



## 4<sup>th</sup> Biennial Research Symposium 2019

Excellence in Science, Technology and Innovation for Sustainable development

# PROCEEDINGS

17 -18 December 2019

Malabe, Sri Lanka





Industrial Technology Institute

## 4<sup>th</sup> Biennial Research Symposium 2019

**Excellence in Science, Technology and Innovation for  
Sustainable Development**

### Abstracts

17<sup>th</sup> – 18<sup>th</sup> December 2019

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## **Message from the Honourable Minister of Higher Education, Technology and Innovation**



It gives me great pleasure to send this message to the 4<sup>th</sup> Biennial Research Symposium of Industrial Technology Institute on Excellence in Science, Technology and Innovation for Sustainable Development. Scientists play a major role and make a noteworthy contribution to the development of thorough research they conducted in multiple disciplines. It is vital to steer Sri Lanka into a technology based developed nation. the symposium provides a forum to present the research findings of scientists and engineers to a wider audience of experts and policymakers and to validate their findings.

I have no doubt that the presentations of research findings on multidisciplinary fields during the technical sessions will provide an opportunity to add to the existing knowledge, ideas and approaches that can be applied in the process of national development.

I wish that the Biennial Research Symposium will become continues to endeavor in Industrial Technology Institute and offer my gratitude for the initiative and best wishes to organizes and the presenters.

**Dr Bandula Gunawardana**  
**Hon. Minister of Higher Education, Technology and Innovation**

## **Message from the Honourable State Minister of Technology and Innovation**



I take great pleasure in sending this message for the 4th Biennial Research Symposium 2019 of the Industrial Technology Institute. Technology and Innovation have become the key drivers of growth and development of the modern world. Every nation on the path to progress and economic prosperity pays much emphasis to its technology sector. It is my desire to see the technology sector in Sri Lanka flourish, and I know that we have the capability, talent & skill to make this vision a reality.

In the past few years we have seen major developments in environmental conservation, biotechnology, electro technology and many other sectors. Laying a sustainable platform is key to its success. The ITI Symposium is a forum for the discussion of ideas and key strategies to look at the future of technology and how we can use it further not only growth and development, but to also harness its power to improve life for all Sri Lankans.

I take this opportunity to wish ITI all the very best in its pursuit of taking Sri Lanka to the next level. And I also extended my gratitude and appreciation to the organizing committee of the symposium for their effort to make this event a deserving success.

**Thilanga Sumathipala**  
**State Minister of Technology and Innovation**

## Message from the Secretary



Let me first congratulate the Director General and the dedicated staff of the Industrial Technology Institute for organizing the Biennial Research Symposium for the 4<sup>th</sup> time in this year with an opportune theme of “Excellence in Science, Technology and Innovations for Sustainable Development ”.

The Sustainable Development Goals (SDGs) cover a broad scope with ambitions to address inequalities, economic growth, decent jobs, cities and human settlements, industrialization, oceans, ecosystems, energy, climate change, sustainable consumption and production, peace and justice. The achievement of many SDGs will heavily depend on Science, Technology and Innovation (STI). Hence our responsibility is to acknowledge basic science as a principal requirement for innovation and provide a productive scientific environment, including long-term investments, and strengthen science education to increase science literacy and capacity-building at all levels. As one of the leading scientific and industrial research organization in the country, Industrial Technology Institute supports this by conducting innovative R&D and providing internationally competitive technical services in myriad of different scientific disciplines.

While welcoming the foreign delegates participating for this symposium, I wish success for all the researchers and their associates, who will be presenting their work. I am sure that this symposium would be an ideal platform to share valuable research findings and co-operate with both national and international research institutions in demand driven research to promote industrial technology development.

I wish Industrial Technology Institute to engage in more R & D activities connected with technology transfers, the adaption of technologies and the development of new technologies to accelerate industrial development for the benefit of the people of Sri Lanka.

**Anura Dissanayake**

**Secretary**

**Ministry of Higher Education, Technology & Innovations**

## Message from the Secretary



Scientific investigations and technological improvements have been upgraded the quality of human life throughout the history. Continuous development of what is existing and novel techniques yet to be introduced are within the scientists like seeds seeking a suitable land for sowing. Conversations, dialogues, discussions are platforms to them to share knowledge and flourish their creativity.

Due to the advancement of Science and Technology, scientific investigations have driven for new areas in broad and more sensitive ways disclosing unseen benefits as well as the life threats not only to humans but to the whole ecological system. Application of science and technology to upgrade the socio-economical life of mankind without harming the ecological systems and the environment is the challenge that a scientist of this era has to face. The scientists in Sri Lanka are emerging into investigating new processes, techniques and upgrading existing technologies as well as traditional processes to uplift the country to a level with the technological development in an eco friendly manner.

Science and technological developments are the key factors for the improvements in a country's economy. As a multi disciplinary research institute in Sri Lanka, Industrial Technology Institute is playing a key role in the development of country in every aspect.

The fourth Biennial Research Symposium of Industrial Technology Institute is another successful gathering of scientists in different areas who will be sharing their knowledge in novel investigations which contribute to the development of our mother country Sri Lanka.

I take this opportunity with pleasure to congratulate those who took part in and work hard to make this a successful event. I wish all the very best to all the participants who will be presenting their work in this symposium.

**Chinthaka S Lokuhetti**  
**Secretary**  
**State Ministry of Technology & Innovations**

## Message from the Director General



Industrial Technology Institute (ITI) records sixty-four years of excellence in Research, Technology, and innovation which contributes in the elevation of the level of technology in Sri Lanka leading to rapid industrialization. Our commitment to the industrial technology development ensures that industries are supported by undertaking research and development, consultancy, technology transfers, adaptation of technologies, development of new technologies, training, surveying and monitoring environmental pollution and recommending remedial measures to mitigate such pollution, and the provision of testing and calibration services.

We are pleased to hold the 4<sup>th</sup> Biennial Research Symposium of ITI under the theme “Science, Technology and Innovation for Sustainable Development” as research conducted at ITI generates new knowledge and technology and contributes towards the progression of sustainable development in the globalized era.

It is with immense gratification and honor I welcome the scientists, engineers, technologists and other invitees from research institutes, academia, other organizations and ITI to the 4<sup>th</sup> Biennial Research Symposium, which will be held on the 17<sup>th</sup> and 18<sup>th</sup> of December 2019, at the Modern Research and Development Complex (MRDC), Malabe. This event is expected to stimulate and foster the growth of science and technology research towards the development of the industry.

The research symposium will be declared open by Honorable Bandula Gunawardene, Minister of Higher Education, Technology and Innovation, the Chief Guest and Honorable Thilanga Sumathipala, State Minister of Technology and Innovation, the Guest of Honour on this occasion. Dr. S. M. Junaid Zaidi, Executive Director of *Commission on Science and Technology for Sustainable Development in the South (COMSATS)* participates as a *Special Guest*.

Our sincere appreciation goes to the Chairman of ITI, the Board of Management, symposium secretary and organizing committee, authors,

researchers and the reviewers who have contributed immensely to make the 4<sup>th</sup> Biennial Research Symposium a successful and a memorable event. My appreciation also goes to all the sponsors for their generous financial assistance toward this event. I wish all of you a most enjoyable and interactive symposium.

**Dr.Radhika Samarasekera**  
**Director General**

## Message from the Organizing Chair



I am deeply honored and privileged to serve as the organizing chair of the 4<sup>th</sup> Biennial Research Symposium of Industrial Technology Institute (ITI) under the theme “Excellence in Science, Technology and Innovation for Sustainable Development” making another successful scientific event. It is with immense contentment I welcome the scientists, engineers, technologists, policy makers, entrepreneurs, other respected invitees and general public for the event.

Being a leading multidisciplinary R&D institution of the country who provides technological solutions and technical support to the industry, 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 4<sup>th</sup> Biennial Research Symposium, which will be held from 17<sup>th</sup> to 18<sup>th</sup> of December 2019, at ITI Malabe premises will be a good scientific platform for ITI researchers to disseminate the key findings of their research in multidisciplinary sciences with greater emphasis on Food Technology, Herbal Technology, Material Technology, Biotechnology, Microbiology, Electronics and Chemical & Physical Sciences. The symposium also provides an opportunity for ITI scientists, technologists, postgraduate and undergraduate students those who conducted their research at ITI to publish their research findings as an abstract in the symposium proceedings. It is also a forum to share, discuss and debate on scientific outcomes in a wider audience connecting students, researchers, academia, policy makers and entrepreneurs.

I take this opportunity to wish all my fellow research scientists, engineers and technologists for 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 Chairman, Director General, Board of Directors, Symposium Secretaries and all those who contributed to the success of the symposium. I would like to extend my sincere thanks to the

keynote speaker, invited speakers and COMSATS delegates for joining with us to enlighten the audience with their insightful speeches. I greatly appreciate the financial assistance given by our sponsors to glamour this event.

**Dr. (Ms.) Ilmi G.N. Hewajulige**

**Organizing Chair and Additional Director General –R&D**



## Message of the Executive Director COMSATS



*The Commission on Science and Technology for Sustainable Development in the South (COMSATS) warmly felicitates its esteemed Centre of Excellence in Sri Lanka, the Industrial Technology Institute (ITI) for holding the 4<sup>th</sup> Biennial Research Symposium. The theme of the event ‘Science, Technology and Innovation for Sustainable Development’ is extremely important for the developing countries and rhymes with the objectives and activities of COMSATS.*

The developing countries are facing grave challenges including food insecurity, epidemics, climate change, etc. The South is generally lagging behind the North due to various reasons including shortage of good human resource (researchers and scientists), absence of a steady supply of financial resources, paucity of the state-of-the-art laboratories and infrastructure, and lack of political will at all levels. Addressing the afore-mentioned challenges needs a collective response at all levels. Consequently, the world has united to address these challenges under the umbrella of UN 2030 Agenda for Sustainable Development adopted in 2015, comprising of 17 Sustainable Development Goals (SDGs).

International partnerships, particularly through South-South and Triangular Cooperation are of pivotal importance in achieving the SDGs. The holding of this international research symposium is therefore very timely. The event is expected to *be an enabler linking the scientific research to the industrial innovation and invention*. I am confident that the workshop will fulfill its objectives.

COMSATS was conceived by Pakistani Nobel Laureate, Prof. Dr. Abdus Salam, who recognized the increasingly widening gap of scientific knowledge and economic development between the North and the South and that sustainable socio-economic development in the South cannot be achieved without building and sustaining indigenous capacities in science and technology. The organization currently has 27 Member States and a Network of 22 International S&T Centres of Excellence. The Democratic Socialist Republic of Sri Lanka is an esteemed Member State of COMSATS and the

Industrial Technology Institute is affiliated with COMSATS Network. ITI has been an active member of COMSATS Network and has established meaningful collaborations with other Centres of Excellence. COMSATS cherishes its productive relationship with ITI and looks forward to enhanced collaboration in future.

**Dr. S. M. Junaid Zaidi**  
**Executive Director COMSATS**

## **Development and validation of a rapid test method for detection of pork meat with beef meat**

Peiris W.P.A.<sup>1,2</sup>, De Silva J.L.I.M.<sup>1,2</sup>, Suriyapperuma S.M.<sup>1,2</sup>  
Athapaththu A.M.M.H.<sup>1</sup>, and Withana W.T.G.S.L.<sup>1\*</sup>

<sup>1</sup>*Biotechnology Unit, Industrial Technology Institute, Colombo,*  
<sup>2</sup>*Business Management School, Colombo*

### **Abstract**

Food adulteration has become an increasing global problem in food industry. Pork is a common meat that adulterated in raw meat due to its colour, texture and flavour. Therefore, precise identification of meat species has become a vital element in meat quality control procedure to monitor commercial products. DNA (Deoxyribonucleic Acid) based methods and protein-based methods are developed to detect adulteration in food products. DNA based methods are more effective in detection of adulteration because DNA is more heat stable molecule. In this study, DNA was extracted from fresh beef and pork meat samples using DNeasyMericon food kit, Qiagen. To validate the method repeatability and recovery was performed. Repeatability was performed by extracting DNA from 50% raw pork-beef meat mixtures for ten times by the same person under same conditions. To perform the recovery, DNA was extracted from 0%, 0.1%, 0.5%, 1%, 5% and 10% concentrated pork-beef mixtures. To confirm, whether the required DNA has been extracted, a spectrophotometer was used. In method validation, a conventional duplex PCR (Polymerase Chain Reaction) was performed using both porcine and bovine species specific oligonucleotide primers targeting the 289 bp and 251 bp of mitochondrial *Cyt b* gene respectively. In recovery detection, both duplex and simplex conventional PCR were performed. PCR results were analyzed on a 1.5 % agarose gel. The validity of the repeatability in this method is 100% and recovery, porcine primer is sensitive even at the lowest raw pork meat concentration of 0.1%. Therefore, the qualitative conventional PCR based method used in this study can be used as a pragmatic solution to detect pork and beef meat adulteration in meat products. The proposed methodology is an easy-to-follow, inexpensive, reliable method used for monitoring food products.

**Acknowledgement:** Financial assistance by Government Treasury to Industrial Technology Institute through research grant TG

## Determination of the sensitivity of a real-time PCR based method for the identification of Genetically Modified (GM) fruit samples

Haroon H.<sup>1,2</sup>, Hewasinghe K.A.<sup>1,2</sup>, Withana W.T.G.S.L.<sup>1</sup>, Athapaththu A.M.M.H.<sup>1\*</sup>

<sup>1</sup>*Biotechnology Unit, Industrial Technology Institute, Colombo,*

<sup>2</sup>*Business Management School, Colombo*

### Abstract

Many agricultural products are being imported to Sri Lanka and some of which are could be genetically modified (GM). However, majority of the imported fruits are not labelled. According to the biosafety rule followed in Sri Lanka, if a genetically modified organism (GMO) content present is greater than 0.5%, the GM food has to be labelled. Therefore, the objective of this study was to determine the sensitivity of a developed real-time polymerase chain reaction (RT-PCR) method for the detection of Cauliflower Mosaic Virus 35S (CaMV35S) promoter which is used in developing GM plants. Negative (S1) and positive (S2) reference fruit samples were confirmed using the RT-PCR method. The S1 and S2 samples were mixed to prepare six standards of concentrations 0%, 0.1% 0.5%, 5% and 100%. The commercial kits, Qiagen DNeasy *mericon* Food Kit and *mericon* GMO Screen 35S-pat Kit were used for DNA extraction and amplification of CaMV35S from each standard respectively. Certain changes to the original protocol of the kit was followed according to the Standard Operating Protocol (SOP). An environmental control was set aside to ensure that no other factors affected the extraction and to detect any crossover contaminations. The results were analyzed using StepOnePlus Software. The two targets used are sequences of CaMV 35S promoter and Internal Amplification Control (IAC). Of the above concentrations, 100%, 5% and 0.5% were successfully detected. It was concluded that the extraction method and the RT PCR method followed in this study could detect GM fruit samples to at least 0.5 %, of the sensitivity of which Sri Lankan regulation requires.

**Acknowledgement:** Financial assistance by Government Treasury to Industrial Technology Institute through research grant TG 16/132.

## **Effect of semi solid-state fermentation using *Saccharomyces cerevisia* on antioxidant activity of *Syzygium cumini* (L.) Skeels (*Maa Dan- Sin.*)**

Perera M.H.R., Wathsara H.P.T. and Ranasinghe, P.

*Herbal Technology Section, Modern Research and Development Complex,  
Industrial Technology Institute, Malabe*

### **Abstract**

Biotransformation is a process where the chemical composition is modified using enzymes or organisms in a fermentation process. *Syzygium cumini* (S. Maa Dan) is a seasonal and underutilized wild fruit in Sri Lanka with high potential as a source of nutraceutical. Therefore, in this study, effect of fermentation on antioxidant property of *Syzygium cumini* fruit pericarp and mixture of fruit pericarp with seeds were evaluated. *Syzygium cumini* fruits collected from Yala area were washed and coarsely blended without seed (Group A) and with seed (Group B) were subjected to standard wine brewing process. After 25 days of fermentation, total soluble solids, alcohol content, acidity, total phenolic compounds and antioxidant activity (Ferric reducing antioxidant power assay (FRAP)) were measured using standard protocols. Alcohol content of fermented Group B ( $6.7 \pm 0.8\%$ ) and Group A ( $4.6 \pm 1.2\%$  v/v) were not significantly different ( $p > 0.5$ ), but Group B showed lower acidity ( $0.9 \pm 0.06\%$  v/v) compared to Group A ( $1.3 \pm 0.2\%$  v/v). Total phenolic content and antioxidant activity were significantly higher ( $p < 0.01$ ) in Group B fermented samples ( $2.3 \pm 0.01$  mg GAE/ml;  $45.8 \pm 4.1$  mg TE/mL) than Group A ( $0.3 \pm 0.05$  mg GAE/ml;  $6.1 \pm 0.8$  mg TE/ml) respectively. Fermentation process has markedly increased the TPC and antioxidant activity compared to controls: Group B (TPC  $0.4 \pm 0.02$  mg GAE/mL, FRAP  $5.4 \pm 0.8$  mg TE/mL) and Group A (TPC  $0.2 \pm 0.06$  mg GAE/mL; FRAP  $2.3 \pm 0.1$  mg TE/mL) respectively. In conclusion, fermentation process can be effectively used to improve the bioactive potential of *Syzygiumcumini* fruits including seeds for development of supplements or beverages.

## **Development of an effective biocarrier to transmit hydrocarbon degrading bacterial strains for bioremediation**

Debnath S.K.<sup>1,2.</sup>, Rodrigo W.W.P.<sup>1\*</sup>, Jayawardhana B.J.G.<sup>1</sup> and Hemachandra C.K.<sup>3</sup>

<sup>1</sup>Biotechnology unit, Industrial technology institute, Colombo, <sup>2</sup>Business Management School, Colombo, <sup>3</sup>Department of Environmental Technology, University of Colombo, Colombo

### **Abstract**

Bioremediation is a sustainable technology that utilizes microbes to degrade a wide variety of pollutants into less or non-harmful products. During the bioremediation of crude oil contaminated water bodies, the natural biological activity of the micro-organism transforms the toxic petroleum components into harmless metabolites. The choice of a carrier to immobilize these microorganisms is an essential element for successful bioremediation. The objective of this study was to find out an effective biocarrier to transmit hydrocarbon degrading bacterial strains. The samples used in this research as carriers are rice husks, luffa sponge, coconut husks, sugar cane and saw dust. These biocarriers are immobilized with *Bacillus infantis* and *Enterobacter* species (a consortium), which have been proved by a previous research as an ideal consortium for the degradation of crude oil. The optical density at 620 nm was monitored throughout five day period using UV-Visible Spectrophotometer. Morphologically, significant degradation was observed throughout a time period of one week with three best results expressed by sugarcane, coconut husk and saw dust. According to results the highest growth kinetic was shown by the bacterial consortium that immobilized in sugar cane. Bacteria that immobilized in coconut husk also showed higher growth kinetic over the other three carriers. However, considerable growth kinetic can be identified in bacterial consortium that immobilized in luffa sponge, saw dust and rice husk. Although sugarcane has shown the highest growth kinetic in bacteria, sugarcane itself is a nutrient source. Therefore, instead of using crude oil as a nutrient source, it may survive on the nutrient source provided by sugarcane thus leading to insufficient degradation of crude oil. Sugarcane also has a tendency to absorb water and sink and it will not remain afloat on the surface with crude oil. This might lead to insufficient crude oil degradation. Accordingly, it can be concluded that coconut husk is the most suitable biocarrier to immobilize bacterial consortium for bioremediation. Further studies are necessary to detect the shelf life of the biocarrier selected.

## Effect of pressure cooking on trypsin inhibitor activity of locally grown legume varieties in Sri Lanka

Abeykoon A.M.C.N.<sup>1</sup>, Gunasekara M.A.<sup>2</sup>, Herath H.M.T.<sup>2\*</sup>, Liyanage S.L.<sup>2</sup> and Jayasinghe M. A.<sup>1</sup>

<sup>1</sup>Department of Food science & Technology, University of Sri Jayewardenepura, Nugegoda.

<sup>2</sup>Food Technology Section (FTS), Modern Research and Development Complex, Industrial Technology Institute, Malabe

### Abstract

Trypsin is an enzyme involved in protein digestion in humans. Trypsin inhibitors, one of the major anti nutritional factors present in legumes, bind with trypsin enzyme and reduce the protein digestibility and absorption of dietary protein. The objective of present study was to determine the effect of pressure cooking on Trypsin Inhibitor Activity (TIA) of selected (12) legumes including Cowpea (*Vigna unguiculata*) varieties of Bombay, Dhawala, Waruni, MICP 1, ANKCP 1, ANKCP 2, Mung bean (*Vigna radiata*) varieties of MI 5, MI 6, soy bean (*Glycine max*) varieties of Pb 1, MISB 1 and horse gram (*Macrotyloma uniflorum*) varieties of ANK-Black, ANK-Brown. The dried seeds were milled to pass through a 0.5 mm sieve for raw seed analysis. Pressure cooking treatment was performed by soaking seeds overnight followed by autoclaving for 10 min at 120°C. Cooked samples were freeze dried and ground to pass through 0.5 mm sieve. In determining TIA, Benzoyl –DL– Arginine – P-nitroanalide hydrochloride (BAPA) is used as a synthetic substrate for trypsin enzyme and rate of hydrolysis was measured by intensity of colour released by p-nitroaniline at absorbance 410 nm. Samples with high trypsin inhibitor contents release low amount of p-nitroaniline. According to the results, TIA in raw legumes ranged from 0.65±0.02 mg/g (ANK- Brown) to 1.52±0.01 mg/g (ANKCP1) while TIA in cooked legumes ranged from -0.11±0.1 mg/g (ANK-Black) to 0.61±0.02 mg/g (MI5) on dry weight basis. A significant difference (p<0.05) in TIA among the raw as well as cooked varieties were observed. Further a significant difference (p<0.05) in TIA was observed in comparison between cooked and raw form in each legume variety. The process of pressure cooking reduced TIA in legume varieties from 53.74% (MI6) to 100% (ANK-Black, Bombay).

**Acknowledgement:** Financial assistance is given by Research Grant TG18/147

## **Evaluation of sodium, potassium and free sugar contents of composite foods in Sri Lanka**

De Zoysa, H.P.E.<sup>1\*</sup>, Prasadani, W.C.<sup>1</sup>, Somasiri, H.P.P.S.<sup>1</sup> and Mahanama, K.R.R.<sup>2</sup>

<sup>1</sup>*Chemical and Microbiological Laboratory, Industrial Technology Institute, Colombo,*

<sup>2</sup>*Department of Chemistry, University of Colombo, Colombo*

### **Abstract**

Changes in dietary patterns cause people to consume foods having high in energy, fats, free sugars, salt/sodium (9–12 g of salt per day) and low in potassium (less than 3.5 g per day) which leads to malnutrition and non-communicable diseases. It is important to assess the levels of sodium, potassium and free sugars of commonly consumed food items in Sri Lanka to generate awareness, and to develop recommendations for possible effective interventions. Food items belong to the composite food category of WHO nutrient profile model for South East Asia region 2017, were randomly sampled from Colombo municipal council area. Fish rolls, fish pastry, ulundu wade, parippu wade, fried rice and rice and curry were selected for the initial study. Samples (n=6) were randomly purchased from high end sellers, middle end sellers and roadside sellers on different time intervals to evaluate whether there is a significant difference in sodium, potassium and free sugar contents based on the source. Free sugar content was analyzed by Lane and Eynon method and sodium and potassium contents were measured using flame photometer after dry ashing at 500 °C. Average potassium content of all the food samples tested vary from 0.42 to 0.04 g/100g, average sodium content varies from 0.03 to 1.04g/100g whereas free sugar was not detected (LOD = 2.0g/100g) in any of the tested samples. No statistically significant difference ( $p>0.05$ ) in potassium content or sodium content were obtained in tested food samples. According to nutrient profile model for South East Asia region by World health organization 2017, for composite food category, marketing should be prohibited if threshold levels exceed 0.35 g/100 g for sodium and 9.0 g /100 g for total sugars. Therefore, all the food samples comply with the values given in the nutrient profile model with respect to sugar content. But for sodium content, only fried rice and rice and curry comply with the threshold level of nutrient profile model, while other food items (fish pastry, fish rolls, ulundu wade, parippu wade) exceed the threshold level. However, threshold limit is not given for potassium content in the model. Therefore, it is important to aware people about the food items high in sodium content to minimize negative health effects.



## **Effect of short-term arsenic and cadmium contamination on physicochemical properties and microbial content of paddy soil**

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### **Abstract**

Pot experiments were carried out to investigate the effect of short term As and Cd contamination at different levels of pH, oxidation reduction potential (ORP) and microbial content of soil under paddy cultivation. Pots were contaminated with single and binary treatments of As and Cd in the concentrations 1.5, 4.0 and 6.0 mg kg<sup>-1</sup> and 0.5, 3.0, 6.0 mg kg<sup>-1</sup> respectively which were selected in such a way to present the average level of As and Cd contamination of agricultural lands in Sri Lanka and also the recommended upper limits in soil. The results showed that there was a reduction of pH of soil contaminated with both single and binary treatments of As and Cd, compared to control ( $p < 0.05$ ,  $r < - 0.95$ ) and the pH values were below the optimum pH range for paddy cultivation pH 5.5 - 6.5. Decrease of pH may due to hydrolysing capacity of As and Cd. Lowest pH value 4.26 was obtained in soil treated with highest level of As, 6.0 mg kg<sup>-1</sup> and Cd, 6.0 mg kg<sup>-1</sup>. Although there was a reduction of oxidation reduction potential (ORP) in pots which were contaminated with lowest level of As and Cd respectively, with the increase of concentration of As or Cd, ORP has been increased ( $p < 0.05$ ,  $r > 0.95$ ). Highest value of ORP, 422 mv was obtained in soil treated with highest level of both arsenic and cadmium indicated that soil is well aerated even under the stress of As and Cd. The effect of heavy metals on microbial population was detected by total plate count in aerobic condition (APC). Statistical analysis of results of APC showed that no significant difference among the mean APC values for both As and Cd single and binary treatments ( $p > 0.05$ ,  $r \approx 0$ ). Therefore, the present study revealed that contamination of arsenic and cadmium affected the soil pH, ORP and microbial content in different manner to each other. Even though there were a reduction of pH and increment of ORP of soil with the increase of As and Cd in both single and binary treatments, compared to control, no significant effect was observed on microbial content of soil by both treatments. Acidification of soil below optimum pH range for paddy cultivation may reduce crop yield and quality in paddy cultivation.

## Identification of aroma constituents in copra coconut oil

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### Abstract

Coconut oil represents the main source of edible oil use in Sri Lanka from long history. There are number of coconut oil types available in Sri Lanka. Among them copra coconut oil is the most widely used and most favorable oil, especially because of its aroma and health benefits. Therefore, efforts were made to identify the compounds which are responsible for its authentic aroma. Copra coconut oil (CCO) was prepared under laboratory conditions with 11 to 12 months matured coconut obtained from Coconut Research Institute, Sri Lanka. Volatile fraction was identified using head space GC-MS system (Thermoscientific trace 1300 model) with MS library system. CCO (2 g) was placed into a glass vial with 300 mg of internal standard (100 ppm eugenol) and fixed the cap and placed in the sample holder. Agitation was done at 65°C for 10 min to equilibrate the volatile compounds into headspace. After equilibration, 2.50 ml of headspace gas was injected in 5ml/min split flow with helium as a carrier gas at a rate of 1.0 mL/min on to Agilent polyethylene glycol DB-WAX UI column (length 30 m, diameter 0.250 mm, film 0.25 µm). The GC oven temperature was programmed from initial oven temperature of 60 °C, to 220 °C at a rate of 5 °C and then maintained for 10 min. Temperature of injector and ion source were 230 °C and 250 °C respectively. The MS separation was carried out with an iron capture detector operating in electronic impact mode with energy of 70 eV, a scan interval of 0.50 fragments and fragment detected in range of 50-450 Da. The volatile compounds were identified by comparing the mass spectrum with spectra from NIST 11 data base. Semi-Quantitative analysis was carried out with equivalent to internal standard of 100 ppm eugenol assuming response factor equal to one. 2,4-dimethylpent-2-ene, 4-hydroxyhex-3-ne-2-one, Acetic acid, Acetyl acetone, propanoic acid, butanoic acid, δ-octalactone, octanoic acid, hexanoic acid and 3-hydroxybutanoic acid were identified from the analysis. Hexanoic acid, δ-octalactone, octonoic acid and 3-hydroxybutanoic acid were in recorded range of 1.5-7.5 ppm. Acetic acid 76.92±0.46 ppm, Acetyl acetone 46.96±0.48 ppm and propanoic acid 170.99±0.48 ppm (mean±RSD) were recorded. In conclusion, components of the volatile fraction of CCO are reported for the first time and could be used as a marker tool for differentiation of CCO from other type of coconut oils.

**Acknowledgement:** Financial assistance given by research grant TG 16/129.

## Health risk assessment of selected macro and micro elements via dietary intake of some widely consuming rice varieties in Sri Lanka

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### Abstract

The aim of the present study was to investigate the mineral composition of selected commercially available rice varieties in Sri Lanka. Thirty rice samples were randomly selected from retailers and supermarkets in Gampaha district and rice varieties were analyzed for levels of phosphorous (P), potassium (K), magnesium (Mg), sodium (Na), calcium (Ca), boron (B), aluminium (Al), antimony (Sb), beryllium (Be), barium (Ba), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), molybdenum (Mo), arsenic (As), selenium (Se), cadmium (Cd), mercury (Hg) and lead (Pb) using laboratory validated, inductively coupled plasma mass spectrometric (ICP- MS) and UV- visible spectrophotometric methods after closed – vessel microwave digestion. Moreover, the levels of elements found in the rice samples of this study were compared with the maximum permissible limits of elements in rice given by WHO/FAO guidelines. Phosphorous (P) was the most abundant mineral element in all rice varieties. All rice varieties contained high levels of P, K, and Mg. Ca, B, Fe, Mn and Zn in rice grains were present in moderate concentration levels. Levels of Sb, Be, Se, Cd and Pb were less than the limit of quantification (LoQ) of the validated method. Mean concentrations of P, K, Mg, Mn, Zn and Mo in rice grains exceeded the maximum permissible limits of WHO/ FAO guidelines. Mean concentrations of Na, Ca, B, Fe, Ni, Cu and As in rice grains were lower than the maximum permissible limits of WHO/ FAO guidelines. Mean concentration of Hg in rice grains were same as the maximum permissible limit of WHO/ FAO guidelines. Mean estimated daily intakes of P and Mn exceeded the safer tolerable daily intake limits of the relevant elements set by WHO/ FAO Committee. Mean estimated, daily intake of Hg was same as the safer tolerable daily intake of Hg. Mean estimated daily intakes of K, Mg, Na, Ca, B, Al, Ba, Cr, Fe, Co, Ni, Cu, Zn, As and Mo were not exceeded the safer tolerable daily intakes of the relevant elements. Pigmented rice varieties have more mineral contents than non – pigmented rice varieties ( $p \leq 0.05$ ).

**Acknowledgement:** Financial assistance given by research grant TG 18/146.

## **Preliminary study on omega-3 and omega-6 essential fatty acids and omega-6/3 ratio in selected ready-to-eat snacks and diets in Colombo district of Sri Lanka**

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### **Abstract**

In this study, omega-3 and omega-6 essential fatty acids in commonly consumed, ready to eat snacks and diets were investigated by GC/FID and omega-6/3 ratios were quantified to determine the omega fatty acid intake by consumers in Sri Lanka. Total omega-3 including alpha-linolenic acid (C18:3n3; ALA), C20:3n3, eicosapentaenoic acid (C20:5n3; EPA) and docosahexaenoic acid (C22:6n3; DHA) were found in the range of 0.13 -1.51 g 100g<sup>-1</sup> of fat of all tested samples (n=48) in six food categories including fish rolls, fish pastry, wade (dhal), wade (uludu), fried rice (chicken) and normal rice and curry (chicken) representing different food vendors from road side seller to high end restaurants in Colombo district. The major omega-3 fatty acid detected in fish rolls and fish pastry was DHA while, in others C18:3n3 was the prominent omega-3 fatty acid. Relatively, higher mean ALA content was detected in fried rice and normal rice (ready-to eat diets) in the ranges of 0.30-0.70 g 100g<sup>-1</sup> and 0.21-0.66 g 100g<sup>-1</sup> respectively. A wide range of DHA was observed within all fish pastry (n=9) and fish rolls (n=9) samples in ranges of 0.02-0.34 and 0.02-1.11 g 100 g<sup>-1</sup> of fat respectively, may correlated to the quantity and quality of fish used during food preparation by different food vendors. Also, it is expected to have higher omega-3 fatty acids in those categories due to inclusion of fish. However, total EPA and DHA contents were lower than the total omega-6 content of both categories. Relatively, higher total omega-6 fatty acids than omega-3 fatty acids were detected in all samples and the average omega-6 content of each food category varied from 7.10 to 13.59 g 100g<sup>-1</sup> of fat. The major contributor to omega-6 fatty acids in all samples was C18:2n6 while C18:3n6, C20:3n6, C20:5n6 were detected in very minor quantities. Relatively higher variation (SD=4.10) was observed within total omega-6 fatty acids in rice and curry samples from road sellers. The analyzed ready to eat diets were deficient in omega 3-fatty acids and also have higher omega 6/3 ratios. Although, several countries and world health organizations have recommended omega-6/3 ratio in healthy diets to be (5-10): 1 or (4 -10): 1 the tested diets have higher ratios except rice and curry samples from middle scale food vendors.

## **Horse Gram: a source of functional food ingredient**

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### **Abstract**

The objective of present study is to investigate the potential utilization of horse gram and underutilized food legume as a functional food ingredient in food industry. Locally grown horse gram variety, ANK Brown (family; Fabaceae and species *Macrotylomauni florum*) was investigated for nutritional and functional properties using standard analytical methods. Results of proximate composition carried out according to AOAC, 2012 showed that the content of protein, fat, dietary fibre (DF), minerals and available carbohydrates on dry weight basis were  $24.2\pm 0.3\%$ ,  $0.8\pm 0.0\%$ ,  $21.2\pm 1.3\%$ ,  $3.6\pm 0.1\%$  and  $64.6\%$  respectively. Starch fractions by enzymatic hydrolysis; resistant starch (RS), non-resistant starch and total starch were  $10.5\pm 0.8\%$ ,  $32.7\pm 1.0\%$  and  $43.1\pm 1.7\%$  respectively and GI value of cooked grains by *in-vitro* analysis was  $39.8\pm 0.6$ . Minerals; Fe, Zn, Ca, K and Phosphorus were  $115 \pm 0.6$  mg/kg,  $30.6\pm 0.9$  mg/kg,  $1572 \pm 2.0$  mg/kg,  $1.0\pm 0.2\%$  and  $369 \pm 1.7$  mg/100g respectively. Results showed that horse gram has high protein, fibre and minerals; specially Fe and Zn and functional properties; high DF, high resistant starch and low GI. Prior to formulation of products, horse gram was pre-processed into gelatinized finely powdered flour (less than 0.5 mm) and horse gram flakes. Five horse gram-based products were formulated namely, granola bar, instant porridge mix, instant powdered drink, whole purpose flour and flakes mix. Horse gram flakes were incorporated in the formulation of granola bar and flakes mix while gelatinized horse gram flour was used for the formulation of rest of the products. Composition analysis of products (n=3) were performed and it was observed that high contents of protein, DF and minerals ranging from  $10.10\pm 0.4\%$  (Granola bar) to  $20.90\pm 0.2\%$  (instant powdered drink),  $12.49\pm 0.7\%$  (instant powdered drink) to  $15.24\pm 0.5\%$  (whole purpose flour) and  $1.5\pm 0.0\%$  (Granola bar) to  $4.87\pm 0.1\%$  (instant powdered drink) respectively. Energy values ranged from 299.02 - 338.32 kCal and products showed high overall acceptability.

**Acknowledgement:** Financial assistance given by research grant TG18/147

## Development of a vinegar free spicy sauce and assessment of its quality

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### Abstract

Most of sauce products contain tomatoes and vinegar as acidulate as well as taste enhancers. However, some people show allergic reactions for tomatoes and vinegar. Therefore, an attempt was taken to (a) develop a sauce consisting of local spices and free of vinegar (b) assess the quality of the sauce according to the standard protocols. Locally available spices including Tamarind (*Tamarindus indica. L*), Ginger (*Zingiber officinale L*), Garlic (*Allium sativum L.*) and Cinnamon (*Cinnamomumpzeylanicum Blume*) were used to develop the spicy sauce as a functional food. These spices are rich in antioxidant and known to perform functionally as antimicrobial, antifungal, anticancer, antidiabetic and cholesterol lowering properties. Two recipes (Formula 1: consist of, 8% Cinnamon powder with Garlic, Ginger and Tamarind in a ratio of 1:1:2 and Formula 2: consist of 4% Cinnamon powder with Garlic, Ginger and Tamarind in a ratio of 1:1:2) were prepared. The two sauce formulae were subjected to a trained sensory panel (n = 10) and consumer panel (n =23) to select the best recipe. Formula 1 (8% cinnamon) was selected as the best out of two formulae by majority preference of the sensory panelists. Formula 1 was free from aerobic bacteria, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella*, yeast and moulds. Furthermore, Arsenic, Lead, Tin, Cadmium, Mercury and Sulphur dioxide were not detected. Reducing sugar content and pH value of the formula 1 were  $7.1 \pm 0.2$  % w/w and 3.45 (at 26 °C) respectively. Proximate analysis revealed the presence of carbohydrate ( $74.3 \pm 0.5$  %), protein ( $0.6 \pm 0.0$  %), fat ( $1.3 \pm 0.5$ %) dietary fibre ( $5.9 \pm 0.0$  %) and crude fibre ( $2.5 \pm 0.3$ %) in dry weight basis. Energy value of the Formula 1 was 311.3 kcal/100 g.

## Antioxidant rich instant herbal porridge from leafy vegetables

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### Abstract

Antioxidant rich products are valued for their health benefits worldwide. They provide protection against multiple diseases. Many Sri Lankans use leafy porridge (kola kanda) as morning diet. The leaves of *Cassia auriculata* (Ranawara (S); Avarai (T)), *Coccinia grandis* (Kowakka (S); Kowwai (T)), *Murraya koenigii* (Karapincha (S); Kariveppilai (T)) and *Vernonia cinerea* (Monorakudimpiya (S); Sahadevi (T)) were selected for this study. Two porridge mixtures (PM) comprising mixture of leaf powder, processed rice, ginger powder, coconut milk powder, salt and green beans in powder and flake forms. The weight ratio of each leaf powder was determined based on the antioxidants (TPC & TFC) and antioxidant properties (DPPH, FRAP, ABTS & ORAC). The water extracts of leaf mixture (LM) and two PM were evaluated for antioxidants, antioxidant properties and nutritional value using standard methods. The sensory evaluations of two PM were based on preference measured with a hedonic scale. The TPC of LM and PM with green bean flakes and powder were  $144.75 \pm 3.85$  mg gallic acid equivalent (GE)/g of LM,  $2.49 \pm 0.07$  &  $2.62 \pm 0.08$  mg GE/g of PM; TFC,  $24.00 \pm 1.11$  quercetin equivalent (QE)/g of LM,  $0.39 \pm 0.01$  &  $0.38 \pm 0.02$  mg QE/g of PM respectively. The antioxidant properties as DPPH,  $5.17 \pm 0.04$  mg Trolox equivalent (TE)/g of LM,  $65.51 \pm 3.70$  &  $63.56 \pm 1.14$  mg TE/g of PM; FRAP,  $155.47 \pm 2.61$  mg TE/g of LM,  $1.56 \pm 0.08$  &  $1.46 \pm 0.04$  mg TE/g of PM; ABTS,  $17.38 \pm 0.76$  mg TE/g of LM,  $5.22 \pm 0.03$  &  $5.65 \pm 0.09$  mg TE/g of PM; and ORAC,  $9755.67 \pm 7.91$  mg TE/g of LM,  $1078.8 \pm 0.78$  &  $1129.07 \pm 0.79$  mg TE/g of PM respectively. The nutritional value of the PM with flakes and powder, crude protein:  $10.4 \pm 0.5\%$  &  $10.4 \pm 0.6\%$ ; crude fat:  $8.5 \pm 0.7\%$  &  $9.4 \pm 0.2\%$ ; crude fibre:  $2.5 \pm 0.0\%$  &  $2.5 \pm 0.1\%$ ; ash:  $2.7 \pm 0.0\%$  &  $3.7 \pm 0.0\%$  and total carbohydrate:  $67.2 \pm 1.2\%$  &  $61.4 \pm 0.8\%$  respectively. There was no significant difference ( $p < 0.05$ ) between two PM in terms of antioxidant activities, nutritional value and sensory evaluation. In conclusion, both PM are rich in antioxidants and possess marked antioxidant properties and can be used as a supplementary food.

## **Preliminary analysis of milk microbiome data of Sri Lankan dairies using 16s rRNA gene sequencing in Illumina MiSeq platform**

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### **Abstract**

Safeguarding and controlling the microbiological quality of raw milk is a worldwide concern, however, only a few studies have examined the bacterial biodiversity of raw milk and many questions exist as to their role in health and disease. In this backdrop, the aim of this study was to investigate the microbial diversity of raw milk produced in Sri Lankan dairies by 16S amplicon sequencing of milk microbial DNA using Illumina MiSeq sequencing platform. Fresh raw milk samples (n=90) were collected from healthy lactating cows of different breeds and lactation periods. Samples were collected from 18 dairy farms representing all three climatic zones during the year 2018 (April to July). The milk microbiome was characterized on the basis of V3 and V4 hypervariable region of the 16S rRNA gene by using paired-end sequencing on Illumina MiSeq device at the genome centre of Massey University, New Zealand. QIIME2 (version 2019.1), Phyloseq and Microbiome software's were used for sequence filtration and data analysis. Overall a total of 1858 OTUs at 97% similarity were assigned to 5 phyla and 9 Classes. Microbiome of the studied dairies was dominated by microorganisms from 5 Phyla; Actinobacteria, Bacteroidetes, Firmicutes Proteobacteria and TM7. Nine bacterial classes were detected and Actinobacteria, Alpha-proteobacteria, Bacilli, Bacteroidia, Betaproteobacteria, Clostridia, Flavobacteriia, Gamma-proteobacteria and TM7-3 were the most abundant. Clostridia were present only in the farm pooled samples and samples collected from Friesian, Jersey and Jersey-Sahiwal cross breeds of wet zone. Gamma-proteobacteria, Flavobacteriia, Bacilli and Actinobacteria classes were present in pooled samples from all 3 climatic zones. This preliminary data analysis reveals the suitability of Illumina MiSeq sequencing platform to investigate microbiome composition of dairy environments.



## **Development of Olu seed (*Nymphaea pubescens* Willd) incorporated food products and evaluation of nutritional, functional and sensory properties.**

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### **Abstract**

The present experiment was conducted to investigate the potential incorporation of seeds of 'Olu' plant also known as hairy water lily (*Nymphaea pubescens* Willd.) in to two suitable food products; a food bar developed from puffed Olu seeds and Olu seed flour incorporated instant string hopper flour mixture. Nutritional properties of the products were evaluated through crude protein, crude ash, crude fat, available carbohydrate and moisture content. Mineral and heavy metal contents were determined using ICP-MS and ICP- OES respectively. Methanolic extracts of samples were used to evaluate Total Phenolic Content (TPC) and Total Flavonoid Contents (TFC) using Folin Ciocaltue method and aluminum trichloride method (quercetin as reference) respectively. In vitro anti-oxidant capacities were determined using DPPH and ABTS<sup>+</sup> radical scavenging activities. Dinitrosalicylic acid reagent (DNS) and pooled human saliva was used to determine In vitro starch hydrolysis rate. Dietary fiber content was determined with reference to AOAC, 2000. Sensory acceptability of products was evaluated by twelve panelists using seven points Hedonic scale. Dietary fiber contents of 'Olu' seed, seed flour incorporated string hopper flour and 'Olu' food bar respectively were  $9.09 \pm 0.6\%$ ,  $5.50 \pm 0.4\%$ ,  $4.48 \pm 0.6\%$  and in vitro starch hydrolysis rates were 87.82, 118.91 and 96.64 respectively. TPC (mg/g GAE) of 'Olu' seed, seed flour incorporated string hopper flour and 'Olu' food bar were  $338.67 \pm 0.0$ ,  $10.33 \pm 0.0$ ,  $1.08 \pm 0.0$  and TFC (mg/g QE) were  $40.29 \pm 0.0$ ,  $2.75 \pm 0.00$ ,  $0.4 \pm 0.0$ . DPPH and ABTS<sup>+</sup> radical scavenging activities were not showed by 'Olu' food bars. DPPH IC<sub>50</sub> ( $\mu\text{g}/\text{ml}$ ) values of 'Olu' seeds and seed flour incorporated string hopper flour were  $23.00 \pm 0.0$  and  $454.89 \pm 0.0$  and ABTS<sup>+</sup> IC<sub>50</sub> ( $\mu\text{g}/\text{ml}$ ) values were  $23.00 \pm 0.0$  and  $229.87 \pm 0.0$  respectively. Results showed that 'Olu' seed possess strong anti-oxidant activities and is a rich source of dietary fibers and minerals. High sensory score was received for the food bar made out of puffed 'Olu' seeds and the string hopper flour incorporated with 35% 'Olu' seed flour.

## **Formulation of kithul (*Caryota urens*) treacle, kithul flour and virgin coconut oil incorporated ice cream**

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Jayawardana, S.A.S, Ransilu P.Y., Premasiri D.L.D.A.S., Samaranyake M.D.W.,  
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*Food Technology Section, Modern Research & Development Complex,  
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### **Abstract**

Ice cream is a ready-to-eat frozen dessert popular among all population sub groups regardless of the age. The present study was focused on formulating an ice cream by incorporating kithul (*Caryota urens*) treacle, kithul flour and virgin coconut oil in ice creams without adding refined white sugar, hydrogenated vegetable oils, artificial stabilizers, colours and flavours. Initially, three ice cream mixtures were formulated by incorporating different percentages of kithul flour instead of artificial stabilizers and based on the physicochemical properties of the ice cream mixtures, the most suitable percentage of kithul flour was selected. Subsequently, ice cream samples were formulated by adding the selected percentage of kithul flour as the stabilizer and by incorporating different percentages of kithul treacle and virgin coconut oil instead of refined white sugar and hydrogenated vegetable oil, respectively. Sensory attributes of the ice creams were evaluated using a trained and screened sensory panel with a seven point hedonic scale and based on the results, the most preferable percentages of kithul treacle and virgin coconut oil were selected. An ice cream prepared using refined white sugar, hydrogenated vegetable oil and artificial stabilizers was used as the control. Proximate composition, fatty acid profile, aerobic plate count and coliforms and *E. coli* counts were evaluated and data of each experiment were statistically analysed. The ice cream sample which was produced by incorporating 2% of kithul flour, 22% of kithul treacle and 1% of virgin coconut oil was selected as the most preferable ice cream sample among the tested samples. Protein, minerals, total dietary fibers, total energy and medium chain fatty acids contents of the selected ice cream are significantly ( $p < 0.05$ ) higher than those of the control ice cream. Ice creams were microbiologically stable and complied with the microbiological limits mentioned in the SLS specification for ice creams. Findings of the present study indicate that refined white sugar, artificial stabilizers, hydrogenated vegetable oils, artificial colours and flavours used in formulating ice creams can be successfully replaced with kithul treacle, kithul flour and virgin coconut oil without affecting the sensory properties.

## **Evaluation of the impact of three-hour power discontinuation on temperature and microbiological stability of refrigerated food: A simulated study**

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### **Abstract**

Intending to reduce electricity consumption, interim discontinuation of electricity supply to refrigerators and freezers for few hours/day is practiced domestically as well as commercially. Impacts of this practice have not been explained so far through a validated scientific study. The objective of the study was to investigate the impact of 3 h electricity discontinuation on temperature and microbiological stability of refrigerated food using a simulated model. Six food preparations representing diverse processing/storage stages were stored in “test” and “control” refrigerators in equal quantities/conditions. “Control” given continuous electricity supply, while electricity supply was interrupted for 3 h/ 24 h in “test”. Experiments were conducted for 72 h. Doors were kept open for 30 sec/30 min during 3 h period. Core temperatures of stored food were monitored. Initial, 24 h and 72 h microbial count of food stored in “test” and “control” was investigated. “Control” achieved 4 °C and -20 °C in refrigerator and freezer compartments, respectively. However in “test”, refrigerator compartment temperature increased from 4 °C to 24 °C; whereas freezer compartment temperature increased from -20 °C to 10 °C. “Test” required 3 h to regain relevant compartment temperature and door opening further elevated the required time up to 6 h. The core temperature of stored food have reached the danger zone (15 °C) creating a serious food safety risk and data from microbiological analysis confirmed these findings. Compared to “control”, food stored in different compartments of “test” demonstrated significant ( $P < 0.05$ ) increment in bacteria and mould. Increment of microflora may cause food poisoning, alter physio-chemical, shelf life and sensory qualities of refrigerated food. Certain strains may produce toxins resulting food intoxication. In conclusion, continuous electricity supply is vital to ensure the temperature & microbial stability of stored food to sustain food safety.

## **Cold plasma sterilization for selected Sri Lankan spices**

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### **Abstract**

Cold plasma technique is experimented worldwide as an effective non thermal surface sterilization method. This study focused both atmospheric and vacuum cold plasma with the objectives to identify the level of contamination of spices in the market, analyze their physicochemical properties and to evaluate the effectiveness of cold plasma for selected spices such as Chilli Powder (CPo), Chilli Pieces (CPi), Pepper Powder (PP), Pepper Seeds (PS), Turmeric Powder (TP) and Curry Powder (CP). Microbial quality of spices was analyzed using Aerobic Plate Count (APC) and Yeasts and Moulds (YM) count. Water activity, particle size distribution, bulk density and color were evaluated to select spices. Experiments on cold plasma sterilization were conducted with Atmospheric Cold Plasma (ACP) (15kV) and Vacuum Plasma (VP) (60W, 0.5 mbar) configurations for PS and PP. Samples were treated for 5, 10 and 15 minutes. Further, PS was diluted with peptone water and spread in plate count agar ( $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ,  $10^{-4}$ ,  $10^{-5}$ ,  $10^{-6}$ ) and dichloro glycerol agar ( $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$ ) and were exposed to ACP for 1 min, 3 min and 5 min. APC and Y & M counts were taken after 24 and 72 hrs. CPo, CPi, PS and PP did not comply with international microbiological standards in terms of APC and Y & M. Water activity, particle size distribution and bulk density were ranged from  $0.332 \pm 0.0$  -  $0.754 \pm 0.0$ ,  $106 \mu\text{m}$ - $1700 \mu\text{m}$  and  $0.53 \pm 0.0 \text{g/cm}^3$  -  $0.65 \pm 0.1 \text{g/cm}^3$ . Approximately one log reduction was obtained for APC and no significant reduction was observed in YM counts for pepper powder and seeds for both ACP and VP treatment while 0.5 – 1.0 log reduction was obtained in spread samples exposed to ACP treatment. No significant difference in color and water activity were observed after treating with ACP. Both ACP and VP have potential for sterilization of spices leading to a log reduction of 0.55, 1.08 and 0.25, 0.60 for APC and Y & M respectively. The effect of ACP interferes with the shadow effect exerted by the level of contamination, cell morphology, cell lamella and the penetration power of the reactive species of the cold plasma.

## **Decontamination of Pineapple (*Ananas comosus*) juice using Ozone as a non-thermal sterilization method**

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### **Abstract**

Ozone is a non-thermal preservation technology used for enhancing shelf life and safety of food products. The objective of this study was to evaluate the effect of gaseous ozone on microbial decontamination and physicochemical characteristics of pineapple (*Ananas comosus*) juice. Ozone treatments were applied for pineapple juice at 4 different ozone concentrations as 0.125g/l, 0.25g/l, 0.375g/l and 0.5g/l at 25°C and the overall impact on microbial load were evaluated. The reduction of Aerobic plate count (APC) was recorded as 2.02 log cycles and the reduction of Yeast and mould (YM) count was recorded as 2.00 log cycles after exposure to 0.5g/l ozone concentration. Considering soluble solids content and pH, Ozone treated samples retained the same soluble solids content of  $11.2 \pm 0.1$  and pH of  $4.03 \pm 0.05$  compared to control. Titratable acidity of control and Ozone treated sample were  $1.38 \pm 0.02$  and  $1.41 \pm 0.03$  respectively. No significant changes ( $p > 0.05$ ) were found in titratable acidity after ozonation. No significance difference was observed in Oxidation Reduction Potential (ORP) of untreated sample ( $267.66 \pm 2.30$ ) and ozone treated sample ( $275.33 \pm 1.52$ ) thus active hydrogen content (rH) of treated ( $23.91 \pm 0.08$ ) and control ( $23.65 \pm 0.16$ ). However, several quality parameters were significantly affected by ozone treatments such as colour where  $L^*$ ,  $a^*$  and  $b^*$  parameter were significantly affected by ozone treatments. Chroma parameter and hue angle showed a significant difference in ozonized juices compared to untreated samples. Fresh juice had the most yellowness and vivid colour (Hue angle =  $86.25 \pm 0.34^0$ ). From a sensorial perception, ozonized juices were substantially lighter than fresh juice. In conclusion gaseous ozone can be used in beverage industry to inactivate the microorganisms as a non-thermal sterilization technique. This method is effective on quality retention compared to thermal processing. It is recommended to optimize ozonation equipment for commercial application. Ozone sterilization technique can be used to develop a Ready to serve beverage through combination of other chemical preservative techniques.

## Screening of phytochemical compositions, mineral elements and antioxidant potentials of selected wild fruit plants in Sri Lanka

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### Abstract

This study was aimed to assess secondary metabolites, antioxidant potentials and mineral elements of 19 wild fruits grown in Sri Lanka including leaves, fruits and seed materials. Further, selected materials were evaluated for anti-diabetic activities, alkaloid content, effect of enzyme assisted extraction and interactions on combined extracts upon antioxidant activities. Methanolic extracts of leaves, fruits and seeds were evaluated for TPC, TFC and TAC by Folin Ciocalteu, AlCl<sub>3</sub> and dragendroff's reagents methods respectively. Antioxidant potentials were determined using DPPH<sup>·</sup> radicals scavenging assays, FRAP and ORAC assays. The mineral elements were analyzed by inductively coupled plasma – mass spectrometer method. The efficiency of enzyme assisted extractions were estimated by using mixture of commercial scale cellulase, pectinase and  $\alpha$ -amylase enzymes (1: 1: 1) by optimizing conditions. The combination interactions were evaluated and encapsulated using different ratios of casein to pectin (CPR) and core to coating material (CCR). The highest TPC, TFC and TAC values were recorded in seed extract of *Mangifera zeylanica* (461.98  $\pm$  18.27 mg GAE / g of extract), seed extract of *Garcinia xanthochymus* (161.08  $\pm$  6.01 mg QE/g of extract) and leaves extract of *Careya arborea* (445.60  $\pm$  3.89 mg/g) respectively. The highest DPPH and ABTS<sup>+</sup> scavenging activities were reported in seed extract of *M. zeylanica* with IC<sub>50</sub> value 7.12  $\pm$  0.09  $\mu$ g/ml of extract and in leaves extract of *C. arborea* with IC<sub>50</sub> value 4.17  $\pm$  0.12  $\mu$ g/ml extract. ICP-MS analysis revealed the presence of essential micro and macro elements. The enzyme assisted extractions of *M. zeylanica* seeds using 0.05 ml mixture of cellulase : pectinase :  $\alpha$ -amylase (1:1:1 by volume) gave higher extraction yield and the higher TPC (81.2  $\pm$  1.9 vs 58.3  $\pm$  0.1 mg GAE/ g of sample) and TFC ( 2.2  $\pm$  0.02 vs 1.7  $\pm$  0.01 mg GAE/ g of sample) compared to solvent extraction. The combination effects of fruit extracts of *Careya arborea* and *Flacourtia indica* revealed that mixing of two extracts lower the antioxidant potentials compared to individual fruit extract. The study concludes that the underutilized wild fruits including *Careya arborea*, *Mangifera zeylanica* and *Syzygium zeylanicum* exhibited the potentials to be used as natural sources for nutraceuticals and food supplements.

## ***In vitro* anti-diabetic activities of *Artocarpus nobilis*, *Artocarpus heterophyllus* and *Artocarpus altilis***

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### **Abstract**

Diabetes mellitus (DM) characterized by high blood sugar levels which could lead to several complications such as cardiovascular diseases, peripheral artery disease, chronic kidney disease, and diabetic retinopathy etc. Medicinal and aromatic plants have been using in the treatment of diabetes from ancient time. *Artocarpus* species are well known medicinal plants used in various medicinal preparations to improve digestion, reduce obesity, cholesterol and blood glucose levels, treat of hypertension, and as immunity and memory boosters. The objective of this study is to evaluate the anti-diabetic related properties of three *Artocarpus* species, *Artocarpus nobilis*, *Artocarpus heterophyllus* and *Artocarpus altilis* grown in Sri Lanka. Ethanol extracts of air-dried powdered bark and leaf extracts of above selected plants were evaluated for  $\alpha$ -amylase,  $\alpha$ -glucosidase, dipeptidyl peptidase IV (DPP4),  $\beta$ -glucuronidase and glycation, inhibitory activities *in vitro*, following standard protocols. Extracts of *A. nobilis* leaves exhibited highest DPP4 inhibitory activity ( $77.7 \pm 0.8\%$  at  $100 \mu\text{g/mL}$ ) but lower than the reference standard, sitagliptin ( $96.6 \pm 0.9\%$ ). *Artocarpus heterophyllus* bark and leaves extracts showed lowest DPP4 inhibitory activities having  $24.6 \pm 0.73\%$  and  $22.7 \pm 1.14\%$  inhibition at  $100 \mu\text{g/mL}$ , respectively. Alfa amylase inhibitory activity of bark extracts of *Artocarpus* species ranges from  $20.5 \pm 3.8\%$  to  $34.7 \pm 6.4\%$  where as leaves showed  $0\%$  to  $10.5 \pm 2.8\%$ . Bark extracts of tested *Artocarpus* species showed significantly high  $\alpha$ -amylase inhibition activity compared to leaf extracts ( $p < 0.05$ ). Leaf extracts of *A. heterophyllus* and *A. altilis* did not exhibit  $\alpha$ -amylase inhibition activity at the tested concentration of  $100 \mu\text{g/mL}$  while *A. nobilis* leaves showed inhibition of  $10.5 \pm 2.8\%$ . However, no significant difference was observed between  $\alpha$ -

amylase inhibition activity of bark extracts of *Artocarpus* species. In contrast leaf extracts of *A. altilis* and *A. nobilis* showed comparatively high glycation inhibitory activity ( $31.52 \pm 1.7\%$  and  $39.6 \pm 2.45\%$ , respectively) compared with those of bark extracts. Bark extracts of *A. nobilis* and *A. heterophyllus* showed highest  $\alpha$ -glucosidase inhibitory activities having  $53.9 \pm 2.8\%$  and  $65.5 \pm 0.6\%$  respectively compared to bark extract of *A. altilis*. However, there were no significant difference observed between leaf extracts of *A. nobilis*, *A. heterophyllus* and *A. altilis*.

This present study provides impetus to search for novel anti-diabetic compounds from *A. heterophyllus*, *A. nobilis* and *A. altilis* which deserves further investigations and supports the traditional claims.



## **Analysis of volatile constituents of leaf, stem bark and root bark oils of *Cinnamomum dubium* Nees (Sewel kurundu) found in Kanneliya forest reserve**

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### **Abstract**

The chemical composition of the essential oils of leaf, stem bark and root bark of *Cinnamomum dubium* collected from Kanneliya Forest Reserve was studied by Gas Chromatographic- Mass Spectrometry (GC-MS), first time in Sri Lanka. The oil contents were  $0.7 \pm 0.05\%$  (v/w) in stem bark,  $1.6 \pm 0.10\%$  (v/w) in leaf and  $1.8 \pm 0.10\%$  (v/w) in root bark on dry basis (In two samples). The oil of stem bark has  $\beta$ -phellandrene (24.7%), linalool (13.7%), selin-11-en-4 $\alpha$ -ol (10.8%) and *p*-cymene(8.8%) as the major compounds among 41 compounds. Thirty three components were identified in the leaf essential oil and the main components were  $\beta$ -phellandrene (39.9%), $\alpha$ -terpinene(15.4%), selin-11-en-4 $\alpha$ -ol(6.9%) and sabinene (6.5%). However, root bark oil contains 84.2% of methyleugenol as the major component. Further,selin-11-en-4 $\alpha$ -ol in leaf essential oil was isolated by recycle-HPLC and confirmed by NMR analysis. Recent Gas Chromatographic study on the steam distilled bark stem and leaf oils of *Cinnamomum dubium* shows  $\beta$ -caryophellene and geraniol respectively as major compounds. Further, Thin Layer Chromatographic (TLC) analysis of essential oils carried out by R. Sritharan showed that *Cinnamomum dubium* bark contains linalool in high amount; leaf oil has  $\alpha$ -terpinene as the major compound and linalool in moderate level, whereas, root bark contains moderate amount of  $\alpha$ -terpineneand traces of cinnamaldehyde, eugenol, linalool and acetyl eugenol. The present GC-MS results of stem bark and leaf oils of *Cinnamomumdubium* are partymatch with TLC results of previously published data. However, previous gas chromatographic analysis result of bark stem and leaf oils does not match with present GC-MS results. In conclusion, the stem bark oil and leaf oil of *Cinnamomumdubium* has high potential to in cooperateinmosquito repellentsin future. Also root stem oil of *Cinnamomumdubium* has high potential to use as fruit flyer trap in future.

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## Pharmacognostical identity of “Agil”, *Erythroxylum monogynum* Roxb and comparison with true Sandalwood for adulteration detection

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### Abstract

Sandalwood (*Santalum album* Linn) is admixed with Agil (*Erythroxylum monogynum* Roxb.) in Sri Lankan herbal market. Devoid of pharmacognostical data for the identification of ‘Agil’ leads to free adulteration in commerce. Effort is made to identify “Agil” by morphological, microscopical, TLC finger print and identification of aroma compounds by GCMS to generate data. Identification of macroscopic, microscopic, powder microscopic and organoleptic characters, development of TLC fingerprint profile GCMS of the essential oil extracted by water distillation of heart wood of “Agil” was carried out as per standard protocols and referring to other published data. Comparisons in terms of organoleptic characters of both the heart wood, differences of TLC & GCMS profiles were compared. Macroscopic data revealed that heartwood was similar to old matured sandalwood and also has similar taste. Microscopically, transverse section of the “Agil” heartwood showed isolated pitted fibres in the transverse section at places studded with simple and compound starch grains. In contrast, transverse section of the Sandalwood heartwood showed thick walled fibres embedded at places with isolated parenchyma filled with starch grains and few prismatic crystals of calcium oxalate; vessels are large, devoid of tracheids in the xylem. Medulary rays are uni to biseriate are filled with redish oily contents and brownish resinous content throughout the wood. TLC profiles showed dissimilar  $R_f$  values and colours in the profile. GCMS profiles are also dissimilar and “Agil” heartwood is reported to have Sandaracopimaral (50.9 %) as the major compound, which is a diterpine reported first time in the plant *Erythroxylum monogynum* which is normally found in *Pinus* and *Juniperus* species. In contrast, Sandalwood contains santalool as major aroma compound. Therefore, with the findings of this study, adulteration of Sandalwood with *Basterd sandal* can be easily identified qualitatively.

## **Analysis of Vitamin E in value added coconut oil**

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### **Abstract**

Tropical countries including Sri Lanka consume coconut oil for thousand years. It is an important vegetable oil with melting point of 24.4 °C (76 °F) and the oil contains 92% of saturated fatty acids which are in the form of triglycerides. Sludge oil is produced by fermenting waste coconut oil and water from oil expelling industries. Sludge oil is mainly used in soap manufacturing industry. However, properly value added sludge oil can be used in cosmetic industry effectively since it is resistance to oxidation and polymerization. Vitamin E or tocopherol is an antioxidant that works as a free radical scavenger in oil based products. Various coconut oil samples collected from different provinces were analyzed by HPLC according to the standard AOAC method. Concentration of vitamin E was calculated by comparison of peak areas of vitamin E in the test samples with those of standards. According to the results, almost all the samples were observed to have vitamin E. However, sekku expelled oil has more vitamin E (296 µg /100g) compared to all others and interestingly sludge oil also observed to have vitamin E (286 µg /100g). Therefore, sludge oil could be used in personal care products as a low cost alternative value added raw material if properly standardized.

**Acknowledgement:** Financial assistance given by research grant TG 16/119

## Promising inhibitors of Renin for management of dyslipidemia

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### Abstract

In recent years, the pathophysiological implications of the Renin-Angiotensin System (RAS) system have been the main focus of attention, and inhibitors of the RAS such as angiotensin-converting enzyme (ACE) inhibitors and angiotensin (ANG) II receptor blockers have become important targets in the treatment of dyslipidemia. The renin-angiotensin system (RAS) is involved in the blood pressure regulation and in the control of sodium and volume homeostasis. Renin selectively catalyzes the reaction of angiotensinogen to angiotensin I. Inhibiting renin appears to be appropriate for the management of dyslipidemia because of this high specificity and unique role of this enzyme in the renin–angiotensin cascade. The intensive effort using molecular modelling techniques, crystallographic structure elucidation and biological assays have led to the design of novel, highly potent and selective non-peptide, natural product inhibitors of human renin. These small-molecule inhibitors have favorable physicochemical properties, such as better water solubility and low lipophilicity as compared to type-I inhibitors, and are resistant to rapid biodegradation by peptidases in the intestinal tract, blood circulation and liver. Crystal structure analysis of renin–inhibitor complexes combined with computational methods was used in the medicinal-chemistry optimization process. Structure analysis revealed that the natural product inhibitor from *Garcinia Mangostana* binds as predicted, to the active site pocket. Likewise, evolitrine, a natural product isolated from *Acronychia pedunculata* (family: Rutaceae) also showed possible interactions in the active site of Renin. The Molecular Dynamic Simulation further proved that the binding of the inhibitor to the active site gorge stabilized the protein and the active site amino acid residues during a given simulation time as compared to that of Aliskiren (Control).

**Acknowledgement:** Financial assistance given by research grant TG 16/136

## **Electronic/Artificial fruit with wireless technology**

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### **Abstract**

Vehicle induced vibrations and mechanical loads cause severe damage to perishable agricultural products. Therefore, studying the nature of the shocks and vibrations during transportation of fruits and vegetables is important to reduce damage and sustain the quality of fresh products. This research focused on developing an artificial fruit to measure the acceleration during transportation and to view real time data from any remote location computer, Android phone or Tablet. Three artificial fruits were developed with electronic devices such as tri-axial accelerometer (ADXL345), Wi-Fi module-ESP 8266(NodeMCU) and re-chargeable lithium ion battery inside a rubber ball. These artificial fruits act as sensor nodes. Diameter of the fruit is 6.7 cm and weight is 36 g. ADXL345 has predefined X, Y and Z axis, therefore transformed accelerometer's data from device's coordinates to real world coordinates. Wi-fi module (ESP8266) acquires ADXL345 accelerometer data and sent through Wi-Fi to mobile and then access from remote PC. Activating mobile hotspot in mobile or tablet allow 10 devices to connect via Wi-Fi. Due to communication speed limitations it is capable of I2C fast data transfer mode at maximum output rate 800 Hz. Therefore data can be collected at every 2 ms. However access from remote location in server mode was not satisfactory, 'Thingspeak.com' was used to update accelerometer data real time. Data saved every 16 s in text file and view from remote location computer. Data collected for 10 minutes while artificial fruit was moving under different conditions (along smooth & rough road) at a data rate 50 Hz and analysed by power spectrum in National Instrument Lab view version 15.0. Accuracy of the Device is  $-0.1 g_n$ . The cost of artificial fruit is relatively low since Node MCU(ESP8266) available at low cost of 10 dollar. It's important to consider battery life in powering the ICs for performance of the device. Size and cost constraints on artificial fruit with wireless transmission/sensor nodes result in corresponding resources such as energy, memory, computational speed and communications bandwidth. For future work, the adhoc network can be implemented.

## **Property enhancement of calcium chloride by synthesizing stable ternary eutectic electrolyte for molten salt electrochemical applications**

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### **Abstract**

The property enhancement of calcium chloride electrolyte by introducing stable ternary eutectic composition has been investigated. The eutectic preparation was mainly achieved by a static melting method where the well ground mixture of calcium chloride (75%), sodium chloride (20%) and potassium chloride (5%) was gradually heated in a tube furnace around 600 °C for 30 minutes. The characterization of prepared eutectic electrolyte and raw materials was mainly achieved by Thermogravimetric analysis/Differential Scanning Calorimetry and X-ray diffraction. Results indicate that newly prepared ternary eutectic electrolyte is significantly accounted for low melting temperature ( $T_m \sim 495$  °C) compared to pure calcium chloride ( $T_m \sim 766$  °C). The significant reduction in melting temperature is essentially required to cut off the surplus energy cost associated with electrochemical processes that are typically carried out in molten calcium chloride at high-temperature. It is evident that ternary eutectic electrolyte is nonvolatile beyond its melting temperature compared to pure calcium chloride that has typically shown very high volatility above its melting temperature. The non-volatile nature ensures the retainment of liquid/molten form of the electrolyte for a longer duration without being undergoing considerable material/weight loss. The suppressed hygroscopic character of newly synthesized ternary eutectic electrolyte is another advantage over pure calcium chloride that further ensures easy and safe storage of the electrolyte for a prolonged period. It is also evident that the composition uniformity is preserved even after eutectic preparation where the static melting method ultimately avoids any form of phase alterations (composition changes) or material decomposition during constant heating. The newly prepared ternary eutectic electrolyte with enhanced physio-chemical properties can be effectively utilized for molten salt electrochemical applications instead of pure calcium chloride.

**Acknowledgement:** Financial assistance given by research grant TG 16/127

## **Characterization of *Terminalia catappa* L. (Kottamba) shell bio char for industrial applications**

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### **Abstract**

Kottamba, *Terminalia catappa* L. is an underutilized food source in Sri Lanka. The kernel of the fruit is around 8-10% of dry weight and the husk is a waste. Kottamba fruit is floatable in water and its husk has sponge like microstructure. Therefore, this study was focused on utilization of kottamba husk as a viable source of biochar. The potential applications of kottamba charcoal could be in pollution control, agricultural use such as mulching agents and floatable charcoal applications. Kottamba husk bio-char was prepared by closed-tort method using laboratory scale LP-gas fired kiln developed by Industrial Technology Institute. The charring temperature was maintained around 700 – 900°C. The yield of the bio-char was resulted as 25.5% dry weight basis. Water absorption and oil absorption percentages of grinded Kottamba bio-char was evaluated through laboratory developed protocol, using Di-ethyl phthalate blended commercial white oil (BB oil) as absorbate oil. Scanning electron micrographs (SEM) of the oven dried (100 °C) kottamba husk and bio-char of kottamba shells were evaluated. The micro-structures of both kottamba husk and bio-char evaluated at 100 times magnification showed that big cavity is surrounded by bunch of small cavities/ pores. SME analysis revealed that pore diameter of big cavities and small cavities were approximately 240 µm and 30 µm respectively. After converting of kottamba husk into bio-char showed more uniform sized structure than the input material. Apparent density of the grinded Kottamba bio-char was  $0.221 \pm 0.005 \text{ g cm}^{-3}$ . The water absorption percentage was observed as  $620 \pm 16$  and oil absorption percentage was  $644 \pm 51$ . The findings provided an avenue for potential use of kottamba husk as a source of bio-char.

## **Evaluation of the effect of graphite content on thermal conductivity and mechanical properties of natural rubber latex-graphite composites**

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### **Abstract**

This study was carried out to assess the effect of graphite content in natural rubber (NR)-graphite composites on thermal conductivity (evaluated by thermal-gradient<sup>1</sup>; lower the thermal-gradient higher the thermal conductivity) and simultaneously on mechanical properties (evaluated by tensile properties). Composites with varying ratios of graphite (10% - 60%) and NR latex were characterized and it was observed that the thermal-gradient was gradually decreasing (from 4.9 – 1.6  $\nabla T$ ,  $^{\circ}C/mm$ ) as the graphite content increased. On the contrary, thermal conductivity of the composites continues to increase proportionately (0% to 67.3 %) with the content of graphite. The elongation at break started to decrease drastically after 20 % of graphite. However, the results of tensile strength of the composites showed an increase up to 20 % after which it decreased significantly. As NR is poor thermal conductive material while graphite is a highly thermal conductive, it can be considered that the resulting composites are more thermally conductive than that of NR itself and at the same time, it can be expected to create adverse impacts on its mechanical properties that is probably due to the inclusion of graphite into its polymer lattice.



## Variation in free and total amino acid contents in rice upon parboiling

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### Abstract

The study presents the variations encountered in free amino acid (FAA) and total amino acid (TAA) compositions upon parboiling conditions across six different rice cultivars.

The compositions of FAA, TAA, non-essential amino acid (NEAA) and essential amino acid (EAA) in rice analyzed using high performance liquid chromatography with diode array detection (HPLC-DAD) and tandem mass spectrometry (LC-MS/MS) were significantly ( $p < 0.05$ ) increased with parboiling process. It was observed that the percentage increment in FAA ranged from,  $5.6\% \pm 0.8$  -  $59.7\% \pm 0.6$  while the percentage increment in TAA ranged between  $2.9\% \pm 0.4$  -  $19.3\% \pm 0.9$  across the cultivars. Further a significant enhancement in the formation of the non-proteogenic amino acid which possesses health promoting functional properties; gamma amino butyric acid (GABA) ranging between,  $1.3\% \pm 0.01$  -  $7.3\% \pm 0.02$  was observed upon parboiling in all the cultivars. In relation to the un-parboiled rice, a significant reduction in the percentage removal of amino acids upon milling was observed in parboiled rice that could be attributed to the inward diffusion of nutrients from bran layers to the rice endosperm during the parboiling process aiding retention of FAA, GABA and TAA upon milling. The percentage increase in FAAs, TAA levels varied upon the parboiling technique. In general, parboiled rice produced by soaking followed by steam reported the highest percentage increment in FAA including GABA. However, the optimum parboiling conditions for producing the highest TAA compositions widely differed across the cultivars. The changes in the enzymatic activities driven by the genetic diversity during the parboiling process could be attributed for these variations in the compositional changes in amino acids. Therefore, study reveals that parboiling imparts a significant increase in the nutritive value of rice with respect to amino acids that varied across the cultivars and upon the parboiling technique. Hence, the findings presented in this study provide an insight to the consumers and nutritionists to reconsider the food consumption patterns and as an important reference to the rice producers in redefining their processing techniques.

## Evaluation of the exposure to aflatoxins at the time of consumption of infusions of *Camellia sinensis* (Tea) by Liquid Chromatography- Tandem Mass Spectrometry (LC-MS/MS)

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### Abstract

Aflatoxins are secondary metabolites produced by certain mycotoxigenic fungal species and aflatoxin contamination can be seen in a wide range of matrices in tropical climates. *Camellia sinensis* (Tea) being a major commercial crop in Sri Lanka was claimed to be contaminated with aflatoxins throughout the processing and market chain. Underivatized aflatoxins were analyzed by Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS) in tea powder and tea brew. The extraction efficiency of aflatoxins into the tea brew was evaluated using artificially contaminated sample. Market samples were collected from supermarkets and retail shops within Colombo municipal area and commonly used brands were selected. Three batches from each brand were collected from 10 tea packs, 8 tea bag packs, 8 green tea bag packs and 5 loose tea samples from different grades. Tea powder and the brew of the tea sample were separately analyzed for aflatoxins and samples were brewed as per the ISO 3103 standard. Tea samples were extracted with 80% acetonitrile and the acidified extract was purified through R-Biopharmmultimycotoxin solid-phase cleanup columns to reduce the matrix interferences. Limit of determination for powdered tea was 4 µg kg<sup>-1</sup> and 0.4 µg kg<sup>-1</sup> for tea brew for all four aflatoxins. Spike samples were analyzed along with samples to assure the accuracy of the method and recovery of the spikes were satisfactory. Further, the extraction efficiency of aflatoxins into the tea brew was found to be less than 5% for all four aflatoxins in three levels analyzed, 0.4 µg kg<sup>-1</sup>, 1 µg kg<sup>-1</sup> and 4 µg kg<sup>-1</sup> of aflatoxins in tea brew. Though the aflatoxins are thermally stable the solubility of aflatoxins in water is comparatively less than in the other organic solvents thus transferring of aflatoxins into the boiled water from the tea matrix is significantly reduced. No significant contamination of aflatoxins above 4 µg kg<sup>-1</sup> was detected in all 31 tea samples tested and even though tea samples were contaminated with aflatoxins since the extraction efficiency of aflatoxins into the water is less than 5%, it can be concluded that the exposure to the aflatoxins at the time of consumption is insignificant.

**Acknowledgement:** Financial assistance given by research grant TG 16/135

## **Direct determination of Glyphosate and Amino methyl phosphonic acid (AMPA) in soil by Liquid Chromatography- Tandem Mass Spectrometry (LC-MS/MS)-Single laboratory method validation**

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### **Abstract**

Glyphosate (GLY) is a non-selective weedicide, used in agriculture and horticulture for mitigating a wide range of weeds and it applies to the foliage of the weeds. GLY has a greater tendency to adsorb into the soil particles, especially via soil organic matters, minerals, oxides and hydroxides. Therefore, extraction of GLY from the soil is hard to attend and needs strong alkaline or acidic conditions. In soils, GLY degrades to AMPA under microbial activities. In the present study, air-dried soil samples were spiked with GLY and AMPA to validate the method in three concentration levels of 2.5 mg kg<sup>-1</sup>, 20 mg kg<sup>-1</sup> and 40 mg kg<sup>-1</sup>. Accurately measured 2 g of soil and 10 mL of 0.2 mol L<sup>-1</sup> KOH were added into a falcon tube, vortex mixed and centrifuged. The resultant supernatant was diluted with 1% acetic acid then centrifuged and injected to the LC-MS/MS filtering through 0.22 µm syringe filter. Matrix matched standard series was prepared in the same way and analysis was performed with Waters X select HSS PFP 5 µm 2.1×150 mm. Validation of the method was carried out against linearity, repeatability, reproducibility and spike recovery in ten replicates at above-stated three levels. The linear range of the method was obtained from 0.5 µg L<sup>-1</sup> to 50 µg L<sup>-1</sup> and the method exhibits excellent linear regressions with 0.999 for both GLY and AMPA. The method demonstrated higher trueness with the recovery of both GLY and AMPA in all three levels higher than 100%. The results attribute well precise results with the relative standard deviations (RSD) less than 3% for both repeatability and reproducibility for all three spike levels in both analytes. Further, the limit of determinations of both analytes was 0.5 mg kg<sup>-1</sup>. Consequently, the proposed method provides an excellent analytical pathway for GLY and AMPA in the soil like complicated matrices.

**Acknowledgement:** Financial assistance given by research grant TG/16/133

## **Validation of RP-HPLC method to simultaneous quantification of vitamin C & citric acid in food, and beverages**

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### **Abstract**

A balance diet is a vital need as per the recommended daily allowances (RDA) for a healthy life. Vitamins play an important role in this respect like the other main nutritional components. Vitamin C is among the important vitamins, as not synthesized in the human body, which must be supplied through a balanced diet. Hence fortification of food with such ingredients is a common practice in food industry. Two such common additives, used especially in the food industry, are vitamin C and citric acid. Vitamin C acts as an antioxidant and citric acid balances the taste and prevents browning reactions. Confirmation of enriched and reported levels of these additives in various food is an imperative requirement for QA / QC aspects of food. This research was, conducted to validate a concurrent method for vitamin C (L-ascorbic acid) and citric acid in beverages with reverse phase liquid chromatography (RP-HPLC). The analysis were carried out under isocratic conditions in 75:25 mobile phase A and B of 20 mM phosphate buffer (A) and a mixed mobile phase of methanol acetonitrile (B). Detection was carried out at the wavelength of 230 nm. Validation of the method performed in terms of accuracy, precision, repeatability, reproducibility, linearity, minimum detection level, working range and recovery according to the Eurachem guidelines. The detection limits for vitamin C and citric acid were 0.5  $\mu\text{g mL}^{-1}$  and 20  $\mu\text{g mL}^{-1}$ , respectively. The linearity indicated by the regression value ( $R^2$ ) for vitamin C was 0.9999 at the working range of 0.5  $\text{mg kg}^{-1}$  to 500  $\text{mg kg}^{-1}$  and that for citric acid was 0.9998 for the working range of 20  $\text{mg kg}^{-1}$  to 600  $\text{mg kg}^{-1}$ . Recovery of the method was between 80% and 120% for both vitamin C and citric acid. The accuracy of the method was determined using a QC sample that falls within the accepted range. RP-HPLC was found to be a reliable detection method for vitamin C and citric acid simultaneously in food, feed and beverages.

## **Monitoring of pesticide residue contamination in tea sold in the Sri Lankan market**

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### **Abstract**

As the most popular beverage among the people, increased consumer demand for tea has led to the elevated usage of pesticides to combat the damage to the crops from pests. The study presented was aimed at providing reference to understand the extent of exposure of the consumer to pesticide residue contamination arising from consumption of tea from the local market. For the study, 73 number of black and green tea samples sold in packets, tea bags representing 15 popular brands within the country and 17 unpackaged tea sold under the trade grades of BOPF and dust sampled from leading supermarkets and sales outlets located in Colombo and the infused tea prepared from the collected samples were analyzed for the presence of 33 pesticide residues using modified QuEChERS method by liquid chromatography-tandem mass spectrometric (LC-MS/MS) detection.

Study revealed that 20 % of the samples investigated were contaminated with at least a single pesticide residue, with 11% from the total exceeding the maximum residue levels (MRLs) stipulated by the CODEX and the European Union (EU) for tea. Pesticide residues of BPMC, Captan, Fipronil, Isoprothiolane, Tebufenozide and Thiacloprid were detected in the range of (0.005-0.05 mg kg<sup>-1</sup>) while none of the samples was found contaminated with Metribuzin, Hexaconazole, Tebuconazole, Diazinon, Thiamethoxam, Quinalfos, Chlorpyrifos, Dimethoate, Diuron, Methomyl, Fenamiphos, Triazophos, Fenitrothion, Pirimiphos methyl, Carbofuran, Phenthoate, Tricyclazole, Diuron, Fenthion, Novaluron, Flutriafol, Indoxacarb, Flutolanil, Azoxystrobin, Imidacloprid, Pyraclostrobin and Sulfoxaflopat 0.005 mg kg<sup>-1</sup> quantification level. Out of the samples analyzed for each category, the highest percentage of contamination of 27% was observed in the tea bags while the percentage contamination of packaged and tea sold in unpackaged form were 17% and 12% respectively. However, none of the pesticides was detected in the infused tea prepared from the contaminated tea powder. Therefore, despite the presence of pesticide residue contamination, the low extraction efficacy of the pesticide residues to the infused tea and the thermal degradation during the infusion warrants the pesticide residue contamination to lie below the levels detrimental to health, rendering the investigated tea safe for consumption.

## **Performance measurement of research institute: case study by Industrial Technology Institute, Sri Lanka**

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### **Abstract**

Research performance analysis is becoming an essential part in Research and Development Institutions worldwide. The research performance of Industrial Technology Institute (ITI) is generally considered to be higher, however no previous analysis or publication were done regarding the performance of the ITI. ITI is the only government own multidisciplinary Research Institute among the Research and Development institutions in Sri Lanka. R&D sections of the ITI comprised of five sections naming Food Technology, Herbal Technology, Materials Technology, Environmental Technology and Biotechnology. The purpose of the study is to evaluate the research performance of the ITI for past 10 years (2008 – 2018). The parameters such as number of articles published in referred journals, local and international communications, major technology transfers, number of patented technologies/ products and local and international awards received by ITI staff were used to measure the research performance. Further, the study investigated an authorship pattern and co-authorship pattern of the publications in referred journals. Around 2127 records were obtained for 10 year period from ITI Annual Reports and data were analyzed using MS Excel 2007. The findings indicated that the highest performance of the ITI during the decade was in year 2017 and the lowest in 2008. In addition ITI shows higher performances in year 2013, 2015 and 2018. The results showed an increasing trend in performance within the 10 year period for all the parameters measured except number of patents. Analysis on authorship pattern showed that single-authored papers are squat compared to multi-authored papers. Hence, this quantitative study showed an increasing trend of performance of the ITI from 2008 to 2018.

## **Implication of mercury (Hg) in fast moving whitening creams available in the domestic market**

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### **Abstract**

Addition of Mercury (Hg) salts to face whitening cream is a dangerous issue of increasing importance, considering the widespread and growing popularity of face whitening products in Sri Lanka. This study reports the levels of Hg in fast moving, selected whitening creams as a potential contributor of Hg into the human and environment. Well known popular whitening creams imported and locally manufactured were randomly purchased from the market for the study. All together 27 samples were purchased and prepared for Inductively Coupled Plasma Spectrometer (ICP-MS) analysis in compliance to ISO/TR 17276:2014 method by microwave digestion with ultra pure con. HNO<sub>3</sub>. ISO/TR 17276:2014 method was verified with respect to trueness and found mean recovery percentage of spiked samples was in the satisfactory recovery range of 80-120%. The results were assessed against the SLS 743:2014 standard. About 52% of the collected market products were found to be over the SLS maximum limit 1.0 mg kg<sup>-1</sup> of Hg. The level of contamination ranged from 1.10 to 51752 mg kg<sup>-1</sup>. More than 37% of the sample contains 5000 mg kg<sup>-1</sup> of Hg that is 5000 times higher than the maximum limit given in the standard and 26% of samples surpass 10000 mg kg<sup>-1</sup> of Hg limit. Only 48% of the samples are complying with SLS maximum allowable limit and most of them were produced within the country. The exceptionally elevated levels of Hg found in imported whitening creams would probably be attributed to use of substandard raw materials or adding Hg salts as raw materials. Upon analysis of all imported samples contaminated with mercury, it was found that contaminated products contain incomplete labeling. The findings, more importantly stress that enforcement of practically safe domestic regulatory mechanism for Hg in whitening cream is an urgent requirement. Restrictions must be in place for use of imported whitening creams by highly vulnerable age groups such as school children's and woman who works in garment industries.

## **Comparison of Total Suspended Particulate Matter (TSPM) concentrations of different industries in Sri Lanka**

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### **Abstract**

The atmospheric dust arises from the mechanical disturbance of granular material exposed to the air. Dust generated from these open sources is termed "fugitive" because it is not discharged to the atmosphere in a confined flow stream. The latest world Air Pollution Report has identified Sri Lanka as the 18<sup>th</sup> worst country in regards air pollution. The Central Environmental Authority noted that 10% of polluted air in Sri Lanka is due to industrial sector. This study was conducted to identify the industrial sectors which have a significant impact to air pollution in Sri Lanka. In order to compare the Total Suspended Particulate Matter (TSPM) concentrations eleven factories from each of the following six industries were selected; wood, rubber & plastic, cement, food, crusher plants and asphalt plants. TSPM, as measured by the standard high-volume air sampler according to the Fugitive Dust Emission Standards. TSPM concentrations of the six industries rely within the following ranges. Asphalt plants 72-852  $\mu\text{g}/\text{m}^3$ , crusher plants 63-437  $\mu\text{g}/\text{m}^3$ , cement-based factories 37-456  $\mu\text{g}/\text{m}^3$ , food-based industries 31-307  $\mu\text{g}/\text{m}^3$ , wood based industries 9-258  $\mu\text{g}/\text{m}^3$  and rubber/plastic based industries 10-248  $\mu\text{g}/\text{m}^3$ . This study revealed that asphalt plants, crusher plants and cement-based industries generates more TSPM than other industries. It is expected to increase the number of such industries with development of the country; therefore more focus on monitoring and regulation of the level of TSPM within the FDE standard is necessary to minimize health and environmental hazards.



## Comparison of microbial contamination of dried tea and brewed tea

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### Abstract

Brew of dried leaves of plant *Camellia sinensis*, commonly known as tea is popular as a stimulant, especially Sri Lankan tea for its flavour. Dried leaves of plant *Camellia sinensis* is a good niche to microorganisms when environmental conditions are favourable. Even though the moisture level is about 3 - 4%, microorganisms may present in dried tea leaves. If, heat resistant microorganisms and spores are present, they may survive during the preparation of brew, making tea brew unsafe to consume. The aim of this study was to determine the initial bacterial and fungal levels in different tea types available in the market and in the respective tea brews at the time of consumption. Tea available as black tea-loose, packed & tea bags, green tea bags and flavoured tea bags in the local market were selected for the study. Pour plate technique followed by preparation of dilution series was used for enumeration. Standard Plate Count Agar (SPCA) was used to culture bacteria in both tea and brew. Dichloran Glycerol 18 (DG 18) agar was used to culture fungi in tea and Dichloran Rose Bengal Chloramphenicol (DRBC) agar was used to culture fungi in brew. Initial bacterial counts were in the range of 100 – 107,000 CFU/g and initial fungal counts were in the range of 100 - 68,850 CFU/g in tea. Bacterial levels and the fungal levels in the tea brew vary between 1 – 47 CFU/mL and 0 – 340 CFU/mL respectively. The highest initial bacterial count is in Flavoured tea packs and is 107,000 CFU/g while the highest initial fungal count was found in Green tea and the count is 68,850 CFU/g. Packed black tea has the minimum level of initial bacterial and fungal counts of 207 CFU/g and 106 CFU/g respectively, as compared with loose tea packs. The reduction percentage of both bacteria and fungi counts in brew of green tea bags was above 88% and 99% respectively. Reduction of both bacterial and fungal counts in brewed tea of others were over 94% and 93% respectively.

**Acknowledgement:** Financial assistance given by research grant TG 16/135

## Microbiological assessment of air & water quality in Sri Lankan tea factories

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### Abstract

The aim of this study was to investigate the microbiological quality of water used in tea factories in moisturizing the environment during the production process. Air quality was also monitored using total yeast and mould counts in packaging areas of the factories. For the study, 28 factories were selected and quantitative analysis of microorganisms were performed as per Sri Lanka standards procedures.

According to air quality monitoring results, the highest and the lowest ranges of colony counts were observed in the factories located in Udupussallawa (380 - 5440 CFU m<sup>-3</sup>) and Uva (390 – 990 CFU m<sup>-3</sup>) respectively, however high average colony counts were observed in the factories located in Nuweraeliya, Udupussallawa and Sabaragamuwa (>1000 CFU m<sup>-3</sup>), whereas factories located in Kandy, Ruhuna, Dimbula and Uva had colony counts < 1000 CFU m<sup>-3</sup>. Yeast & mould counts had no significant difference within the factories located in Ruhunu, Udupussallawa, Nuwaraeliya and Dibula regions ( $p \geq 0.05$ ). However, yeast & mould counts were significantly different in factories located in Kandy and Uva regions ( $p \leq 0.05$ ). The comparison of results, within different agro climatic regions, indicated no significant difference, but there was a significant difference in results among the three elevations. Out of the 28 factories subjected to analysis only three factories (11%) located in Ruhuna, Udupusallawa and Didula gave highest coliform counts (> 1000 CFU m<sup>-3</sup>) in water samples. Forty-six percent of the factories had coliform counts within 500 – 999 CFU m<sup>-3</sup> whereas another 46 % of factories showed coliform counts <499 CFU m<sup>-3</sup>. Similarly, 39% of the factories showed *E. coli* count of < 100 CFU m<sup>-3</sup> in the water, but 21% of the factories had *E. coli* counts of > 500 CFUm<sup>-3</sup>. The coliform counts were significantly different among the factories located in different agro climatic regions, whereas, the *E. coli* counts were not significantly different. The results indicated that only two factories in Sabaragamuwa region and one factory in Ruhunu region comply with the Sri Lankan standard (SLS 614). It is concluded that there is a necessity to consider coliforms and *E. coli* counts in the final product (tea) before any definite conclusion is made.

## **Molecular characterization of thermophilic bacteria present in solid-waste composting**

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### **Abstract**

Landfills in Sri Lanka are rapidly grown due to the collection of solid waste, with one person generating an average of 0.4-1kg of waste per day. An environmentally friendly way of managing these solid wastes is composting. Microorganisms play a key role in composting process by degradation of solid waste. Thermophilic bacteria contribute largely to the degradation of waste, which involves the degradation of major structural molecules in plants and animals. Hence, the main objective of this study was to isolate and perform a molecular characterization of thermophilic bacteria in the solid waste compost mixture. Three compost samples in the thermophilic phase (50-55 °C) were collected from a compost bin, by measuring the temperature of the collection spots. The three samples collected were mixed into one sample in the laboratory under sterile conditions. A weight of 4 g (10%) of the compost mixer was dissolved in the 40 ml of autoclaved Double Distilled Water (DDW) and mixed in room temperature at 150 rpm for 2 hrs. The liquid compost was filtered and the filtrate was serially diluted from  $10^{-1}$  to  $10^{-8}$  in DDW. A volume of 100 ul from each serially diluted filtrate was plated on primary Nutrient Agar (NA) plates separately and incubated at 55 °C overnight. The colonies were morphologically analyzed and randomly selected colonies were re-cultured on carboxymethyl cellulose (CMC) plates and incubated at 55°C overnight. A number of ten colonies which were grown only on NA plates and both NA /CMC plates were sequenced for 16S ribosomal RNA for bacterial characterization. A number of thirty-three colonies were morphologically identified as bacterial and four as fungal. Only five colonies were grown on CMC plates. A number of eight out of nine colonies were genetically characterized as *Aneurinibacillus hermoaerophilus* of family Paenibacillus while one colony was *Bacillus smithi* of family Bacillaceae. The isolated bacteria from this study are thermotolerant lipolytic bacteria and the most prevalent bacteria in the studied compost was *Aneurinibacillus hermoaerophilus*. Further studies should be carried out to isolate multiple microorganisms, with lipolytic as well as cellulose degradable ability, for rapid and efficient degradation of solid waste.

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