this study aimed to evaluate the sugar profile in ready-to-export low-grown factory black tea samples and different brands of black tea samples collected from local market using a developed and validated High-Performance Liquid Chromatography refractive index detector (RID) method. The sample preparation was done by solvent extraction, and the chromatographic separation was performed by acetonitrile and deionized (DI) water (78:22, v/v) as the mobile phase on a NH2, 5 µm column (250 mm × 4.6 mm). The validation of the method was done according to the Eurachem and AOAC guidelines using analytical grade standards. The analysis time was less than 20 minutes and the calibration curves showed good linearity over the concentration range of 100-2000 mg/kg for Sucrose, 0.2-250 mg/kg for Fructose and 1.2-400 mg/kg for Glucose. The limit of detection and limit of quantification value for all three sugars were 0.05 mg/g, and 0.06 mg/g respectively. The linearity of sucrose, glucose and fructose were found to be very high with a regression coefficient of 0.9997. Accuracy as the percentage of spiked recovery for sucrose, glucose and fructose were between 93.8-110.0%, 103.2-104.6% and 91.2-107.3% respectively corresponding to the spiked levels of 25 mg/kg to 500 mg/kg. The precision calculated in terms of repeatability and reproducibility of the method was lower than 5.4%, 4.6% and 4.5%, when expressed as relative standard deviation (%RSD) for tested sugars. The percentage expanded uncertainty which was calculated with the coverage factor of 2 (k=2) was 3.2. The developed method was simple, accurate, precise and sufficiently sensitive for the simultaneous quantification of black tea samples. According to the statistical analysis, there was a significant difference of glucose content between local market samples and factory samples ($p<0.05$, n= 20). It was observed that 30% of the market samples containing different brands were exceeding the correspondence values given by the Tea Board guidelines. In the same manner 20% of low grown factory samples were found more than the maximum permissible levels of the sugars.

Microbial community of Beira lake in Colombo City

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Abstract

Beira Lake, an artificial shallow water body in Colombo, Sri Lanka, serves the dual purpose of flood control and reception of waste water. Due to unauthorized urbanization and inadequate sewerage infrastructure development in Colombo, Beira lake has become contaminated with various alien organisms. The present study aims to assess the extent of microbial contamination and identify the diverse bacteria and green algae inhabiting the lake. Sediment samples were collected from the bottom of the Beira lake using a sediment sampler. These samples were analyzed using culture-based methods to detect and identify indicator microorganisms, pathogenic species, blue-green algae and green algae. The results revealed the presence of coliforms, *Escherichia coli,* sulphite-reducing clostridia, and *Enterococci Spp.* Coliforms were consistently found at levels exceeding 110 MPN g^{-1} in all samples and *Enterobacteriaceae* ranged from 6.3 x 102 to 5.2 x 104 CFU g^{-1}. However, *Salmonella* spp. and *Staphylococcus aureus* were not detected in any of the tested samples. Various *Bacillus* species (*B. cereus, B. amyloliquefaciens, B. siamensis, B. xiamenensis, B. altitudinis, B. subtilis, B. megaterium*), *Citrobacter freundii* and *Proteus mirabilis* were identified in the collected sediment samples. The presence of *Escherichia coli* indicated recent fecal contamination and identified species, including *Escherichia coli*, *B. cereus, Proteus mirabilis* and *Enterococcus* spp. which are potential human pathogens. Sulfite-reducing microorganisms are capable of reducing various oxidized inorganic sulfur compounds. *Bacillus amyloliquefaciens* is a non-pathogenic soil bacterium, while *B. subtilis*, although non-pathogenic can potentially contaminate food and pose a risk to immuno-compromised individuals. Additionally, *Bacillus* species are capable of producing endospores. Cyanobacteria (blue-green algae) belonging to the genera *Microcystis, Oscillatoria* and *Nostoc* also were detected. *Chlorophytes* (green algae) such as *Scenedesmus, Cladophora, Planktosphaeria, Chlorella, Pediastum* and *Chlamidomonas,* as well as *Spirogyra* from the Charophyta group (green algae) were also identified. *Cyanobacteria* and green algae are naturally occurring in nutrient-rich aquatic environments and can have both beneficial and harmful effects on ecosystems. Microorganisms remain dormant within the sludge and when released into surrounding water bodies can lead to algal blooms. In conclusion, several identified organisms have the potential to be harmful to humans if they come into contact with water and agricultural food sources. Therefore, precautions should be taken to prevent their leaching into bathing water sources.

Influence of moisture, iron, and aluminum contents in soil on sorption behavior of Glyphosate in selected soils of Sri Lanka

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Abstract

The persistence of glyphosate [N-(phosphanomethyl)glycine] in the environment depends primarily on adsorption (ADS) and desorption (DES) to the soil by reducing its availability for plant uptake and microbial degradation limiting its leaching and runoff to surface and ground waters. Therefore, understanding the ADS mechanisms of glyphosate on soil is essential for assessing its environmental impact and risk. In this study, five soil samples (two from red-yellow podzolic, one from reddish brown latasol and two from alluvial) were collected by composite sampling, covering soil groups found in Colombo and Kandydistricts, Sri Lanka. The analysis of soil pH, moisture, iron, and aluminium content was conducted before the ADS and DES studies. The residual glyphosate content was analyzed by liquid chromatography-tandem mass spectrometry. Both alluvial soil samples demonstrated an ADS greater than 99% and DES less than 0.2%, while a 97% ADS was observed in the sample taken from the reddish brown latasol soil with a DES of 0.3%. Further,85% and 81% ADS and 6% and 15% DES, respectively, were observed with red yellow podzolic soils. However, a significant difference was not observed ($p>0.05$) among the threesamples having the highest ADS and the lowest DES with different moisture percentages (49%, 44%, and 16%). However, a significant difference ($p<0.05$) in ADS and DES was observed with aluminium content (3.6, 2.5, 1.2, 0.8, and 0.4 mg kg^{-1}) of samples. Among theanalyzed samples, the highest ADS and the lowest DES percentages were demonstrated by the samples containing higher aluminium content. Further, it was observed that a decline in DES occurred when the soil's iron and aluminium contents were higher. Therefore, it can beconcluded that the ADS of glyphosate in the soil increases along with the iron and aluminiumcontents present in the soil. In contrast, the DES of glyphosate to the water in contact with thesoil behaves oppositely.

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A validation of a liquid toilet soap as per SLS 1142:2009 and consumer satisfaction survey on liquid toilet soap vs hand wash

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Abstract

Soap is a salt of sodium or potassium fatty acids which is produced from the hydrolysis of vegetable or animal fats resulting in the chemical reaction called saponification. Among the many types of soaps available in the market, liquid toilet soap (LTS) is a personal wash product which soap is liquid base. The aim of this study was to formulate a LTS and validate as per the SLS 1142:2009 and compare the consumer satisfaction of the soap with an anionic hand wash. Three different LTS formulations were prepared in the laboratory and stability such as layer separation, physical qualities, skin feeling and other rheological properties were observed. The most suitable formulation from the preliminary observations after several trials, was selected for the validation and it showed 23.5% of total fatty matter (TFM), 1.6% of matter insoluble in ethanol, 0.03% of total free alkali and a pH value of 8.0. The above results complied with all the requirements of SLS 1142:2009. Further, the formulation which incorporates with 85% of coconut oil, 10% of lanolin, 5% of beeswax can be accepted as a liquid toilet soap. It has many advantages over the conventional synthetic surfactant-based hand wash and body wash out of which, is TFM enrichment in the product that can be effectively used in all skin types especially for dry skin. Further, the present formulation is environmentally friendly due to the absence of synthetic surfactants and also, can bemarketed at a lower price than the synthetic surfactant products. In addition, perception of the soap was evaluated through a preliminary survey on consumer satisfaction using a Googleform which also indicated that the liquid soap had higher consumer satisfaction compared tosynthetic surfactants.

Development of a bathing bar as per SLS 1220:2016 and preliminary evaluation of consumer satisfaction

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Abstract

Among the cleaning products, soaps play an essential role in our day today life as they are used for cleansing and moisturizing properties. Bath soaps are prepared to clean the body and are also known as bathing bars which help to remove dirt and dust from the skin. The aim of the study was to provide the consumer with a cost-effective and quality bathing bar complying with the SLS 1220: 2016. Formulation was prepared using coconut oil (90%), sodium laureth sulfate (3%), sodium carbonate (2 g), pigment and fragrance in the laboratory and their physical and chemical properties were analyzed according to the respective SLS standard. A preliminary survey on consumer satisfaction was conducted among 20 individuals using a Google form. Total fatty matter value of the bathing bar was 67.2% indicating its superior quality. The free caustic alkali was also within the range stipulated in the standard. In addition, synthetic surface active agent of the bathing bar was 2.9%. As per the SLS 1220: 2016, mush should not be more than 10% and in the formulated bathing bar soap, it was 9.4%. The pH value of the developed bathing bar was 10.6. In conclusion, results of the present study indicated that the developed bathing bar complied with the specifications of SLS 1220: 2016 for bathing bar. In addition, as per the preliminary survey, consumer satisfaction with the skin feeling, foaming quality, fragrance, color, shape, hardness and feelings after applying this product fulfils the consumer expectations.

Development and quality assessment of a transparent soap enriched with *Aloe vera* Linn.

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Abstract

Soap is sodium or potassium salt of a fatty acid formed by saponification. There are many types of soap available in the market such as toilet soap, liquid soap, bathing bar, etc. Among them, transparent soap looks very attractive and is used for various cosmetic purposes such as amenities such as face and bath products having esthetic effects other than surfactant properties. The benefits of transparent soap over other soap products are due to enrichment with glycerin, retention of moisture, smoothness and prevention of acne. The primary objective of the present study was to formulate a transparent soap from locally available fixed oil and to assess the quality control parameters as per IS 11303- 1985. The second objective was to reduce the pH of the soap by incorporating *Aloe vera* Linn. juice. One set of transparent soap samples was prepared in the laboratory using a standard formulation as per published data and another set of transparent soap samples was prepared by in-cooperating *A. vera* leaf juice instead of water for the preparation of the lye. For both formulations, the oil phase consisted of coconut oil and stearic acid. Results revealed that total fatty matter (TFM), pH and un-saponified fatty matter of transparent soap (without Aloe juice) were 65.0, 11.5, and 0.4, respectively. On the other hand, TFM, pH and un-saponified fatty matter of transparent soap (with Aloe juice) were 65.6, 10.0, and 0.4, respectively. Free caustic alkali was not detected in both type of transparent soaps. *A. vera* juice has significantly reduced the pH (10.0) whose maximum level is 11 as per the standard. In conclusion, the present research emphasizes the possibility of in-cooperating A. vera leaf juice as an ingredient for the production process of transparent soap to reduce the pH.

Development of a pet soap based on traditional claims and premarketing surveillance study

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Abstract

Market demand for pet products is increasing day by day due to the domestication of animals as a result of urbanization. Bathing is a basic requirement for both humans and animals however, bathing products focusing on animals are limited. Dogs frequently suffer from fleas and ticks, dry, flaky skin, shedding and hair loss, allergic dermatitis, and skin wounds for which effective treatments have been documented in the literature of ancient Ayurvedic and traditional medicine. "Neem and Karanja" seed oil has been used for many years to get rid of the above pet diseases and therefore, it was aimed to develop a pet soap with the above oils. Dried seed samples were collected from wildly growing trees of the Kirinda Puhulwella divisional secretariat, Pericarp of the fruit and seeds were removed and fixed oil was expelled using a mechanical press. The saponification value for the oil blend was determined according to the SLS 313-2-1: 2014 and then the soap was prepared using a solution of NaOH at the ratio of 9:1 coconut oil: neem karanja oil v/v. Analysis of pet soap was carried out as per the SLS 1220:2016. The prepared soap was given to 20 individuals to use as a pet soap and consumer perception was evaluated using a questionnaire. Trials were carried out in triplicate and the results were expressed as mean ± SD. Total fatty matter content (TFM) of the soap was 83.2 ± 0.2 percent by mass while the pH at 25 °C was 8.5. Free caustic alkali as NaOH expressed in percent by mass was not detected. The TFM value is a quality parameter that is used to grade soaps. The TFM content of the formulated pet soap was 83.2%and complied with the requirement for TFM in the SLS 34:2009 and bathing bar, SLS 1220:2016. Moreover, it complied even with the SLS 34:2009 due to the high TFM value which is capable of rehydrating and leads to non-irritating skin while acting as a lubricant owning to its high oil content. The pH value of the product was 8.5 which was more alkaline than the human skin. Soaps available in the market also have a similar pH range. Free caustic alkali was not detected in the product where the standard allows a maximum limit of 0.06%. Present study was limited to analyzing only three major parameters. The developed pet soapcomplied with the quality and the premarketing surveillance study indicated that the productis effective in controlling common pet skin issues and therefore, it is recommended for commercialization.

Enhancement of properties in high temperature grease using graphite and polymer additives

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Abstract

Properties of high temperature grease can be improved by adding graphite, polymer additives and fillers. This study focuses on the effects of polyethylene glycol (PEG) with graphite. Initially, the grease was prepared and varying percentages of PEG and later 25% graphite was added to each sample. The ASTM D 2265 method was adopted in dropping point measurements. The maximum dropping point of 240 ^{o}C was observed in 27% of PEG added sample and 240 ^{o}C for graphite added samples. Fourier Transformation Infrared (FTIR) spectroscopy was used to determine the bond formation of pure grease, PEG and for graphite added grease. The three peaks of PEG-containing grease at 1736 cm^{-1}, 1455 cm^{-1}, and 723 cm^{-1} have been shifted to 1738 cm^{-1}, 1459 cm^{-1}, and 727 cm^{-1} respectively. These shifted peaks are evident that bonds getting changed and the chemical changers have also been taken place when incorporating PEG. The qualitative properties were compared according to the ASTM D 217 standard. The selected percentages, 0%, 9%, 15%, 21%, and 27% of PEG were tested with cone penetration that gave values of 265 dmm, 263 dmm,261 dmm, 252 dmm and 256 dmm respectively. For the graphite added samples, the cone penetration values were 259 dmm, 256 dmm, 259 dmm, 252 dmm, and 246 dmm respectively. Depending on the results of dropping points, it could be concluded that PEG is 21% and 27% of PEG with 25% graphite could be recommended. These findings suggest that the combination of graphite and PEG polymer additives could enhance the properties of grease, particularly improving thermal stability. In conclusion, this study demonstrates that the addition of PEG and graphite could significantly improve the thermal stability of grease. The results suggest that this combination could be an effective approach for enhancing the properties of grease for high temperature applications.

Design and development of water ionizer

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Abstract

Water ionizer (WI) produces alkaline ionized water (AIW) by an electrolysis process that involves delivering an electric current through two electrodes immersed in water to split into H^+ and OH^- ions and increasing alkalinity on the cathodic side and acidity on the anodic side. The AIW is one of the growing fields due to its medical advantages, such as the cure for non-communicable and chronic diseases, and the ability to combat hyperacidity. The main importance of AIW is its antioxidant properties that are measured by the oxidation-reduction potential (ORP). Besides, AIW acid water is also helpful for cleaning and hygiene. Commercial WI uses a platinum electrode, which is very expensive. In the present study, a novel electrode was invented using the locally available graphite minerals. It was fabricated using a mixture of graphite (95% w/w) and phenol formaldehyde resin (5% w/w), followed by hydraulic pressing and firing at 180 ±10 °C for 2 hours. Polyvinylidene fluoride was used as the semi-permeable membrane. The process was done as a continuous process with a constant power supply of 24 V through a DC power adaptor. The WI was designed to collect AIW at pH of 8.5, 9.0, and 9.5 respectively. The number of electrodes/cells, inlet water flow rate, and voltage supply time for the electrolysis process were optimized to collect AIW at the desired pH values within the shortest time and investigate the possible collected volume. The optimal number of graphite electrodes was six (three anodes and three cathodes). It was possible to obtain 500 -1000 mL of AIW at pH 8.5 at a water flow rate of 1.5 L min^{-1} and 20 s voltage supply time, 350-750 mL of AIW at pH 9.0 at the water flow rate of 2.0 L min^{-1} and 60 s voltage supply time, and 350–800 mL of AIW at pH 9.5 at the water flow rate of 1.0 L min^{-1} and voltage supply for 40 s to the electrolysis process, respectively. The AIW at pH of 8.5, 9.0, and 9.5 showed ORP values of -89 -106, -128 respectively indicating good antioxidant properties while complying with the WHO drinking requirement for total dissolved solids (< 56 ppm). Thus, the present study concluded that graphite electrodes can be used in WI to produce AIW for consumer use.

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Polyaniline conjugated graphite-clay composite electrodes fabricated by electro-polymerization for supercapacitor applications

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Abstract

The graphite-montmorillonite (GMMT) composite electrode (GMMTCE) and graphite-graphite derivative-MMT composite electrodes (GGdMMTCE) were fabricated in the form of binder-free nature. The applicability of these composite electrodes for energy storage devices was determined by the development of supercapacitor cells, which were constructed using polyaniline coated composite electrodes and a separator that contains H_2SO_4 acid as the electrolyte. The specific capacitance of constructed cells was determined via solid state cyclic voltammetry, scanning between (-0.5 V to 1.0 V for GMMTCE and -0.8 V to 1.5 V for GGdMMTCE) at 5 mV s-1 respectively. The aniline electro-polymerization on both electrode surfaces resulted in an inter-linked nanofiber network of polyaniline (PANI), where the morphology was observed using the scanning electron microscope (SEM). The SEM micrographs revealed that PANI network is uniformly distributed throughout the entire electrode surface, resulting in the lowest serial and charge transfer resistance. The serial and charge transfer resistance reported with PANI- GMMTCE were 6 and 66 Ω, whereas that for PANI-GGdMMTCE were 16 and 181 Ω, respectively. The specific capacitance values obtained for super-capacitor cells constructed using PANI-GMMTCE and PANI-GGdMMTCE were 342 F g-1 and 782 F g-1, respectively. It revealed that the specific capacitance of PANI-GGdMMTCE is much greater than that of PANI-GMMTCE, reflecting that PANI-GGdMMTCE is more effective in constructing super capacitor devices with respect to its performance. Further, modifications to such PANI- coated composite electrodes definitely may result in high specific capacitance that might be essential to improve the performance of energy storing devices.

Novel filter cartridge to be used in the pre-treatment process of reverse osmosis plant

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Abstract

The water hardness is a major concern in areas affected by CKDu, particularly in the north-central and north-western provinces of Sri Lanka. The water hardness is caused by the dissolved calcium and magnesium ions. There are different water purification processes applied globally. Among them, Reverse Osmosis (RO) has become the leading technology to date. However, it is desired to undergo an adequate pre-treatment process to remove most of the contaminants from the water before reaching the RO membrane. In the present study, a novel filter cartridge using locally available materials to be used in the pre–treatment process of RO plants has been invented. The hardness removing efficiency of raw zeolite and zeolite fired at 500 ℃, 600 ℃, 650 ℃, 700 ℃, and 1000 ℃ was analysed using the APHA method. The zeolite successfully removed the water hardness at both room temperature and at 650 ℃ by the ion exchange mechanism of Na^+ ions attached to exterior bonding sites in its tetrahedral structure with Ca^{2+} and Mg^{2+} ions in hard water. The hardness removing efficiency of zeolite is increased when treated with 0.5 $moldm^{-3}$ sodium chloride solution as it is saturated with Na^+ ions. A filter cartridge was fabricated using zeolite (50%) as the active material, southern clay (5%), Colombo clay (25%) as the binder, and rice husk (20%) as the porous material and fired at 650 ^oC has been invented. It had 47.29% water absorption, 1.06% linear shrinkage, 20.85% loss of ignition, 66.7 MPa flexural modulus, and 45.50 mL/h water flow rate as per the ASTM D790. The developed cartridge exhibited 100% hardnessremoving efficiency up to four consecutive water (initial hardness of 220 mg/L) filtering cycles. The surface morphology of raw zeolite, zeolite fired at 650 ^oC, and the developed cartridge was investigated using scanning electron microscopy (SEM) and it exhibited a tetrahedral crystalline structure and bonding sites of zeolite that helps to remove hardness from water and they remained intact when fired at 650 ℃. The SEM image of the cartridge showed a porous structure that facilitated a reasonable flow rate while increasing the surfacearea. The present study concluded that the composition of the invented cartridge is ready to be used in an industrial scale filter in the pre-treatment process of RO plants, as it showed promising performance in the hardness removal from water.

Acknowledgment: Financial assistance by Treasury Research Grant (TG/21/195)

Synthesis of slow release bio char-urea inclusion composite to mitigate nitrogen leaching loss and increase nitrogen usage efficiency

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Abstract

Nitrogen loss of urea is a major constraint in sustainable agriculture and it directly contributes to greenhouse gas emissions and climate change. In this study, slow release bio char-urea inclusion composite (BUIC) was developed to reduce the nitrogen loss via leaching and increase the nitrogen usage efficiency (NUE) in plants. Urea was dissolved in 8% poly vinyl alcohol (PVOH) solution. Bio char, starch and bentonite were mixed according to 'Fibonacci sequence' and this fine powder mixture was added into urea-poly vinyl alcohol solution. The BUIC 30%, BUIC 50% and another urea inclusion composite without bio char (WBUIC) were prepared. The FTIR and XRD analysis were carried out to characterize the above mixtures. Leaching experiment and pot experiment were carried out to determine the slow releasing property and to evaluate the effect of above fertilizer mixtures on plant growth and NUE. Fertilizers were applied on 2nd and 4th week only and the plant height of *Capsicum frutescens* L. and *Oryza sativa* L. were measured weekly for fertilizers of commercial urea, 30% BUIC, 50% BUIC, WBUIC with a control treatment for 70 days. Results were analyzed using ANOVA with Tukey post-hoc analysis using SPSS software. The FTIR and XRD studies indicated that strengthening the interactions among urea, bio char, bentonite, starch and PVOH. 50% BUIC had the lowest cumulative nitrogen loss of 23.20% and it was a considerable reduction of nitrogen loss compared to that of urea (43.45%). All the fertilizer treatments had positive effect on the overall plant growth of capsicum while plants under 50% BUIC showed significant growth compared to urea and other treatments. The 50% BUIC resulted taller plants (19.3±2.4 cm, 21.8±3.0 cm) by 9th and 10th week after the fertilizer application. The mean height measurements of rice plants, proved that the most significant effect was caused by 50% BUIC treatment. Bio char in the composite greatly contributed to this considerable minimization of nitrogen loss and cumulative nitrogen loss of WBUIC (57.64%). Noticeable plant growth in both crops tested under 50%BUIC within the observation period was related to the slow release properties. The BUIC was capable to retain and release nitrogen timely while synchronizing with the nutrient requirement of plants.

Application of vermifiltration technology for the treatment of waste water generated from food testing laboratories

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Abstract

Research and testing laboratories generate waste water during the routine operations. This waste water is mostly discharged into the environment without adequate treatment leading to environmental pollution. The cost effective vermifiltration technology can be a promising technology for the treatment of waste water generated from laboratories. The present study evaluated the efficacy of macrophyte assisted vermifiltration technology for treating of waste water generated from the food analysis laboratory of Industrial Technology Institute (ITI), Sri Lanka for the first time. Three laboratory scale sub-surface vertical flow units were established (a) without earthworms and plants (Control unit), (b) with earthworms (*Eisenia fetida*) virmifiltration unit (VF unit), (c) with both earthworms and macrophytes (*Canna indica)* (VF + Constructed Wetland (CW unit). Waste water from food analysis laboratory was fed in batch wise with a waste water feeding rate of 10 ml/min and 7 days hydraulic retention time (HRT) for eight consecutive batches. Physico-chemical parameters; Chemical oxygen demand (COD), total phosphorus (TP), total nitrogen (TN), pH of the influent and effluent of all three units were analyzed to investigate the treatment efficiencies. One-Way ANOVA was performed to evaluate the significant differences in the treatment efficiencies. The COD, TN and TP levels of the waste water of the food analysis laboratory was highly variable which ranged from 205 - 4150 mg/L, 7-13 mg/L and 3-13 mg/L respectively. The average COD removal efficiencies of the control unit, VF unit and VF+CW unit were 60.2%, 71%, and 72%, respectively. The average TN removal efficiencies of control unit, VF unit and VF+CW unit were 8%, 10.9% and 24.9%, respectively. The average TP removal efficiencies were 35.8%, 35.8% and 40% respectively. One-Way ANOVA results showed that the removal efficiencies of COD, TN and TP were not significantly different. In conclusion, the COD removal displayed promising results whereas the means for enhancing TP and TN removal should be further studied.

A study on the composition of the odor generated from a tobacco industry for development of odor mitigation measures

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Abstract

The tobacco processing industry produces a number of harmful odorous volatile substances which require proper odor control measures. Especially, the studies on the composition and control of tobacco environmental odor are very limited in the world. The primary aim of the present study was to identify the odorous substances emanated during the different stages of tobacco processing in a well-known tobacco processing industry in Sri Lanka for the first time. Four ambient air samples were collected into specific Tedlar air sampling bags by a suction pump from (i) before the heat exchanger (ii) after scrubber (iii) dust regulating filter (DRF) I outlet (iv) DRF 2,3 and 4 outlets in this industry. Moreover, tobacco leaf samples were collected from before processing, after steaming, before drying and after drying. All these air samples and tobacco leaf samples were analyzed for odorous volatile substances by gas chromatography/mass spectrometry - headspace method using a gas chromatograph with a mass selective detector: Agilent 6890 series/Agilent 5973 N series with a capillary column at the Residue Analysis Laboratory of Industrial Technology Institute. The results showed that the tobacco leaf sample collected after drying at 85 ^{o}C had emanated four volatile compounds namely (i) Methylbenzene (Toluene) (ii) 2,2,4,6,6, Penta methylheptane, (iii) Butanal-3-methyl, and (iv) 3-(1-methyl-2-pyrrolidinyl) pyridine (Nicotine). However, no substances were detected from the ambient air samples and the other three tobacco leaf samples. The results of this study could be applied for the improvement of the present full scale air pollution control system of this industry for better odor control.

The physico-chemical properties of waste water generated in the manufacturing of natural rubber latex foam (NRLF) and its chemical treatability

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Abstract

The physico-chemical properties and the chemical treatability of the effluent generated by the manufacturing process of Natural Rubber Latex Foam (NRLF) bedding products have not yet been investigated. Therefore, this study focuses on characterizing the physico-chemical properties of the waste water generated during the manufacturing of NRLF and evaluating the potential of chemical treatment for its remediation. Waste water samples were collected from a manufacturing facility, and basic quality parameters were analyzed. The waste water exhibited a high level of COD (2465 mg O_2/l), BOD5 (830 mg/l), TSS (157 mg/l) and TDS (3385 mg/l). Subsequent treatability studies were conducted by employing alum as the coagulant, cationic polymer as the flocculant and lime as the pH adjuster. Optimaldosages of 250 ppm alum, 60 ppm lime, and 0.5 ppm polymer were identified for treating the raw effluent. The results of chemical treatment indicate a 26.1% and 17.3% reduction inCOD and BOD5 respectively suggesting partial efficacy in pollutant removal. In contrast, ammoniacal nitrogen content increased significantly after the treatment, indicating a potential shift in nitrogen forms. As chemical treatment exhibited limitations in treating NRLF waste water, further investigations into alternative treatment methods are required to address the removal of existing pollutants effectively.

Acknowledgement: NRLF bedding products manufacturing companies in Sri Lanka for providing the raw waste water samples and Chemical and Microbiology Laboratory of ITI for performing the water quality analysis.

Intelligent watering system at low cost with real-time soil moisture

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Abstract

Water is a scarce resource and need to be managed more wisely. In dry zone farms, it is not affordable for farmers to install modern sprinklers, sprayers or drip irrigation system and difficult to maintain favorable moisture content for plants. Optimum environmental and moisture conditions are vital for plant growth. Therefore, objective was to develop an economical and efficient watering system for plants considering pipe losses along PVC pipes. A literature survey was carried out to optimize watering agricultural farm fields based on soil moisture scheduling and water budget approach. Watering less or more than the required amount does not provide a friendly environment for roots. The main focus of the research was to introduce evenly distributed and efficient plant watering system when irrigation frequency varies depending on crop growth stage and considering site specific variables such as area, type of crops, environment and soil factors. A drip irrigation mechanism prototype was developed with PVC pipes laying horizontally and fixing syringe tips to water plants in PVC pipe network. Two electrodes of effective root zone height used as capacitive sensor to measure soil moisture. Computer software are used to identify the pipe losses along the pipe and to calculate required water content and time interval for watering. VB interface was used to simulate pressure along pipes, calculate varying drip sizes required to have equal flow rate. Flow rate selected was 3 ml/min which is lower than soil infiltration rate and depend on soil type and real moisture. Intelligent irrigation system consists of microcontroller, solenoid valves for water flow and 555 timers. Microcontroller was programmed for in built Soil Moisture Sensor and timer for watering till soil get saturated with the optimum moisture. Dielectric constant (relative permeability) of soil is relates to soil moisture content. During data analysis measured capacitance were used to calculate the Di electric constant and compare that data with required moisture database and calculated the required amount of water for plants. Moisture calibration curve was drawn which could vary on soil type and temperature. In conclusion, intelligent watering system, water the required amount comparing with real-time root moisture content in plants at a low cost with increasing efficiency and minimum labor usage.

The noise variation with distance using selected different types of firecrackers

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Abstract

Firecrackers are known to produce loud and sudden noises, which can exceed the safe noise levels and cause disturbances. These loud noises can be a significant source of noise pollution, particularly in densely populated areas or during festivals and celebrations where firecrackers are commonly used. A study was conducted to determine the existing noise levels and perform acoustic analysis on different firecrackers available in the Sri Lankan market. This study analyzed the noise variation with distance using various types of firecrackers. In this study, 21 types of firecrackers were considered and individual firecracker performances were examined separately. The emission of peak sound pressure level at a given location due to an individual firecracker depends mainly on its sound pressure, the distance from the explosion, and the sound pressure distribution in the time and frequency domains. During the measurements, sound level meters (Brüel & Kjaer meters) were placed at distances of 10 m, 20 m, 50 m, and 100 m from the source (firecracker) and 20 m away from the rear side. The measurements were conducted during the daytime in open free space using calibrated sound level meters, and the noise level descriptors LIAeq, LCpeak, & LAFmax were recorded during the measurements. The results showed that the noise levels generated by most firecrackers were significantly higher than the 140 dB LCpeak value at a distance of 10 m. The data also indicated that the maximum noise levels (LAFmax) and equivalent continuous impulse noise levels (LAIeq) did not change significantly (approximately 3 dB(A)) throughout the measurement time for all firecrackers.It was observed that the LCpeak value decreased as the distance increased. As the distance between the sound level meter and the source increased, the drop in LCpeak value also increased. Furthermore, all firecrackers exhibited their highest noise frequency range between 100 Hz and 630 Hz, with only a few frequencies detected below 100 Hz. The study revealed that it is preferable to explode firecrackers at a distance exceeding the 50 m limit from humans. Overall, the study indicated the necessity for raising awareness among people, implementing warning signs, and enforcing firecracker acoustic standards and regulations for the country.

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Analyzing the sound pressure level variation in calls received by mobile phones across different brands

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Abstract

The present research study focused on exploring and analyzing the variation of acoustic properties in signals received by mobile devices. The aim was to gain insights into factors influencing signal quality and potential areas for improvement. The study specifically investigated the quality of speakers and microphones in mobile phones, as these are crucial for effective communication. Voice recordings were collected in controlled environments at the Industrial Technology Institute, Colombo, ensuring the ambient noise levels remained below 40 dB. Voice signals were played using ODEON and captured by placing smart phones approximately 30 cm away from an omnidirectional speaker. This process was conducted for 10 different mobile phone brands (Apple, Samsung, Huawei, and Sony), with sound level meter data collected simultaneously. In addition, examined the voice signals received by mobile phones in a natural environment, where ambient noise levels ranged from 40 to 55 dB. One mobile phone represented as the receiver, recording voice signals transmitted by other mobile phones represented as callers. The voice signals were recorded using a sound level meter (Breuel & Kjaer type 2250). The mean LAeq values of Apple and Sony were 30.4958 and 30.017, which was close to the mean LAeq value of the original voice at 30.2194. The minimum and maximum LAeq values of the recorded voice of Apple (-10.34 and 62.26, respectively) and Sony 01 (-13.38, 64.32 respectively) cover a comparable range as the original voice (V2) (-14.84 and 60.87, respectively), indicating the microphone's capability to capture a similar range of sound levels. The results subjected to Wilcoxon signed-rank test confirmed that, there was no significant difference between the original voice and recorded voice of Apple (p=0.668), Sony 01 (0.454), Sony 02 (0.044), Xiaomi 01 (0.264), and Xiaomi 02 (0.532), which means these mobile phones have good capability to capture the sound pressure level. There was no significant difference between the recorded voice of Apple and Sony 01 and the received voice from other mobile phones when transmitted through mobile communication. It was confirmed by Wilcoxon signed-rank test. Some mobile phones exhibited significant differences in received voices compared to the original voice, possibly due to signal loss or degradation. In conclusion selected mobile phone brands have good capability to capture the sound levels depending on their brands, Apple and Sony are at a significant place in voice recognition of receiving calls.

Industrial power analysis of a 3-phase 4-wire system – A case study

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Abstract

Electricity power conservation is critically important in today's society, with individuals, organizations, and communities all having a responsibility to participate. Governments, private entities, and international organizations worldwide acknowledge the importance of energy efficiency and have implemented policies and targets to encourage electricity power saving. Industrial power analysis enables businesses to track and manage their energy costs effectively. By analyzing power usage patterns, peak demand periods, and power quality, companies can identify opportunities to reduce energy expenses, negotiate favorable utility contracts, and implement load management strategies. The main purpose of this research is to identify power variations in the Technical Services (TS) divisions of Industrial Technology Institute, Sri Lanka. In brief, connected the power meter to the 3-phase 4-wire system and collected the data such as active power, reactive power, apparent power, electrical energy, power factor, RMS current and phase angle. Finally, collected data were processed using software. Measurements were recorded continuously for three weeks at 10-minute intervals. In addition, the institute's power bills for several months were analyzed alongside the measured data. According to the data, power consumption during normal working hours was approximately 86.5 kWh. Power variations were observed during other working hours, ranging from 24.5 kWh to 30.8 kWh. The total inefficient electricity consumption for a weekday was 444.5 kilowatt-hours (kWh). Power consumption during specified working hours accounted for 3459.5 kilowatt-hours per week (37.6%), while power consumption during non-working hours accounted for 5727.9 kilowatt-hours per week (62.4%). The continuous operation of certain instruments and AC systems in specific sections contributed to this imbalance in power consumption. In conclusion, findings of the present study highlight the efficient current flow in the system, substantial wastage of electricity during non-working hours and the dominance of kWh (day) in energy consumption. These conclusions underscore the importance of optimizing energy usage, reducing wastage, and implementing effective energy management strategies.

Design and development of standard AC-DC current shunts

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Abstract

A shunt is designed to provide a low resistance path for an electrical current in a circuit. Shunts are used when the measured current exceeds the range of the measuring device. The shunt is connected in parallel to the measuring device and is commonly used in a variety of applications including power distribution systems, electrical measurement systems, automotive and marine applications. There are various techniques to measure current parameters and measurements obtained using current shunts claim to be a relatively accurate method. The objective of the present study is to describe the designed calibration of current shunts to suit both AC and DC currents. Impedance of the shunt significantly influenced for AC current shunts in obtaining high accuracy measurements. AC-DC transfer difference of a current shunt represented an accuracy which achieved ideally to zero. To reduce the impedance, most impedance reduction structure was a cylindrical cage structure. Three cylindrical current shunts were designed for three current ranges (1A, 5A and 10A) using Vishay Y114 resistors, a known load was incorporated with an AC/DC transfer standard, and 8 ½ digital multimeter. Current shunts were calibrated for DC as well as for many frequencies. AC-DC transfer difference was calculated for each shunt. Temperature stability, accuracy, sensitivity and stability were determined. It was observed that temperature of all the shunts increase with time. In addition, the temperature of the shunts gradually stabilises after approximately 5 minutes. When current increases, the rate of change of temperature as well as the stabilized temperature point increases. In conclusion, AC/DC transfer difference of 1A and 5A current shunt (for 50Hz to 1kHz frequency) are less than the 1000 μΩ/Ω (ppm) and uncertainty is 41μΩ/Ω and 140μΩ/Ω, respectively. AC/DC transfer difference of 10A is 1460μΩ/Ω for 1kHz frequency with uncertainty of 180μΩ/Ω. Accuracy of the current shunts are 60 μΩ/Ω and TCR is ±0.05 ppm/ ºC.

Design and development of tachometer using magnetic field sensor: A theoretical approach

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Abstract

Digital tachometers are used to measure the rounds per minute (RPM) of rotational or spinning bodies for various purposes. Digital tachometers usually measure the RPM either directly contacting the rotational body using attached wheels or non-contacting sensing usually Infrared radiation or light (LED/Laser). Rotating body enclosures (eg. centrifuges without inspection glass on the lid) may not have the visibility to measure RPM using the existing tachometer. The objective is to introduce an innovative low-cost digital tachometer system to measure the RPM 3 to 100,000 by attaching a magnet to the rotating body and using a magnetic field sensor to sense therotation. A Hall effect sensor is proposed to be used to measure the magnetism variations, which generate an electrical signal proportional to the magnetism. The magnetism variation has a sinusoidal pattern. The variation of the electrical signal is acquired by the DAQ card Ni-USB 6009. Fast Fourier Transformation (FFT) analysiscan be used to measure the frequency of the rotating body by peak detection and calculate the rpm from the acquired frequency data. A graphical user interface and data acquisition system will be developed using LabVIEW software and Digital Signal Processing (DSP) techniques will be used to improve the accuracy of the system by filtering the harmonics and reducing the noise by taking the moving averageof the data. The effect of the magnet to the motor of the rotating body needs to be determined as the motor has magnets. In conclusion, a low-cost digital tachometer canbe developed using a magnetic field sensor (Hall effect sensor) to measure and perform the RPM calibration in a rotating body (e g. centrifuge) which is inflexible tomeasure the RPM with optical tachometers and this device can be used to evaluate theperformance of the rotating body by taking the RPM profile.

Vibration analysis of the electrical fan motor in an outdoor air conditioner (AC) unit: A case study

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Abstract

The efficiency of electrical fan motors can be enhanced by monitoring and identifying faults within them. This study focused on the mechanical vibration analysis of the electrical fan motor unit in an outdoor air conditioner (AC) unit. This was carried out to identify the fan motors' issues and raise their effectiveness. Initially, a tachometer was used to measure the revolutions per minute (RPM) value of the fan motor measured as 720 RPM. Then it was converted to the rotating frequency of the motors (12 Hz). The BK Connect software was then used to measure the vibration in the X, Y, and Z directions from the AC unit's top four corners and bottom four corners. The readings were taken from the AC unit while it was operated on a normal day. Then, using a Fast Fourier Transform (FFT) analyzer, the time-domain data was transformed into the frequency domain, and a graph was taken from each corner for further analysis. For the analysis, the seven highest peak values were selected from every corner and direction. Due to the insulation that was used at the bottom, the average peak values in the bottom four corners as compared to the top four corners were reduced by around 80%. In order to figure out motor faults in the AC unit, the vibration spectra of the top four corners were analyzed. In order to identify the faults, the peaks below 60 Hz (five times the RPM value) in the X, Y, and Z directions of the top four corners were analyzed. Probabilities were calculated for the defects that could be found in the selected AC unit's electrical motors. In conclusion, there was approximate 80% reduction of the averages of the seven highest peak values (amplitudes) of the vibration at the bottom four corners with respect to the top four corners. The actions required to fix these errors with the highest likelihood can be implemented. Consequently, using insulation at the bottom of an AC unit can enhance the efficiency of its selected motor by reducing vibration.

Spectrometric concept to identify the adulteration of bee honey using reflected light

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Abstract

Bee honey is a natural product that has a value for its sweetness and medical use since ancient times. With the increasing demand, bee honey is adulterated with cheap liquids. The objective of this study is to develop a device to identify adulterated bee honey qualitatively using a low-cost optoelectronic system and validate the results using authentic bee honey samples. The AS7265x is a light spectroscopy sensor which measures the transmittance of substances in a wavelength range from 410 nm to 940 nm and can detect 18 individual light frequencies with the precision of 28.6 nW/cm^2 was interfaced with a microcontroller to build an optical detection mechanism. To increase the accuracy of the results, the optical detection mechanism was precisely tuned. Pure bee honey samples from the Wariyapola, Kothmale, and Mahiyanganaya areas and one market sample were collected and tested via the system. The same samples were diluted by adding a known amount of glucose. Pure bee honey samples responded for the wavelengths between 435nm to 510nm and the wavelength decreased gradually for the diluted samples. The fluorescence spectroscopic technique was used to validate the results. It was observed that the height of the peaks changes in the range of 420nm to 620nm, which coincides with the results obtained from the spectroscopic instrument built in the laboratory. Furthermore, the pollen count was obtained qualitatively for the samples through microscopic counting. The spectral response obtained in the range of 435 nm to 510 nm range for each sample can be correlated with the respective pollen count. The relationship between the pollen count and the spectral response was strong with high pollen count whereas samples with low absorption had low pollen count. According to the present study, it is clear that the spectroscopic instrument can be used to identify the quality of the bee honey in the field qualitatively.

Evaluation of selected performance criteria extracted from annual reports of Industrial Technology Institute from 2008 to 2022 and predictions with Autoregressive Integrated Moving Average (ARIMA) models

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Abstract

Evaluation of various types of performance indicators and their associated factors of an institution using different approaches including statistical models provide useful information for continuous improvement and policy formulation. Therefore, in this study, a selected set of performance indicators and associated factors of the Industrial Technology Institute (ITI) for 15 years were evaluated and time-series ARIMA model was used to predict the future trends of some selected parameters. Information on 25 parameters were collected from annual reports of ITI from year 2008 to 2022. All collected information was considered as counts except for income and expenditure. Descriptive statistics were done for all parameters and correlation analysis was carried out to find out possible relationships between selected indicators. Time series ARIMA models were fitted with variables such as publication, total staff, scientists, engineers and technologists using auto-arima function of R software. The prediction was done for these parameters for the next 5 years using the best fitted model for each parameter. All data processing and analysis were done using R version 4.2.3 with RStudio. Minimum, median and maximum values for selected count criteria are; publication (2,32,52), patents (2, 0, 8), awards (6, 0, 12), international communications (13, 3, 56), local communications (53, 3, 126), foreign training (13, 0, 52), local training (4, 0, 104), staff with BSc (40, 15, 53), staff with MSc (31, 19, 38) and staff with PhD (19, 10, 29). Correlation analysis showed significant ($p>0.05$) positive relationships only between number of publication and number of staff with PhD degrees. None of the other tested parameters including patent, technology transfers and local and international communications did not show a significant correlation with potential influencing factors such as number of staff, their composition, and other qualifications. The best fitted ARIMA models (p,d,q & AIC) for publications, total staff, scientists, engineers and technologists were (0,1,0 & 140), (1,1,0 & 92), (0,0,1 & 1125),(0,0,1 & 101), (0,1,0 & 54) and (0,0,0 & 106) respectively. The predicted values from 2022 to 2026 for each were (323.08, 325.87, 354.25, 362.39, 375.44), (603.81, 628.63, 653.44, 678.26,703.07), (51, 48, 55, 54, 60), (347, 339, 339, 339, 339), (77, 72, 72, 72, 72), (18, 18,18, 18,18) and (101,101, 101, 101, 101) respectively. Analysis indicates that the parameters in annual reports were not sufficient to find out influencing factors affecting the major indicators. Further, it demonstrates that methods like ARIMA modelling can be used to predict progress of some parameters.

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