# Wayamba University Research Congress

# PROCEEDINGS

OF

# WURC - 2022

**December 09, 2022**

*Building Connectivity Through Innovative Multidisciplinary Research*

**Senate Research and Higher Degrees Committee**

Wayamba University of Sri Lanka

# PROCEEDINGS

## 7th Wayamba University Research Congress – 2022

# WURC - 2022

*Building Connectivity Through Innovative Multidisciplinary Research*

**Senate Research and Higher Degrees Committee**

Wayamba University of Sri Lanka

**Proceedings of the Wayamba University Research Congress 2022**

**Wayamba University of Sri Lanka**
**Kuliyapitiya**
**Sri Lanka**

# *"Building Connectivity through Innovative Multidisciplinary Research"*



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# *Message from the Vice-Chancellor*

Wayamba University of Sri Lanka

**Senior Prof. Udith K. Jayasinghe**
**Vice-Chancellor**
Wayamba University of Sri Lanka


I am pleased to write this message for the proceedings of the 7th Wayamba University Research Congress 2022 (WURC), on the theme "Building Connectivity through Innovative Multidisciplinary Research". The Wayamba University of Sri Lanka considers the sustainability of research tradition as an integral part of the academic landscape of the University and this annual event is one the main highlights.

Over the years, the Wayamba University of Sri Lanka has produced many global, regional and national award winners in research and innovations. It is encouraging to note that these senior and young scientists have set the stage for more upcoming researchers to follow in their footsteps, under their able guidance. WURC serves as the platform for presentation of such research.

The number of postgraduate research students seeking admission to the Wayamba University of Sri Lanka increases regularly. They are fortunate to be able to make their presentations at WURC and be exposed to an important aspect of research, i.e., the dissemination of the research outcomes.

I congratulate the scholars who have won the awards and merit awards for 'the Most Outstanding Researcher' and 'the Most Outstanding Young Researcher' for the year 2021 and those who are recognized for their Publications in Indexed Journals in the year 2021.

I also wish to commend the Chairman and Members of the Senate Research & Higher Degrees Committee, for organizing this event to encourage the tradition of research and innovation, and to recognize and honour the research capabilities of the staff.

# Message from the Dean of the Faculty of Agriculture and Plantation Management

**Prof. Jagath Edirisinghe**
**Dean**
**Faculty of Agriculture and Plantation Management**
Wayamba University of Sri Lanka

I am extremely delighted to write this short message on the 7th occasion of the Wayamba University Research Congress. The Faculty of Agriculture and Plantation Management value high quality research. Thus, we fully support Wayamba University research programs, the pinnacle of which is the research congress, where all researchers and research students present their important and valuable findings in one place. Many researchers and postgraduate students from the Faculty of Agriculture and Plantation Management have presented in the previous occasions of this congress and is presenting at this 7th congress as well.

Research is the backbone of any developing society. Universities take leadership in research all over the world. The Wayamba University is also taking steps in leaps and bounds in this direction. As a Dean of a Faculty, I am extremely delighted to see this happening. Therefore, I am very much grateful to those who have worked hard towards this successful event. Without their untiring and voluntary efforts, a congress of this magnitude would not have been possible.

I congratulate all those presenters who are presenting and showcasing their exciting research in this congress. I sincerely hope that the researches that are presented will get debated, discussed and thereby improved to make a change in Sri Lanka and the whole world.

# *Message from the Dean of the Faculty of Applied Sciences*

**Prof. L.D.R.D. Perera**
**Dean**
**Faculty of Applied Sciences**
Wayamba University of Sri Lanka

It is with great pleasure that I write this message to mark the Wayamba University Research Congress-2022, which runs into its seventh successful chapter this year.

Scientific Research is the foundation of new knowledge. Research is an integral component of university academics' career. Significant emphasis is placed on creation of new knowledge and innovations through research carried out at universities, and its potential contribution to economic development of a country. Wayamba University has also been engaged in this endeavor by promoting research activities at the University through provision of financial assistance and other opportunities.

Wayamba University Research Congress (WURC) is such an opportunity, where a platform is provided for the university community, especially to the university research grant holders and postgraduate students, to present their research findings and share their experiences and knowledge with peers. It is encouraging to see that research work to be presented at WURC covers wide areas in Science, Technology and Management, and that the whole academic community of the university are to make a share. This trend would ensure a sustainable research environment at Wayamba.

Research Congress-2022 is a result of collaborative effort of the academic community and the university administration. With the directions of the Vice-chancellor and the Senate, the Senate Research and Higher Degrees Committee (SRHDC) has taken the initiative to hold this event annually. I take this opportunity to thank the Vice-chancellor, the Chairman of SRHDC, the co-chairs of WURC and the reviewers for their contribution towards the success of the event. I also appreciate the dedication and the effort of the researchers in producing high quality work.

It is hoped that the deliberations at the technical sessions would be highly productive and pave the way for advancement of the Sciences, and for the economic development of the country, in turn.

# *Message from the Dean of the Faculty of Business Studies & Finance*

**Prof. S.K. Gamage**
**Dean**
**Faculty of Business Studies & Finance**
Wayamba University of Sri Lanka

It's my great pleasure to send this message for the Wayamba University Research Congress (WURC) organized by the Senate Research and Higher Degrees Committee (SRHDC) of the Wayamba University of Sri Lanka.

In the context of the present economic recession in Sri Lanka, the Government and the policy makers are trying to find the ways to overcome the prevailing issues with the assistance of the multi-disciplined intellectuals. This development reflects importance of research findings based on empirical studies in wider society in terms of social and economic growth. The aims of the research conferences go far beyond the disseminating and sharing of knowledge and the contribution of the research findings can play a significant role for the sustainable development of the country.

I hope that the the Wayamba University Research Congress is a great opportunity for the academia, researchers and scholars to acquire new knowledge and to exchange their experience and findings of the research results that encompasses with creation and dissemination of novel intellect to ensure the advancement of social human beings.

I congratulate and convey my best wishes to the Chairman of the Senate Research and Higher Degrees Committee, and the Co-chairs and members of the Wayamba University Research Congress and to all the presenters, awardees and participants for a very fruitful research session.

# *Message from the Dean of the Faculty of Livestock, Fisheries and Nutrition*

**Prof. C.V.L. Jayasinghe**
**Dean**
**Faculty of Livestock, Fisheries and Nutrition**
Wayamba University of Sri Lanka

I am delighted and honored to convey this message to the Wayamba University Research Congress- 2022.

In the "knowledge economy" of today, there is an increasing emphasis on multi-disciplinarity or interdisciplinary knowledge. Organizations are increasingly using multidisciplinary research in order to fuel breakthrough innovations. Multidisciplinary research is needed to solve many of the major research challenges of the next decade. This cooperative and coordinated research requires the unified effort of experts from different disciplines. They all pool their knowledge to solve the problem(s) at hand.

To provide a better understanding of the complex relationships between food, well-being and environment, it is pivotal to generate multidisciplinary knowledge on the promotion of human well-being in relation to multiple interconnected factors such as diet and nutrition, environment, and economic, social, and legal aspects. Therefore, within the macro-field of food, nutrition, and human health, a variety of specific research lines could be developed through several methods and perspectives. This goal is pursuable through various innovative methods based on a dense dialogue between scientists from different disciplines and these methods are seeds that should be allowed to grow.

Wayamba University research teams also execute research studies focusing on this theme and successful stories are showcased today. Thus, I would like to extend my sincere gratitude and congratulations to the presenters, and I sincerely hope that this congress will be enriching novel ideas that will lead to a better, merrier, and prosperous country.

I wish the Wayamba University Research Congress -2022 a great success.

# *Message from the Dean of the Faculty of Medicine*

**Dr. P.G.C. Sanjeewa Bowatte**
**Dean**
**Faculty of Medicine**
Wayamba University of Sri Lanka

On behalf of the Faculty of Medicine, Wayamba University of Sri Lanka, please allow me to extend my heartiest congratulations to the 7th Wayamba University Research Congress – WURC 2022 under the theme "Building Connectivity Through Innovative Multidisciplinary Research". WURC 2022 is a platform for the undergraduates, postgraduates and academic staff to present and discuss their research.

Research at Wayamba University of Sri Lanka endeavors to make original contributions by discovery of new knowledge to foster the development of the identified thrust areas in view of providing meaningful solutions to current agriculture, health, economy and industry problems that could subsequently evolve as emerging solutions to the problems and new technologies.

The Faculty of Medicine, Wayamba University of Sri Lanka is established as the 9th Medical Faculty in Sri Lanka to offer an excellent educational environment for learning, teaching and research in the fields of medicine. As this young medical faculty is stepping into the third year of its academic activities, the faculty is committed to conducting impactful research and conforming to international standards of excellence. Research at our faculty primarily attempts to identify and find solutions to significant health problems in our country and the region. We aim to expand our collaborative and translational research areas by exploring new avenues of investigation innovation and fostering the growth of a healthy research culture while nurturing a future generation of young scientists.

The contribution of the faculty of medicine in scientific research of the Wayamba University of Sri Lanka, is improved in leaps and bounds as our academic staff submitted quite a number of their research findings in the abstract format to present and communicate with other scientists in WURC 2022. We are proud of our growing number of research projects, publications and citations and the global impact created in our respective fields.

Research is "formalized curiosity", which as scientists, we ought to do. I wish you a very productive conference with exciting and encouraging discussions and interactive exchange of knowledge so that together we can anticipate a future of groundbreaking knowledge, research, and technology for humanity.

# Message from the Dean of the Faculty of Technology

**Dr. A.M.N. Alagiyawanna**
**Dean**
**Faculty of Technology**
Wayamba University of Sri Lanka

It is with great pleasure I send this message to seventh Wayamba University Research Congress 2022 which is organized by the Senate Research and Higher Degrees Committee of the Wayamba University of Sri Lanka and to be held on the 09th December, 2022 at the Kuliyapitiya premises. The theme of the Research Congress "Building Connectivity Through Innovative Multidisciplinary Research" to address the need of innovative multidisciplinary research is timely important.

The production of new knowledge by research and placing them in the public domain is the duty and responsibility of any university which is worthy of its name. I am pleased that academics and administrative staff and postgraduate students of the Wayamba University of Sri Lanka have met these challengers and have enthusiastically submitted their innovative research for presentations at the seventh Wayamba University Research Congress 2022. The value of this Research Congress will be further enhanced by the maximum participation of academics and administrative staff and postgraduate researchers together with scientists from other organizations and industry engaged in research and innovation.

It is expected that the Wayamba University Research Congress would continue to foster research in various fields and the outcomes would be sustainable and supportive to the development of the country. I expect that this research congress will help academics, scientists, industrialists, and postgraduate students to share their research findings for the mutual benefits and to showcase their innovations.

I wish the Wayamba University Research Congress 2022 every success and I believe that all our university staff will be encouraged to strengthen their resolve towards the engagement in future research activities that will greatly assist the university in achieving higher ranking among other universities, and most importantly it will help achieve the development goals of our country.

# Message from the Co-Chairs - WURC 2022

**Dr. Sharmila Jayatilake**
**Co-Chair – WURC 2022**
Wayamba University of Sri Lanka

**Dr. Menuka Udugama**
**Co-Chair – WURC 2022**
Wayamba University of Sri Lanka

It is with immense pleasure that we pen this message as we mark the 7th Wayamba University Research Congress (7th WURC). The Wayamba University has grown from strength to strength as a forerunner of initiatives. WURC is a great reflection of this development. 7th WURC is themed "Building Connectivity through Innovative Multidisciplinary Research" to highlight the importance of leveraging the gathering of WUSL researchers to bridge the research gaps in many different fields of study. This congress will provide some valuable opportunities on top notch research, showcasing innovative research that is utilizing revolutionary technologies. With a record number of participants expected this year, we hope that this annual congress will grow substantially every year creating mutually beneficial relationships creating strengthened university-industry linkages. We are also thankful to Deshamanya Dr. Rohantha Authukorala for enlightening us on the importance as the keynote speaker.

As co-chairs, we know that the success of the event depends ultimately on the many people who have worked with us in planning and organizing the congress. We are very grateful to the Vice Chancellor and the Senate Research and Higher Degrees Committee. We appreciate the great support by academic, academic supportive, administrative and non-academic staff members and the students of the University. The support, collegiality and teamwork made this a success.

We wish the congress and participants all the best.

# *Message from the Keynote Speker*

## Deshamanya Dr. Rohantha Athukorala

Dear Friends,

Whilst some say that Sri Lanka is at one of the most challenging situations in history, to my mind it is at the ' tipping point' if we are to make Sri Lanka the miracle of Asia.

The reason why I say ' tipping point' is because, we have no option but to go through the painful reforms required from a trade, political, business and social end. If we do not do this Sri Lanka will not survive in the next couple of months as poverty is at 42% as per the latest research done by University of Peradeniya. Which means almost 9.6 million people are going through tough times to keep the home fires burning.

We have no option but sign-up free trade agreements with Singapore, China etc and look for deeper integration in the current FTA's with India and Pakistan. Businesses are all setting up business in the African region and in Dubai. Just because a company sets up in this part of the world one cannot be competitive unless there are innovative and cutting-edge products that are better than global competitive products which are available in those market. Which is where the relevance of universities come into the framework of work in Sri Lanka.

Which brings me to the importance of today's discussion. Innovation. You will be a key pivot in the next phase of the development agenda of Sri Lanka. I am eager to listen to the work you have done. I am committed to linking you with the business work and trade organizations. It's a commitment. We are at tipping point and each of us have a role to play in the next few months in Sri Lanka.

Let's enjoy this experience

# Table of Contents


Page

*Session A-1: Agricultural Economics and Technology*

1 Use of Key Performance Indicators (KPIs) to Evaluate and Define Impactful Programme of Research for Commercial Agriculture 1
*P. C. Abeysiriwardana and U.K. Jayasinghe-Mudalige*

2 An Inquiry into the Effect of Government Policy on Productivity of the Corporate Tea Sector 3
*K.R.H.M. Ranjan and J.C. Edirisinghe*

3 Perceived Benefits of Urban Residential Gardens: Perception of Urban Residents in Sri Lanka 5
*J.K.W.N. Subashini, K. Yakandawala and E.S.Minor*

4 An analysis of Drought Incidences in the Coconut Plantations in Dry Zone: A Study of Puttalam District 7
*A.D.K.S.S. Somarathna and J.C. Edirisinghe*

5 Assessing Environmental Awareness, Farmer Perceptions, and Excessive Fertilizer use in Kalpitiya 9
*L.H.N. De Silva, I.V. Kuruppu, J.C. Edirisinghe, N.W.B.A.L. Udayanga and D.R. Gimhani*

6 Evaluation of Nutrient Leaching in Red Onion Grown on Sandy Regosols in Kalpitiya, Sri Lanka 11
*D.S.G.G.C. Swarnathilake, H.M.I.K. Herath, D.R. Gimhani, N.W.B.A. L. Udayanga and J.C. Edirisinghe*

7 An Empirical Study on the Application of ICT Tools to Supply Chain Management in the Vegetable Industry in Nuwara Eliya District of Sri Lanka 13
*W.K.G.K.S. Weerasinghe, W.H.M.A.B. Waidyarathne and G.W.D.D. Fonseka*

8 Critical Analysis on Public-private Intervention in the Giant Freshwater Prawn Culture-based Fishery Extension in Sri Lankan Reservoirs 15
*D.S. Digamadulla, U.K. Jayasinghe-Mudalige, W.M.H.K. Wijenayake, U.S. Amarasinghe and M.D.S.T. de Croos*

9 Modelling Awareness, Perception and Adoption of Recommendations in Rubber Smallholder Sector in Sri Lanka 17
*B.M.D.C. Balasooriya, J.C. Edirisinghe and P. Seneviratne*

***Session A–2: Agricultural Biology and Biotechnology***

10 Is the Floral Polymorphism of *Vanda tessellata* (Roxb.) Hook. ex G. Don. (Orchidaceae) Site-Specific? 19
*R.S. Gunasekara, K. Yakandawala, S. Jayakody and D.S.A. Wijesundara*

11 Effect of Adenine Sulphate, Salicylic Acid, Carbendazim and Paclobutrazol on *In Vitro* Growth of *Stevia rebaudiana* 21
*P.S. Warakagoda, S.S. Millavithanachchi and R.G.G.M.D. Jayasundara*

12 Nutritional and Physicochemical Properties of Arrowroot (*Maranta arundinacea*) Flour from Five Different Provinces in Sri Lanka 23
*M.K.S. Malki, J.A.A.C. Wijesinghe and R.H.K.M. Ratnayake*

13 Characterization of Exotic Parental Varieties of Sugarcane (*Saccharum* spp. hybrid) by SSR Markers 25
*A.M.M.S. Perera, D.P.S.T.G. Attanayaka and A. Wijesuriya*

14 Evaluation of Crop-Generated Microclimatic Models on Beetroot (*Beta vulgaris*) Growth in Kalpitiya Peninsula 27
*A.S. Jathunarachchi, A.S.A. Salgadoe, P.I.P. Perera, D.R. Gimhani, S.B.A. Weerawarna and H.G.A.S. Sathischandra*

15 Non-Destructive Estimation of Above Ground Biomass of the Rice Plant (*Oryza sativa. L*) Using Drone-based Multispectral 29

Vegetation Indices and Plant Height Model
*P.P. Dharmaratne, A.S.A. Salgadoe, W.M.U.K. Rathnayake and A.D.A.J.K. Weerasinghe*

16 Discovery of a New Species of the Genus *Lagenandra* from the Wet Zone of Sri Lanka 31
*G.K.I.S. Madola, K. Yakandawala and D.M.D. Yakandawala*

17 Mass Culturing of *Chlorella* sp. and the Potential for Biodiesel Production 33
*S.A.V. Viduranga, B.L.W.K. Balasooriya, I.G.S.S. Ekanayake and N.G.C.A. Bandara*

18 Growth and Flowering of *Nymphoides hydrophylla* under Different Light and Water Logging Conditions 35
*D. Wijayawardhana, K. Yakandawala and V. Herath*

19 Sensory Properties and Antioxidant Capacity of Butterfly Pea Flower Incorporated Herbal Tea Formulations 37
*H.A.C. Sandharuwani, M.K.C. Nanayakkara. K.M.G.K. Pamunuwa and J.M.M. Udugama*

### *Session B: Applied Sciences*

20 Suitability of a Mg based Redox Capacitor with a Natural Rubber based Electrolyte in the Field of Power and Energy 39
*H.G.N. Rajapaksha, K.S. Perera and K.P. Vidanapathirana*

21 Effects of Bending Stiffness on Localized Bulging in a Pressurized Hyper-elastic Tube 41
*G.S. Francisco*

22 Image Security Method by Combining of Visual Cryptography and Stegnography 43
*K.M.G.M. Ishara and D.M.S. Bandara*

23 A Novel Architecture Embedded with a Temperature Sensor for an Energy Harvesting Circuit 45

*G.C.W. Thilakarathne, P.M. Senadeera, J.M.J.W. Jayasinghe, W.A.S. Wijesinghe and M.A.A. Karunarathna*

24 Impact of Short Text Classification Performance with Feature Augmentation 47
*J.R.K.C. Jayakody, V.G.T.N. Vidanagama, I. Perera and H.M.L.K. Herath*

25 A Mathematical Model for Predicting the Outcome of Twenty20 Internationals in Cricket 49
*G.A.C.M. Karunananda and E.M.P. Ekanayake*

***Session C: Management, Finance and Sustainability***

26 Impact of the Modern HRM Practices to Retain Generation-Z Software Professionals in Post-Pandemic WFH Environment 51
*H.D. Jayathilake, S.S. Weedige and S.K. Gamage*

27 Influence of Macroeconomic Variables on the Stock Prices: A Study on the Colombo Stock Exchange 53
*I.D.W. Samarawickrama and A. Pallegedara*

28 Impact of Leadership Style on Organizational Effectiveness: A Systematic Review 55
*K.W.C.U.K. Kendangamuwa, D.A.M. Perera and T.K. Karandaketiya*

29 Disparities between Sustainability Disclosures and Practices by Sri Lankan Firms: A Case Study Using Food and Beverage Industry 57
*R.N.K. Soysa, A. Pallegedara, and A.S. Kumara*

30 Determining the Effect of Human Resources Management Practices in Sri Lankan Universities towards Organizational Performance: A Survey Conducted at the Wayamba University of Sri Lanka 59
*W.A.D. Chithrananda*

31 A Study on Factors Affecting Undergraduates' Attitudes to 61

Taking Part in Sports with Special Reference to the Wayamba University of Sri Lanka
*R.J. Wellassa*

### *Session D-1: Food Production Systems*

32 Distribution of Wild Elephants and Human-Elephant Conflict in Maduruoya Area, Sri Lanka 63
*A.S.C. Wilson, S. Jayakody and U.K.G.K. Pathmalal*

33 Assessing Phosphate Solubilizing Ability of *Aspergillus* sp. 65
*A.A.A.U. Aberathna, D.A. Satharasinghe, A.P. Jayasooriya, R.N. Jinadasa, S. Manopriya, B.P.A. Jayaweera, C.A.N. Fernando, W.A.D.V. Weerathilake, G.A. Prathapasinghe, J.A. Liyanage and J.M.K.J.K. Premarathne*

34 Improving Phosphorus Solubility of ERP by Acidulation and Calcination with $Na_2CO_3$ 67
*S. Manopriya, B.P.A. Jayaweera, A.A.A.U. Aberathna, C.A.N. Fernando, M.M.M.G.P.G. Mantilaka, P.G.D.C.K. Karunarathna, D.A. Satharasinghe, L.J.P.A.P. Jayasooriya, G.A. Prathapasinge, W.A.D.V. Weerathilake, J.A. Liyanage and J.M.K.J.K. Premarathne*

35 Effect of Temperature on Extraction of Acid-Soluble Collagen from the Skin of Yellowfin Tuna 69
*A.G.D.M. Ampitiya, S.T. Gonapinuwala, C.A.N. Fernando and M.D.S.T. de Croos*

36 Spatiotemporal Distribution of Benthic and Pleustonic Jellyfishes in Coastal Waters of Sri Lanka, with Respective to Physicochemical Parameters 71
*K.D. Karunarathne and M.D.S.T. de Croos*

37 A Comparative Integrated Approach of Mangrove Vegetation Mapping using Remote Sensing Data 73
*A.P. Abeygunawardana, S. Jayakody, E. Wikramanayake, S. Fernando and C. Wickramarathne*

***Session D-2: Food and Nutrition***


38 Tools to Examine the State of Junior Secondary School Food Literacy Education in Sri Lanka 75

*M.P.S. Rathnayake, W.K.S.H. Weerasekara, J. Nanayakkara, T. Perera, A. Worsley, A. Booth and K.D.R.R. Silva*

39 Blending of Ginger (*Zingiber officinale*) and Coriander (*Coriandrum sativum*) Oleoresins to Uniformly Disperse in a Beverage Product 77

*G.D.M.P. Madhusankha, C.V.L. Jayasinghe and O.D.N.A. Perera*

40 Physical Properties of the Pomegranate (*Punica granatum* L.) Fruit cv. Kalpitiya Hybrid during Growth and Development 79

*L.M.C.J. Kumara, W.A.H. Champa, S.B.A. Weerawarna and H.G.A.S. Sathischandra*

41 Impact of Dietary Fat Intake on Vascular Function, Blood Pressure and Other Cardiometabolic Risk Markers in Healthy Adults 81

*U.L.D.S. Perera, M.A.R.M.P. Jayathilake, A. Chandrasekara and K.M. Rathnayake*

42 Development of Frozen Probiotic Fruit Sherbet incorporating *Phyllanthus emblica*, *Elaeocarpus serratus* and *Pouteria campechiana* 83

*H.A.C.O. Hettiarachchi, S. Jayatilake and K.D.P.P. Gunathilake*

43 Formulation of a Functional Noodle Incorporating Underutilized Millets and Root Flours 85

*N.N.G. Chiranthika, K.D.P.P. Gunathilake and A. Chandrasekara*

44 Comparative Study on the Fatty Acid Composition and Health Lipid Indices of Processed Edible Plant Oils Available in Sri Lankan Market 87

*H.P.S. Senarath, J.M.Y.V. Jayasinghea, and E.M.R.K.B. Edirisinghe*

*Session E–1: Medicine and Medical Education*


45 Association Between Awareness and Attitudes on Patient safety and Medication Errors among Medical Students: A Descriptive Cross-Sectional Study done in Wayamba University of Sri Lanka 89
*W.M.A.B.W. Eriyawa, U.M.S. Sathsarani, G.K.S. Fernando, N.D.S.C. Dharmapala and S.M.M.S. Bandara*

46 A Descriptive Study of Learning Strategies of High and Low Performers as Assessed at the End Semester Examination in Microbiology 91
*H.P.R.K. Ranasingha, N.W.R.D. Perera, W.S.M. Wickramasinghe, P.K.B.K.M. Bandara and J. Perera*

47 Self-Medication Practices among Medical Undergraduates 93
*W.M.A.B.W. Eriyawa, N.D.S.C. Dharmapala, U.M.S. Sathsarani, G.K.S. Fernando and S.M.M.S. Bandara*

48 Effects of Online Learning on the Academic Performances of Medical Undergraduates in Wayamba University of Sri Lanka 95
*H.M.T.D Herath, J.M.D.C. Jayasinghe, C.B. Karunarathne and L.J.M.M.M. Kumarihami*

49 A Preliminary Study on Female Undergraduates' Awareness regarding the Importance of Preconception Folic Acid Supplementation for Prevention of Neural Tube Defects 97
*E. A. A. M. Wickramarathna, H. P. D. P. Nayanananda, D. S. Waranakulasooriya, R. P. Y. N. S. Akalanka and A. Wijayasekara*

50 Impact of Class/Lecture Attendance and Learning Management System Utilization on the End Semester Examination Results of Microbiology, among Second Year Medical Undergraduates of Faculty of Medicine, Wayamba University of Sri Lanka 99
*N.W.R.D. Perera, H.P.R.K. Ranasingha, S.S.L.J.B. Dayatathne, W.S.M. Wickramasinghe, P.K.B.K.M. Bandara and J. Perera*

51 Case Report: Successful Management of Cardiac Toxicity of an Acute Yellow Oleander Poisoning Patient at a Tertiary Care Hospital, Sri Lanka 101
*W.M.A.B.W. Eriyawa, S.F. Jayamanne, N. Lokunarangoda,*

*G.R. Francis, S.S. Dharmica, S.H.M. Rushki and P. Jayawardane*

52 Variability of the Incidence of Necrotizing Fasciitis with the Local Rain Pattern in Mahiyangana; Is it a Seasonal Killer? 103
*G.P.U.P. De Silva, P.S.K. Madugalle, A.T.M. Alawattegama, R.M.S.S.B. Rathnayake, P.C.K. Muthukumarana and M.S.E. Karunadasa*

53 Dispensing Practices of Oral Medications to Children in Kuliyapitiya Teaching Hospital 105
*H.M.N.P Herath, Y.H. Inshifa, M.G.H.M.K.M. Maliyadda, S.L.D. Dharmasiri and K.M. Chandimal*

54 The Knowledge and Associated Factors of Contraceptive Methods after Delivery among Women Attending to the Antenatal Clinic at Teaching Hospital Kuliyapitiya 107
*W.A.K. Wijayasuriya, S.B.Y.M.A. Siwarathna, U.M.C. Somachandra, N. Thileeban, M.R.R. Zainab and K.M. Chandimal*

55 Attitude and Behaviour Towards Snakes and Their Determinants among Medical Undergraduates in Wayamba University of Sri Lanka 109
*M.A.A.E. Wijayasekara, N.K. Jayakodyi, L.W.H.C. Wijesooriya and E.A.A.M. Wickramarathna*

56 Snakebite Exposure Patterns in Dry Zone Farmlands; A Descriptive Study in Anuradhapura district, Sri Lanka 111
*M.A.A.E. Wijayasekara and N.K.A. Silva*

57 Physicochemical Properties, Total Phenolic Content, Antioxidant and Anti-Inflammatory Activity of Fresh Virgin Coconut Oil and Copra Derived Coconut Oil 113
*H.A.S.S. Hettiarachchi and R.A.N. Ranathunga, K.D.P.P. Gunathilake and D.N. Kekulandara*

58 Renal Involvement in Dengue Fever; A Baseline Study 115
*P.M. Nanayakkara, P.G.C.S. Bowatte, S. Jeevathayaparan and R.A.N. Ranathunga*

59 Development of a Risk Prediction Model to Predict the Risk of Hospitalization due to Exacerbated Asthma among Asthma Patients Aged ≥ 20 Years in the Gampaha District 117
*D.H. Punyadasa, V.A. Kumarapeli and W. Senaratne*

***Session E-2: Anatomy and Surgery***

60 Assessment of Overweight and Obesity Status of the Purana (Old) Population Residing in Sigiriya, Sri Lanka 119
*K.M. Chandimal, U.L.P.D.K. Amarasinghe, K.M.W.W. Priyadarshani, E.A.A.M. Wickramarathna and S.G. Yasawardene*

61 A Comparison of Nila Point Locations in Selected Indigenous Medical Texts 121
*G.V.P. Samaranayake, V. Tennakoon, K.M. Chandimal, W.A.L.C. Waliwita and S.G. Yasawardene*

62 Study of Mandibular Foramen in Dry Adult Human Mandibles in Sri Lankan Population 123
*U.L.P.D.K. Amarasinghe, K.M.W.W. Priyadarshani, E.A.A.M. Wickramarathna, K.M.M. Dilhara and K.M. Chandimal*

63 Feasibility of Conducting Online Surveys among Histopathologists Currently Practicing in Sri Lanka 125
*T. Somarathne, E.P.D.S. Ediriweera and P.D. Burhan*

64 Distance Measuring Device to Calculate the Height and Width of the Human Ear Lobe 127
*H.K. Abayakoon, U.L.P.D.K Amarasinghe, E.A.A.M. Wickramarathna and K.M. Chandimal*

65 Laparoscopic Appendicectomy in Peripheral Hospital: Is it Safe Option for Basic Laparoscopic Training? 129
*G.P.U.P. De Silva, R.M.S.S.B. Rathnayake, W.M.T.S. Dissanayake, P.C.K. Muthukumarana and M.S.E. Karunadasa*

66 Valentino's Syndrome: A Case of Rare and Lethal Differential Diagnosis for Acute Appendicitis 131
*D. S. H. Jayasinghe, S. P. B. Thalagaspitiya, S. Shrishankar, D.*

*Wickramarathne, V. E. U. Rodrigo, P. C. K. Muthukumarana, M. S. E. Karunadasa and G. P. U. P. De Silva*

67 A Pilot Study on Screening "Hidden" Adult Pelvic Floor Dysfunction (PFD) and its Impact on Quality of Life (QOL) among Patients Presented to Outpatient Department (OPD) of Teaching Hospital Kuliyapitiya (THK) 133

*P.C.K. Muthukumarana, S.H.D.S. Warnasooriya, S.M.H. Salih, W.K.A.M.A.P. Arthanayake, A.H.M.G.D. Abeysinghe, H.A.B.P.R. Jayasekara, C.J. Peris and M.S.E. Karunadasa*

68 An Unusual Instance of Large Bowel Obstruction due to Sigmoido-Rectal Intussusception: A Success Story in Resource Limited Setting 135

*P.B. Dharmasena, P.C.K. Muthukumarana, A.H.M.G.D. Abeysinghe and M.S.E. Karunadasa*

69 Development of a Psycho-Behavioural Intervention to Enhance Resilience among Grade 10 School going adolescents in Sri Lanka 137

*D. M. S. Manori, P. Godamunne and P.L. Jayawardana*

70 Evaluation of the Effect of Continuous Education to Doctors, Nurses, and Patients on the Improvement in Care Quality and Clinical Outcomes of Diabetic Patients of Base Hospital Nintavur, Sri Lanka 139

*P.G.C.S. Bowatte*

71 Profile of Gastric Histopathology Reports among Patients Who Undergo Upper Gastrointestinal Endoscopy for Dyspeptic Symptoms in Sri Lanka 141

*T. Somarathna and E.P.D.S. Ediriweera*

72 Accidental Poisoning of a Family due to Ingestion of 'Binthamburu' (Ginger-Leaf Morning-Glory, *Ipomoea asarifolia*), Misidentified as 'Kankun' (Water Spinach, *Ipomoea aquatica*) 143

*P.G.C.S. Bowatte, J.M.M. Jayakody, P.M. Wijewardane, K. Yakandawala, W.M.P.G.R. Dissanayake and W.M.A.B.W. Eriyawa*

73 A Glimpse of Childhood Cancers in Sri Lanka 145
*D.M.S. Manori and S. Perera*

74 Neonatal and Maternal Outcomes of Pregnant Mothers Who Were on Antipsychotics during Gestational Period in Selected Hospitals in Sri Lanka 147
*W.M.A.B.W. Eriyawa, K.P.J. Perera, G.K.S. Fernando, U.M.S. Sathsarani, N.D.S.C. Dharmapala, S.M.M.S. Bandara and W.U.N. Sovis*

***Session F: Technology***

75 Materials and Tools Related Factors Influencing Efficiency of Labour in Sri Lankan Building Construction Projects 149
*K. Manoharan, P.B.G. Dissanayake, C.K. Pathirana, M.M.D.R. Deegahawatura and K.D.R.R. Silva*

76 Effect of Graphite Oxide Loading on Physical Properties and Electrical Conductivity of Natural Rubber Composites 151
*W.D.M. Sampath, C.A.N. Fernando and D.G. Edirisinghe*

77 A Miniaturized Uniform Meander Line UHF Antenna for a Passive RFID Tag 153
*W.M.S.M. Wickramasinghe, J.M.J.W. Jayasinghe and P.M. Senadeera*

78 Analysis of the Effect of Solar Irradiance on the Total Harmonic Generation of the Grid-Connected Rooftop Solar PV Systems 155
*S. Ediriweera and K.K.C.S Kiriella*

79 Investigation of the Optical and Physical Properties of Green Synthesized Silver Nanoparticles using Ceylon Olive Extract (*Elaeocarpus serratus*) 157
*J.A.K.M. Fernando, C. Yalegama, S.P.A.U.K. Samarakoon, C.A.N. Fernando and T.M.S.G. Weerasinghe*

80 Development of a SDFT based, Grid Connected, Voltage Source Inverter for Current Harmonic Compensation 159
*W. N. D. Fernando*

81 Machine Vision-based Defect Detection Scheme with Adjustable Computational Burden for Typical Manufacturing Environments 161
*H.M.R.E. Bandara, W.A.S. Wijesinghe and I.P.M. Wickramasinghe*

82 A Comparative Assessment of Direct Heating Method and Autoclave Method for Deacetylation of Chitin into Chitosan in Developing a Chitosan Extraction Method 163
*C.S. Liyanage, S.T. Gonapinuwala, C.A.N. Fernando and M.D.S.T. de Croos*

83 n-$Cu_2O$/p-$Cu_2O$ p-n Junction Electrode on Cu Substrate for Photovoltaic Applications 165
*L.H.M.B.P.S. Lansakara, R.D.A.A. Rajapaksha and C.A.N. Fernando*

# *Session A–1:*
# *Agricultural Economics and Technology*

# Use of Key Performance Indicators (KPIs) to Evaluate and Define Impactful Programme of Research for Commercial Agriculture

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## Abstract

Research in the field of agriculture is meant to fuel innovations that greatly enhance economic prosperity by ensuring food and nutrition security and the well-being of people. In light of this, those working on the management of research should work objectively to ensure their efforts are well informed to the stakeholders and are spanned by the advancements in science, technology, and innovation. Now more than ever, the policymakers and leaders in the research institutes are depending on the Key Performance Indicators (KPIs) that are evolved around Key Performance Drivers (KPDs) and derived on Critical Success Factors (CSFs) to inform and guide the decisions that they make on research practices. To date, nevertheless, there exists very little information on these aspects that were generated through empirical research. On this justification, this study was directed to illuminate the use of KPIs and KPDs in leveraging organizational research capacity in producing impactful research that is acceptable to all stakeholders, where the special case considered includes the commercial agriculture sector in Sri Lanka. Ten research administrators, scholars, and practitioners attached to top research institutes working in this particular sector were contacted through direct in-depth interviews supported by a well-designed interview guide consisting of 15 probing questions. The study used Thematic Qualitative Models generated through MAXQDA 2022 statistical software to analyse the perceptions of those top-most administrative officers. Thematic Analysis dissected those perspectives into 5 themes namely; 1. Research commercialization, 2. Research collaboration, 3. Research for society, 4. Institutional management and 5. Technology integrated systems along with 12 sub-themes, 32 categories, and 119 codes to underscore the importance of context, policy attributes, enablers, and organizational benefits gained from a well-thought performance management system consisting of

carefully selected smart KPIs. Some analysis techniques such as Code Frequency Table, Single-Case Model, the Code Map etc., provided by the software were systematically used to synthesize the new knowledge on the KPI-KPD subject with respect to research that involves commercial agriculture. For example, the code frequency table confirmed that leaders were more thoughtful and showed trust toward the technology-integrated system in the performance management of research institutes on research and development towards commercial agriculture although they were not strategically equipped with necessary potentials that cause such systems to be in effect in performance management according to the results exposed by Code Maps. Thus, the findings were further upscaled to develop a framework covering KPIs-KPDs that can be used to develop a well-thought research agenda to facilitate research in this economically important sector.

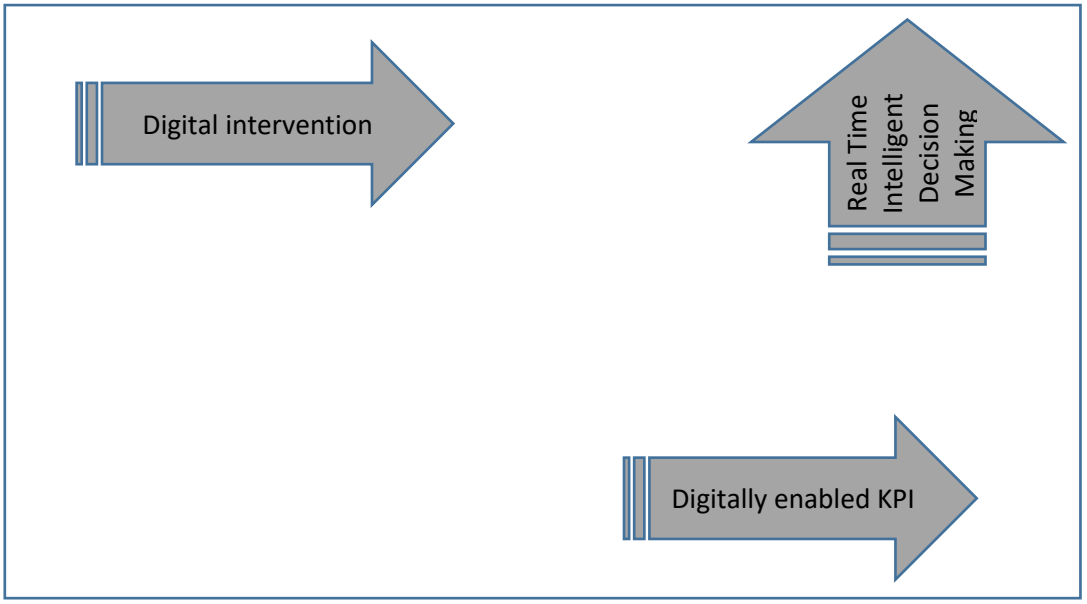


**Figure 1:** KPIs-KPDs Framework of Intelligently Driven PMS for Research in Commercial Agriculture

**Keywords:** Commercial Agriculture; KPIs; Performance Management; Research Agenda; Thematic Analysis

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# An Inquiry into the Effect of Government Policy on Productivity of the Corporate Tea Sector

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## Abstract

Research on the impact of government policy on tea sector productivity is scarce in the literature. This study attempts to fill this gap by investigating the direct or indirect impact of existing broad policy statements on the long and short-run performance (Total Factor Productivity) of the corporate tea sector as an initiative. Monthly panel data spanning from the year 2005 to 2019 were collected from 35 large-scale tea estates. Total Factor Productivity (TFP) was estimated using a translog stochastic production frontier. Secondary data on different major policy tools relating to tax, exchange rate, protection, wage, open economic and unplanned, ad hoc policies were related to the TFP in an Auto Regressive Distributed Lag (ARDL) framework to assess their impact on TFP in both the long and short run. Two error correction models: the Pool Mean Group (PMG) and the Dynamic Fixed Effect (DFE) model were estimated. Hausman test results showed that DFE was a better fit and hence it was chosen to derive conclusions, the results of which are reported in Table 1.

The results of the DFE model revealed that the real exchange rate has a positive and statistically significant impact on TFP in the long run while it has a negative and statistically significant impact on the estate sector TFP in the short run. The daily wage rate of a plantation worker accounted for a negative and statistically significant impact on TFP in the long run. It implied that the raising daily wage rate did not add much value to the tea sector's performance on a productivity basis. This emphasizes the importance of linking wage hikes of the plantation worker with productivity or output because the cost of production of Ceylon tea has increased more than its competitors due to high labor costs. The nominal protection coefficient (NPC) has a negative and statistically significant impact in the short run. However, in the long run, the NPC does not significantly

contribute toward the TFP. The mean value of NPC for the tea industry during 2005-2019 is 1.26. This implied that the government focused more on the protectionism policy on tea. This made Ceylon tea to be price inefficient and less competitive in the world tea trade. Further, the CESS tax shows a weak significant impact on TFP but was negative showing that it had failed to achieve its intended outcome. Trade openness does not have a significant contribution to the TFP both in the long-run as well as in the short run. Ad hoc policies of the government without stakeholder consultation have made dire consequences on productivity during the study period. Results concluded that the error correction term is -0.23 which means the short-run adjustment dynamics towards long-run quilibrium is almost 23%.

**Table 1:** Results of the Estimated DFE-ARDL model.

| | **Variable** | **Coefficient** | **Std. Err.** | **p-value** |
|---|---|---|---|---|
| Long | lnER | 0.00039 | 0.00017 | 0.024** |
| Run | lnWAGE | -0.00025 | 0.00014 | 0.066* |
| | lnNPC | -0.00003 | 0.000055 | 0.604 |
| | lnCESS | -0.000009 | 0.00008 | 0.904 |
| | lnOPEN | -0.00009 | 0.00015 | 0.539 |
| Short | ECT | -0.23167 | 0.00922 | 0.000*** |
| Run | lnER | -0.00095 | 0.00016 | 0.000*** |
| | lnWAGE | 0.00003 | 0.00006 | 0.602 |
| | lnNPC | -0.00007 | 0.00003 | 0.021** |
| | lnCESS | -0.00009 | 0.00005 | 0.099* |
| | lnOPEN | -0.00009 | 0.00011 | 0.418 |
| | Dummy_Ban | -0.00002 | 0.000005 | 0.000*** |
| | Constant | -0.00049 | 0.00039 | 0.207 |

***Note:****Std. Err- Standard Error, ln-Natural log, ER- Real Exchange Rate in USD, WAGE- Daily wage rate of a plantation worker in Rs., NPC- Nominal Protection Coefficient, CESS- Tea Cess collected from tea exporters in Rs. Million, OPEN- Trade openness, Dummy_Ban-Dummy variable to represent the periods of Glyphosate ban, ECT-Error Correction Term; *** significance at 1% significance level, ** significance at 5% significance level, * significance at 10% significance level.*

Driving the tea industry towards a competitive edge, ploughing back the tea CESS for the development of the tea industry, establishing a sustainable productivity-based Revenue Sharing Wage model, and avoiding ad-hoc policy measures without any scientific backing are some policy recommendations to revive the Sri Lankan tea industry from its current state.

**Keywords:** Autoregressive Distributed Lag Framework; Corporate Tea Sector; Government Ppolicy; Total Factor Productivity

# Perceived Benefits of Urban Residential Gardens: Perception of Urban Residents in Sri Lanka

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## Abstract

Residential gardens make up an essential part of green space in urban areas. These gardens are the most frequent contact with nature for many urban residents. These interactions between various naturalistic elements and associated human activities provide economic, physiological, sensory and physical health benefits while supporting biodiversity which is far beyond the simple growing of plants. Despite the fact that these gardens occupy major space in urban green spaces, the broader social meaning and the value to human well-being are less concerned, making them ignore elements in urban planning. In the developing world, relatively little research has been carried out on the role and value of these gardens to human well-being. The research presented here explores the attitudes of urban residents towards the perceived benefits of residential gardens while investigating the correlation with sociodemographic factors. The study was conducted targeting the urban community in Colombo and Gampaha districts. In each district, 150 households were used for the study (n=300). A pre-tested, interviewer-administrated questionnaire was used to acquire the socio-economic details and to evaluate the perceptions towards the values of the residential gardens. In terms of age, in both Gampaha and Colombo districts, the majority of the respondents were 51-65 years old (41.7% and 43% respectively), and the highest fraction of the respondents received a monthly income ranging from LKR 81,000-120,000. In Gampaha district, 53% of the respondents had completed Advanced Level qualification while in Colombo district, the majority (40%) were with the qualification of a basic degree. In the Gampaha district, those occupied in the private sector (27%) dominated the sample while in the Colombo district, those in the government sector (27%) did so. In both districts, the majority of the gardens were self-designed (51% in Gampaha and

52% in Colombo). It was interesting to note that according to the respondents of both districts, stress release and health benefits, aesthetic value and growing of food are the top most perceived social benefits of the residential gardens. In both districts, more than 91% of the respondents were in strong agreement that their gardens positively affect their well-being by reducing stress. According to the respondents, pollution control, connecting with nature, and facilitating small wildlife are the top environmental benefits of the residential gardens. The majority of respondents (84%) strongly agreed with the fact that residential gardens can connect people with nature. A residential garden is like an 'extra room' in the residence, which gives space for nature. The chi-squared test provided overwhelming evidence that the age, education level, occupation, monthly household income, land area of the garden, mode of garden design, and time spent on gardening had a significant effect on the attitude of the urban residents in the Gampaha district towards perceived benefits of residential gardens ($p<0.05$). Subsequently, in the Colombo district, the attitude significantly correlated with age, land area of the garden, mode of garden design, and time spent in gardening only ($p<0.05$). Nevertheless, the attitude level of the respondents in both districts regarding the perceived benefits of their residential gardens displayed statistical significance. The results of the present study reveal that urban residents benefit a lot from regular contact with plants and nature through their residential gardens. Since these gardens are private spaces, they are highly interactive and correlate with the sociodemographic factors of the owners. According to the results, it is apparent that preferences and perceived benefits varied with the facts such as age, education level, occupation, the land area of the garden, designing aspects of the garden, and time spent with the gardening activities. Since these gardens are multifunctional spaces with central roles in socio-cultural and environmental aspects, they should be interlinked with urban green space planning to harness their full potential, where the associated knowledge generated during the present study could effectively be used.

**Keywords:** Green Space; Perceived Benefits; Residential Garden; Socio-Demographic Factors; Urban

**Acknowledgements**: *Authors would like to thank the support from the Wayamba University Research Grant-SRHDC/RP/04/19-02 and AHEAD grant- AHEAD/PhD/R3/Agri/448 for the financial assistance.*

# An Analysis of Drought Incidences in the Coconut Plantations in Dry Zone: A Study of Puttalam District

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## Abstract

Coconut palm is one of the major plantation crops in tropical areas throughout the world. The global annual production of coconut is around fifty-two billion nuts. Sri Lanka is ranked fourth, in terms of its contribution to the world's coconut production and land extend under coconut. The most popular Sri Lankan coconut exports to the global market are desiccated coconut, virgin coconut oil and coconut water. In the Sri Lankan context, coconut is one of the major plantation crops and it covers around 410,000 ha. Coconut grows in different types of soil with diverse moisture and nutrient regions in different agroecological zones. The annual national production of coconut is between 2500-3000 million nuts mainly depending on the climate condition. Around 70% of this production is consumed domestically, and the rest is used to produce coconut-based products such as coconut oil, copra, coconut milk powder, etc. The coconut sector accounts for approximately 12% of all agricultural produce in Sri Lanka. The main coconut-growing districts in Sri Lanka are Kurunagala, Puttalam, Gampaha, Hambanthota and Rathnapura. Among these districts, Kurunagala, Puttalam and Gampaha are known as the coconut triangle in Sri Lanka. The coconut yield depends on climatic and weather variables such as rainfall, temperature and relative humidity. This study was carried out to investigate the trends in Meteorological Drought incidence over selected coconut plantations located in the Puttalam District, Sri Lanka.

In this study, 11 coconut estates were considered and GPS coordinates were taken by visiting those estates. Rainfall data were obtained for the study period from the Department of Meteorology in Sri Lanka and predicted to the coconut estate locations by using the kriging technique. This was done with QGIS

software. The Standardized Precipitation Index (SPI) was used to evaluate the drought incidence at both the short-term (3 and 6 months) and the long-term (12 months) time scale. In order to calculate the SPI index, for each time scale, the variability of precipitation totals was normalized and fitted into a gamma distribution. The analysis was done in different time sequences, and time duration from October to September was used as the hydrological year (SPI12), and October to March and April to September were used as a 6-month time scale (SPI6) as these periods are the cropping seasons of Maha and Yala, respectively, in Sri Lanka. October to December, January to March, April to June, and July to September were used as the 3-month time scale (SPI3).

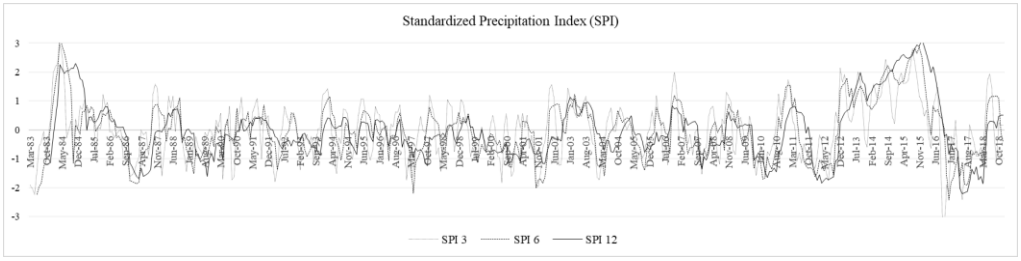


**Figure 1:** Temporal variation of the Standardized Precipitation Index

Calculated SPI values were compared with the SPI classification values for the dryness/wetness category to recognize the status of the drought. SPI was calculated at different time scales, but the analysis showed that more drought events had occurred at the short-term time scale. According to the SPI3 and SPI6 values, there were moderate drought events that occurred in 1984, 1992, 2000, 2003, 2007 and 2012. Severe drought events occurred in 1986, 2009/2010, 2011 and 2017. Extreme drought events can be observed in 1997 and 2016. When considering the long-term time scale (SPI12), moderate drought events can be observed in 1997, 2000, 2001 and 2008. Severe drought events can be observed in 1986/1987, 1989, 2007, 2010 and 2012. An extreme drought event occurred in 2017. Therefore, after these years coconut production should have been reduced because of water stress.

**Keywords:** Climate change; Coconut; Drought analysis; Rainfall; SPI

***Acknowledgement:*** *This work was supported by the National Science Foundation of Sri Lanka [grant number: NTRP/2017/CC&ND/TA-02/P-02/01].*

# Assessing Environmental Awareness, Farmer Perceptions, and Excessive Fertilizer Use in Kalpitiya, Sri Lanka

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## Abstract

Fertilizer is crucial for boosting agricultural productivity and ensuring food security in any nation. In many regions of the world, including Sri Lanka, excessive fertilizer use has long been acknowledged as a serious problem. Despite the best management practices advocated by research institutions, indiscriminate chemical fertilizer use and low fertilizer use in tropical environments is increasing environmental pollution, adversely affecting human's and ecosystem's health and causing social and political unrest in the nation. A rise in the use of fertilizer in crop fields is the result of changes in farmer attitudes and beliefs regarding the quality of fertilizer. Farmers frequently use chemical fertilizers without taking the Department of Agriculture's fertilizer recommendations into account.

With this context, this study aims to identify the driving forces behind the misuse of fertilizer in the Kalpitiya farming community. Face-to-face interviews with 107 vegetable growing farmers in Kalpitya area provided the primary source of data. The study's objectives were carefully considered when choosing farmer areas. Farmers were chosen for the study using a two-stage sampling technique. Six Grama Niladhari (GN) divisions were purposefully chosen for the initial stage. In the second stage, farmers were randomly chosen from these GN divisions. A pre-tested questionnaire was used to estimate a Bayesian Probit model.

Only 30.8% of farmers applied the correct quantity of fertilizer as recommended. As a result, almost 70% of farmers are over fertilizing their crops against advice. The statement that "fertilizer and chemicals used in agriculture does not have any impact on water pollution and they just go into soil" was accepted by almost 54% of the farmers. Therefore, the majority's perception of the effect of fertilizer was false. Interestingly, the majority of respondents (85.1%) agreed with the statement that "ground water in Kalpitiya Peninsula is extremely polluted," indicating that a significant majority of people in the region recognized the existence of ground water contamination in Kalpitya. Farmers held the view that excessive use of pesticides and fertilizer was not the cause for ground water pollution.

The two variables "Fertilizer Impact [FI]" and "Water Pollution [WP]" were the focus of this study's primary attention. The variable FI had a negative coefficient, indicating that farmers who believe excessive fertilizer use has no negative effects on the environment are more likely to use more fertilizer than is recommended. Farmers who are aware of the fact that local groundwater is contaminated usually use the recommended fertilizer rate. In other words, overuse of fertilizer reduced with the level of education because educated farmers were more likely to apply the recommended dosage. Furthermore, large-scale farms use the recommended dosages more frequently than small-scale farmers.

The study's findings elicited that an incorrect perception of fertilizer's impact on the environment is a major contributor to overuse of chemical fertilizer. The decision to overuse is also heavily influenced by environmental awareness. It is essential to spread awareness through appropriate extension services, mobilize the current extension force for not only their daily tasks but also with a focus on knowledge exchange and environmental awareness. Additionally, targeted programmes for local farmers through local media may be helpful. Finally, it could be suggested that, combining economic incentives with other efforts to influence behaviour of the farmer will be effective.

**Keywords:** Awareness; Fertilizer application; Kalpitiya; Perception

**Acknowledgement:** *Financial support from AHEAD DOR grant awarded to the Faculty of Agriculture and Plantation Management is acknowledged.*

# Evaluation of Nutrient Leaching in Red Onion Grown on Sandy Regosols in Kalpitiya, Sri Lanka

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## Abstract

The application of fertilizers to agricultural lands can contribute to contamination of the surface and groundwater. Excess amounts of fertilizer can be leached through the soil profile. Sandy Regosol (Haplic Arenosols) is the dominant soil type in Kalpitiya. Red onion is a short-term crop cultivated in Kalpitiya with excessive use of fertilizer. The aim of the study was to evaluate the leaching of nitrate ($NO_3^-$), ammonium ($NH_4^+$), calcium ($Ca^{+2}$), potassium ($K^+$), fluoride ($F^-$) and phosphorous (P) in red onion cultivation in sandy Regosols under grower managed fertilizer practices compared to Department of Agriculture (DOA) recommendation. Lysimeters were installed below the soil surface of separated plots. Prior to the planting of the variety Jaffna Local, compost (10 t/ha) was applied for both treatments. Growers' use rate [i.e. Five split applications of urea at 100 kg/ha, Triple Super Phosphate (TSP) at 250 kg/ha, onion fertilizer (12:9:9) at 125 kg/ha, blue granules (12:12:17) at 62 kg/ha and calcium nitrate at 62 kg/ha at 10 days intervals] was considered as the treatment 1 (T1). DOA recommendation [i.e. Basal dressing: urea at 68.5 kg/ha, TSP at 100 kg/ha, Muriate of Potash (MOP) at 50 kg/ha, Top dressing 1: urea at 65kg/ha at 3 weeks after planting (WAP), Top dressing 2: urea at 65 kg/ha and MOP at 25 kg/ha at 6 WAP] was used for treatment 2 (T2). Irrigation was done twice a day and leachate samples were collected at weekly intervals. The initial soil samples were analysed for pH, electrical conductivity (EC), available P, total N, exchangeable $K^+$, $Ca^{+2}$ and $F^-$. Available P in leachate was determined by sodium bicarbonate extraction method. $K^+$ and $Ca^{+2}$ concentrations were determined using a flame photometer (BWB-XP). $NO_3^-$, $NH_4^+$ and $F^-$ concentrations of leachate were analysed using ion-selective electrodes (CPI505). Analysis of variance followed by Tukey's test was used to analyse the data using R software.

All the available nutrients in the initial soil were very low except $Ca^{+2}$ (608.7±64.7 mg/kg), indicating the need for an external supply. Soil exchangeable $K^+$ and $F^-$ contents were 6.5±0.3 mg/kg and 0.84±0.21 mg/kg, respectively. The pH of the soil was neutral (7.17±0.02) and EC was 39.46±3.58 µs. Total N and Soil available P levels were as low as 0.04±0.01 and 0.36±0.03 mg/kg, respectively (Table 1).

**Table 1:** Cumulative Leached Amount of Nutrients (kg/ha) throughout the Season

| Treatments | Nutrient | | | | | |
|---|---|---|---|---|---|---|
| | $NO_3^-$ | $NH_4^+$ | $Ca^{+2}$ | $K^+$ | P | $F^-$ |
| **T1** | $340.1^{a}$±21.4 | $9.2^{ab}$±1.8 | $659.6^{ab}$±17.7 | $72.1^{b}$±12.9 | $26.4^{a}$±1.7 | $4.9^{a}$ ±0.9 |
| **T2** | $311.4^{ab}$±3.5 | $8.1^{b}$±0.9 | $524.3^{b}$±17.9 | $79.5^{ab}$ ±12.1 | $11.9^{a}$±4.9 | $4.4^{a}$ ±0.9 |

***Note:*** *Means with the same superscript letter in each column are not significant at 5% level of significance.*

The concentration of $NO_3$- in both treatments ranged from 35.1 mg/l - 160 mg/l, which was higher than the WHO permissible level of $NO_3^-$ (50 mg/l) for drinking water. A higher cumulative $K^+$ was observed in T2 than T1. This may be due to the application of MOP as a K source for T2. K is usually leached in much smaller quantities than Ca when applied as fertilizer. Moreover, a higher cumulative leached $Ca^{+2}$ was observed in T1 than in T2. Ca is one of the elements that can be leached from soils in high amounts. In addition, Regosols in Kalpitiya contain higher levels of Ca due to deposition of tiny windblown shell fragments. Unlike $Ca^{+2}$, accumulation of phosphate was not significant in the leachate. Although the agricultural lands in Kalpitiya have been fertilized for decades with P fertilizer, soil phosphate content is low. The average $F^-$ concentration of both treatments ranged from 0.26 mg/l-1.84 mg/l. Both treatments showed a lower concentration in the leachate than the WHO standard (<1.5 mg/l) for drinking water excluding a few samplings. Among all the tested elements, nitrogen is found to be the critical element in terms of leaching and contamination of groundwater. This emphasizes the pressing need for an improved nitrogen management strategy for the sustainable production of red onion grown in Kalpitiya.

**Keywords:** Groundwater Contamination, Nutrient Leaching, Sandy Regosols

**Acknowledgement:** *Authors acknowledge the support from the AHEAD DOR grant.*

# An Empirical Study on the Application of ICT Tools to Supply Chain Management in the Vegetable Industry in Nuwara Eliya District of Sri Lanka

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## Abstract

Supply Chain Management (SCM) is the management of the flow of goods and services and it encompasses all procedures that convert raw materials into finished items between organizations and locations. Vegetables have a fairly convoluted supply chain as a result of their perishable nature and the fact that they pass through numerous distribution channels from the farm gate to the customer. Vegetables grown in the farmer's field in different parts of the country in Sri Lanka reach the end consumer through a long chain of intermediaries, such as field collectors, retailers, wholesalers, transporters etc. They are subjected to post harvest handlings such as loading, packing and transporting which create different degrees of quantitative and qualitative losses in a complex market chain. This results consumers to pay a high price for vegetables, while giving farmers very low pricing for their products.

Information is an important driver to any organization that serves as the element that creates and results in a coordinated effective supply chain. Therefore, information must be up-to-date, accurate, authentic and accessible in a timely and suitable manner. Lack of sufficient information makes difficulties in the vegetable industry. Information Communication Technology (ICT) tools (mobile phones, internet and email, barcode reader, e-commerce applications, etc.) support supply chain activities, proper planning and management strategic decisions by holistic visibility on inventory transportation, facility and use. The ICT tools for example, Enterprise Resource Planning and Customer Relationship Management (ERP, CRM) also

allow enhancing the performance of the entire supply chain to make it less troublesome.

This study was conducted to ascertain the extent to which ICT tools are employed in vegetable supply chain Nuwara Eliya district in Sri Lanka and to investigate the factors that might have an impact on this industry's ability to adapt to ICT. A structured questionnaire was used to gather data from three sets of stakeholders (n=135) in the vegetable supply chain: wholesalers (30), retailers (50), and field collectors (55). Results from the studied survey data showed that the use of ICT tools in the vegetable supply chain is extremely low in Nuwara Eliya district (Figure 1). The vegetable traders in this district mainly used telephones and emails, with little to no use of modern ICT tools like Quick Response codes, Information Systems, Radio Frequency Identification, and Enterprise Resource Planning. As retailers are busy places where it is challenging to run the firm using traditional methods, they use ICT tools more frequently than wholesalers and the field collectors. The survey also discovered that the level of awareness of ICT usage affects ICT utilization in this industry. The awareness of the importance of the various information and communication technologies among the people plays a key role with regards to access and use of reliable information for supply chain. Therefore, it is important to conduct awareness programmes on the ICT technologies in rural areas to get the maximum benefits.

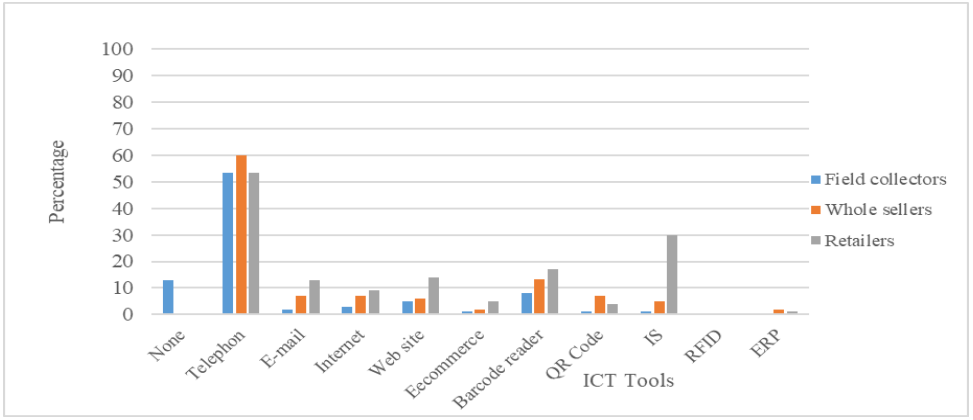


**Figure 1:** Percentage of ICT useage by Different Groups of Vegetable Supply Chain

**Keywords:** Information Communication Technology; Supply Chain Management; Vegetable Industry

# Critical Analysis on Public-Private Intervention in the Giant Freshwater Prawn Culture-based Fishery Extension in Sri Lankan Reservoirs

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## Abstract

Giant freshwater prawn (GFP) (*Macrobrachium rosenbergii*) has become one of the most economically important culture-based fishery (CBF) species in this decade. Stallholders' interest in the GFP has been hyped in recent years, as it possesses a higher market demand and selling price. Before the prevailing economic crisis, the government of Sri Lanka (GoSL) and the National Aquaculture Development Authority (NAQDA) successfully supported the CBF extension of GFP in reservoirs by public intervention (PI) approach through subsidised and free stocking of post larvae (PLs), where now it seeks the public-private intervention (PPI) for the extension, due to the prevailing situation as a remedy. The objective of our study was to critically analyse the pros and cons of PPI in the CBF extension, with the experiences in GFP reservoir fishery. For the study, we selected 8 reservoirs, 04 reservoirs from each PPI (Akkarayankulam, Irranimadu, Puthumurippu and Vavunnikkulam) and PI (Mahakanadharawa, Nachchaduwa, Huruluwewa and Mahawilachchiya) categories. Data were gathered via a structured interview-based survey conducted among fishermen (10) from each selected reservoir. Based on the gathered survey responses, the core structure of both PPI and PI approaches were well studied, and perspectives on the development of the reservoir fisher community and natural resource management were discovered. Structurally, PPI strategy weakens the NAQDAs influence and authority on

the reservoirs compared to PI, where functionally limited to monitoring, controlling and surveillance (MCS) of fishing activities, where private entities are involved in the CBF extensional activities, such as stocking, providing subsidised nets, interest-free loans for boat purchases and secured buy-back facilitation of GFP on the agreement.

During our study, the farm gate price in PI (LKR 1950 ± 57/Kg) was significantly higher than that of PPI (LKR 1650 ± 57/Kg) ($p=0.000$). However, the price paid to the fishermen in PI (LKR 1162.5 ± 48/Kg) and PPI (LKR 1175 ± 50/Kg)was not significantly different ($p=0.733$). It shows the middlemen influence in PI, as well as the inefficiency of PPI by failing to contribute the fishermen with the higher price than of PI even avoiding the middlemen from the trade. Hence, the PPI approach is seen as the step to gallop the financial burden caused to GoSL by subsidies and free stocking. It doesn't appear effective, as there is no evidential growth observed in society funds to ensure the monetary independency of the fisher organisation in a long-run. Furthermore, unmonitored overloading of fishing pressure and incentives to race for GFP are discovered as the major threats in the PPI approach, as the effect of monopolistic market behaviour over the PI's open market. Revision of the PPI approach is needed, via adding rent or taxation for resource use from the entities, to secure the independence of the fisher societies. As a whole, a more comprehensive approach than the one in practice, which inclines more towards privatization of natural resource management is essential.

**Keywords:** Culture-based Fishery; Giant Freshwater Prawn; Natural Resource Management; Public-Private Intervention; Reservoir

# Modelling Awareness, Perception and Adoption of Recommendations in Smallholder Rubber Sector in Sri Lanka

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## Abstract

The adoption of recommendations on agronomic practices, harvesting and processing has a positive impact on both production and profitability in the smallholder rubber sector. This is not a simple process which is shaped by a multitude of other factors, including farmer's awareness and perception of the recommendations. At the same time, the awareness of the farmer and perception are governed by various factors, which indirectly affect adoption. Hence, this study was planned to identify the relationship between awareness, perception and adoption of recommendations, together with the factors affecting each of them in the smallholder rubber sector in Sri Lanka.

The study was conducted in four traditional rubber-growing districts of the country viz. Kegalle, Gampaha, Kurunegala and Kandy. A semi-structured questionnaire survey was conducted to collect data on awareness, perception, adoption, crop details and demographic features of rubber smallholders. The sample size was 850. The Generalized Structural Equation Model (GSEM) was used to model the hypothesized relationship between awareness, perception and adoption. The relationships were built up using the literature and prior knowledge. Awareness of recommendations is the first requirement for adoption. Some farmers adopt the recommendations just after they become aware of the recommendation, believing the source of information. The other group of farmers build perceptions on recommendations, and this developed perception creates an intention to adopt or not to adopt the recommendations.

Three equations were developed to model the relationships of awareness, perception and the adoption of recommendations. Binomial responses were

obtained for the awareness and the adoption for each recommendation, where the total count of positive answers was taken as the awareness count and adoption count, respectively. This awareness and the adoption count were the dependent variables of the developed awareness and adoption equations, respectively. The perception of recommendations was measured on a Likert scale calibrated into three: 1-not important, 2-important and 3- very important. The perception index was constructed using the percentile rank method, and the value of the index ranges from 0 to 1. Parameters of the developed equations were estimated using regression analysis. Awareness and adoption equations were estimated using the Poisson regression which is recommended for the count data as the dependent variable in the regression model. The other equation in which the dependent variable was the perception index has been estimated using the Tobit regression model censoring the data limits.

Results of this study revealed that the training and extension significantly affect awareness at the probability levels of1% & 5%, respectively. These findings were in line with the literature. Farmers' perception was significantly influenced by the awareness and the membership of rubber society at the probability level of 1%. At the same time, the education level significantly affects perception. The Farmers who have been educated above O/L showed a high tendency to build up positive perceptions about recommendations. Perception and awareness significantly affect adoption at the probability level of 1%. The total land owned by a farmer and distance to land from the house showed a negative relationship with adoption technologies although it was not statistically significant. The results conclude that organizing training on rubber cultivation, strengthening extension services and establishing rubber societies are important criteria to enhance adoption of recommended technologies for rubber cultivation and processing.

**Keywords:** Awareness; Adoption; Perception: Rubber; Structural Equation Model

**Acknowledgement:** *Authors wish to acknowledge the financial support given by the Wayamba University of Sri Lanka under the research grant SRHDC/RP/04/18-02.*

# *Session A–2:*
# *Agricultural Biology and Biotechnology*

# Is the Floral Polymorphism of *Vanda tessellata* (Roxb.) Hook. ex G. Don. (Orchidaceae) Site-Specific?

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## Abstract

An epiphytic indigenous orchid species, *Vanda tessellata*, is well-known for its wide range of floral variations. This species is protected in Sri Lanka under the Fauna and Flora Protection Ordinance and listed as a threatened species under the Endangered (EN) category of the National Red List (2020) of Sri Lanka. Due to its floral beauty, this plant has high ornamental demand, thereby causing serious threats to over-exploitation. Habitat destruction has also increased the threats faced by *V. tessellata*. Therefore, better knowledge of floral polymorphism will be important in the sustainable utilization and conservation of this species. This research was conducted in Sri Lanka from January 2007 to December 2021 to investigate the relationship between environmental factors and the unique floral polymorphism of *V. tessellata.* Site selection was made to observe the floral characteristics and environmental factors in different geographical areas. Four sites of natural habitats represent different geographical parts of the island; Madatugama (Anuradhapura district), Anamaduwa (Puttlum district) and Siththandy (Batticaloa district) representing the dry zone of Sri Lanka and Bogollagama (Kurunegala District) representing the intermediate zone of the country were selected. As home gardens, four sites: Polonnaruwa (Polonnaruwa district) in the dry zone, Yanthampalawa (Kurunegala district) in the intermediate zone and Pepiliyawala (Gampaha district) and Dehiwala (Colombo district) in the wet zone were selected. The home gardens were used to cultivate selected colour varieties to check if the environment has any effect on morphological character development. The flowering phenology was monitored and the colours of the tepals and labella from 6310 flowers were monitored once a week under the same light conditions. The observations were recorded in the morning and afternoon (from 7.30 – 8.30

a.m. and 3.30 – 4.30 p.m.) and the colour was recorded by using the RHS colour chart and a comparison was done. In the natural habitats, flowering was recorded from February to July and throughout the year in all four nursery sites. It took 3-4 days for the maturity of a flower and the duration lasted on average three weeks in the wet zone and on average more than three weeks in the intermediate and dry zones. The results indicated that there is no colour or any other major morphological changes when grown under nursery conditions. There was a slight decline in the intensity of colours when grown under nursery conditions in the wet zone. However, there was no such change in the dry and intermediate zones. According to the RHS colour chart, the colour range in flowers of *V. tessellata* ranged from white (155-159), yellow (1-13, 155-162), orange (20-35, 163-174), red (36-74, 175-186), mauve (75-76), purple (77-78), blue (89-110), green (111-154), to grey-brown (186-202). The results suggest that the floral polymorphism of *V. tessellata* is not site dependent. Hence, the unique floral diversity could be exploited in the floriculture industry. Further, as flowering was recorded throughout the year in nursery sites, breeding programmes could be carried out in nurseries for crop improvement.

**Keywords**: Floral Polymorphism, Flowering Phenology, RHS Colour Chart, *Vanda tessellata*

# Effect of Adenine Sulphate, Salicylic Acid, Carbendazim, and Paclobutrazol on *in vitro* Growth of *Stevia rebaudiana*

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## Abstract

*Stevia rebaudiana* (Asteraceae) is a perennial herbaceous plant that is commercially cultivated in a wide range of tropical and sub-tropical agro-ecological regions in Asia as a natural substitute for cane sugar. *In vitro* clonal propagation is identified as a viable solution to overcome limitations encountered with conventional propagation methods for many plant species including stevia. The availability of an optimized protocol for the mass production of true-to-type plants is essential in this line. Hence, the objective of this study was to evaluate the effect of adenine sulphate, salicylic acid, carbendazim, and paclobutrazol (PBZ) on *in vitro* shooting and rooting stages of the micropropagation of *S. rebaudina*.

Experiments were carried out to evaluate the growth performances of *in vitro*-derived shoots in different shoot proliferation and rooting media consisting of different concentrations and combinations of adenine sulphate, salicylic acid, carbendazim, and paclobutrazol (PBZ). Shoots collected from healthy-looking mother plants maintained in a plant house were surface sterilized using 1% Topsin, 70% ethanol, and 15% Clorox, and excised into single nodal cuttings to be used as explants. Murashige and Skoog medium (MS) fortified with 2.0 mg/L Benzyl Amino Purine (BAP) was used as the culture initiation medium. As shoot proliferation medium, MS medium fortified with 0.3 mg/L BAP and 0.3 mg/L Kinetin (Kin) was used. The sub culturing was practiced in four-week intervals.

The pH of the culture media was adjusted to 5.8, gelled with 8 g/L of agar, and autoclaved at 1.5 kg/cm$^2$ at 121 °C for 20 min. All the cultures were incubated at 25 ± 2 °C, 65- 70% relative humidity, and 16 h light/ 8 h dark photoperiod with 3000 lux light intensity provided by cool white fluorescent tubes. Aseptic conditions were maintained as required throughout the study. As the

experimental design, Completely Randomized Design (CRD) was practiced, where each treatment consisted 10 replicates. The experiments were repeated three times. The data were analyzed using Statistical Analysis Software (SAS) and means were compared by the Least Significant Difference (LSD) test ($P \leq 0.05$).

MS medium fortified with 0.3 mg/L BAP, 0.3 mg/L Kin, 40.0 mg/L adenine sulphate, and 200.0 mg/L carbendazim resulted in the highest number of shoots (44.9 shoots/ explant) up to seven subcultures. The highest mean number of roots per shoot (8.35) was observed in ½ MS medium followed by ½ MS medium fortified with 0.1 mg/L PBZ within six weeks. In addition, tested concentrations of PBZ resulted in reduced shoot and root lengths during the shoot multiplication and rooting stages of micropropagation. Incorporation of adenine sulphate, carbendazim, and PBZ is essential to improve the number and quality of the *in vitro* derived shoots of *S. rebaudiana*.

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**Keywords:** Adenine Sulphate; Carbendazim; Micropropagation; Paclobutrazol; Salicylic Acid

# Nutritional and Physicochemical Properties of Arrowroot (*Maranta arundinacea*) Flour from Five Different Provinces in Sri Lanka

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## Abstract

Commercial exploitation of underutilized tuber crops is an emerging global trend, and it requires characterization of their functional properties. Arrowroot (*Maranta arundinacea*), locally known as "Hulankeeriya" or "Aerukka", is such a tuber crop that belongs to the family Marantaceae. Therefore, the present study aimed to determine the flour yield (%), proximate composition, and physicochemical properties of arrowroot flour from, Western, North-Western, Sabaragamuwa, Southern, and Uva provinces of Sri Lanka. Arrowroot flour was extracted by crushing rhizome with water, subsequent sedimentation, and oven drying of sediment at 40 °C for 48 h, followed by grinding the dried pellets to a fine powder. Flour yield (w/w) was calculated as a percentage of flour obtained from raw rhizomes (fresh weight basis). The proximate composition of arrowroot flour was determined as moisture, ash, total solid, crude protein, crude fat, crude fiber, and carbohydrate as percentages and also the energy content (kcal/100 g). The physicochemical properties namely least gelation concentration (%), moisture sorption capacity (%), flour colour, starch granule morphology, flour density (g/ml), viscosity (cP), amylose content (%), total starch content (%), swelling power (g/g) and solubility (%) were determined.

Arrowroot flour yield was recorded as 11.13–12.79% (w/w). Flour samples had pH values in the acceptable range (5.71–7.37) for food preparations without fermentation. The flour contained 0.88–1.17% ash, 0.68–0.75% crude protein, 0.13–0.63% crude fat, 0.94–1.19% crude fiber, 86.83–90.17% carbohydrate and 356.03–365.26 kcal/100 g energy contents which were not significantly different ($P>0.05$) among the samples collected from five

different provinces. The least gelation concentration ranged between 6.66-8.66% indicating a high gel-forming ability of arrowroot flour. The moisture sorption capacity of flour samples was low (18.57–24.88%) after storage for 72 hours at 98% humidity and room temperature (27 °C) which was not significantly different across the five provinces. A low moisture sorption capacity of flour is useful in the pharmaceutical industry.

The colour of arrowroot flour was very much closer to that of wheat flour, with minor reddish and yellowish colour tones. Oval, spherical, and irregular globular shapes were the three main starch granule shapes. Granule length and width were 42.91–45.86 µm and 30.81–32.32 µm respectively. The bulk density (0.68–0.72 g/ml) of arrowroot flour has a high potential to be used in the pharmaceutical industry. Viscosity ranged between 6304–13585 cP and the increased viscosity levels indicate a high gel-forming ability of flour. The amylose content of the arrowroot flour from five provinces ranged between 24.24–28.06%. The total starch content of flour ranged between 65.34–66.66% which represents the purity of flour. The swelling power of arrowroot flour ranged from 8.32–13.38 (g/g) while the solubility was 9.30–13.47%. Although solubility indices were significantly different from each other, their variation was minimum across the provinces. Cluster analysis for arrowroot flour samples from the five provinces (Figure 1) also revealed that the flour samples had a high level of similarity with each other in terms of their proximate compositions. The results indicated that the effect of geographical location within Sri Lanka on the physicochemical properties of arrowroot flour is minimum.

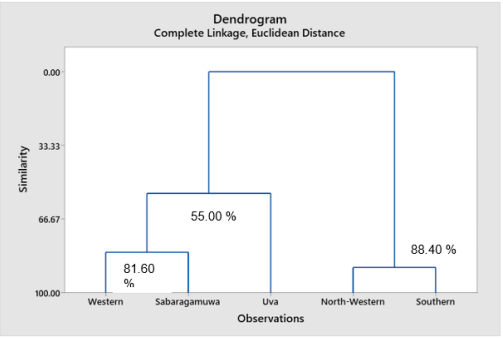


**Figure 1:** Results of Cluster Analysis for Proximate Composition of Arrowroot Flour from Five Provinces in Sri Lanka

**Keywords:** Arrowroot; Chemical Composition; Flour Yield; *Maranta arundinacea*; Physicochemical Properties

# Characterization of Exotic Parental Varieties of Sugarcane (*Saccharum* spp. hybrid) by SSR Markers

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## Abstract

Sugarcane is a raw material for sugar production. Most of the currently-cultivated sugarcane varieties are derived from inter-specific hybrids of *Saccharum officinarum* and *S. spontaneum* followed by subsequent back crossing. Good knowledge of the population structure of sugarcane parental varieties is a preliminary requirement for the success of sugarcane crop improvement programs. Two hundred and fifty exotic sugarcane varieties that are frequently used in sugarcane crop improvement were subjected to study the genetic diversity using 23 simple sequence repeat (SSR) markers. The varieties have been introduced from 17 countries around the world. The total DNA of individual varieties was extracted using a CTAB-based method with slight modifications and the quality and quantity of extracted DNA were measured. The 23 SSR primers produced a total of 387 amplified loci and they were identified on PAGE. Based on the values of genetic distances, the analysis of molecular variance (AMOVA), and principal coordinate analysis (PCoA), the genetic diversity of exotic hybrids was assessed using GenAlEx 6.5. A dendrogram was constructed based on the similarity coefficients using NTSYSpc 2.2.

At the 75% similarity coefficient, two major clusters were identified in the dendrogram. All the varieties except a few varieties imported from Pakistan, were grouped into a single cluster whereas above Pakistan varieties formed a separate cluster. The genetic similarity values among varieties ranged from 0.625 to 0.935. A similar clustering pattern was obtained in PCoA as well.

AMOVA confirmed that the genetic variation existed among the varieties imported from individual countries was higher (84%) than the genetic variation

within the varieties (16%). The highest Nei's gene diversity (0.16), the Shannon's information index (0.26), and a higher percentage of polymorphic loci (70.54%) were observed in sugarcane varieties imported from Coimbatore, India indicating that they are more genetically diverse than the varieties imported from other countries around the world. The information on the genetic diversity derived from this study can make an important contribution in designing cross-combinations to maximize the genetic variability in the progenies of sugarcane for breeding.

**Key words:** AMOVA; Genetic Diversity; PCoA; SSR; Sugarcane

# Evaluation of Crop-Generated Microclimatic Models on Beetroot (*Beta vulgaris*) Growth in Kalpitiya Peninsula

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## Abstract

Beetroot (*Beta vulgaris*) is a cool-season vegetable mostly grown in the upcountry and Kalpitiya areas in Sri Lanka for its leaves and roots. Kalpitiya is located in the Puttalam district of Sri Lanka in the $DL_3$ agro ecological zone with an annual rainfall of 600 mm and Sandy Regosol soil type. The maximum day and night temperatures reach up to 34 and 28℃ respectively in this area. High temperatures and sandy soil cause low nutrient and water retention capacities, which is unfavourable for the cultivation of vegetables. Though climatic conditions in Kalpitiya are less favourable for beetroot cultivation, farmers extensively practice high-input farming with frequent irrigation for cooling down the microclimate and excess fertilizer application to compensate the amount loss by leaching. Over-irrigation and fertilization create economic and environmental problems such as groundwater contamination, leading to human health issues. To mitigate these malpractices, one strategy could be improving the microclimatic condition around the beetroot crop. Therefore, the aim of this study was to evaluate the beetroot growth under three different crop-generated microclimatic models (crop models); 1) monocrop, 2) intercropped with chili (*Capsicum annuum*) only, 3) intercropped with chili and included crop border.

The research was conducted at the Agriculture Research Station, Kandakuliya. Crop models were established in a Randomized Complete Block Design (RCBD) with two blocks and three crop models in each block. Each crop model consisted of 60 beetroot plants maintained with 10 replicates. Beetroot was established in 30×10 cm spacing, in model 1; beetroot only, model 2: intercropped with chili (*Capsicum annuum*) 60×60 cm spacing and model 3; intercropped with chili and border of long bean (*Vigna unguiculata* ssp.

*sesquipedalis*) and sun-hemp (*Crotalaria juncea*). The crops were irrigated by overhead sprinklers three times per day followed by agronomic practices recommended by the Department of Agriculture (DOA), Sri Lanka. Beetroot was harvested 80 days after planting. Total plant weight and root fresh weights were recorded during the harvesting. In addition, climatic factors, air temperature and relative humidity (RH) were measured using the multifunctional environmental meter (Brannan, England) weekly in each model. Three data points were recorded for each model between 10 a.m. to 12 p.m. The recorded data were subjected to Analysis of Variance and mean separation was done using the Least Significant Difference.

**Table 1:** Beetroot (*Beta vulgaris*) Yield Performance in Response to Different Crop Models

| Crop model | Plant weight ($g/m^2$) | Root weight ($g/m^2$) |
|---|---|---|
| Model 1 | $655.66 \pm 31.5^c$ | $350.55 \pm 20.4^c$ |
| Model 2 | $930.66 \pm 28.6^b$ | $545.27 \pm 21.5^b$ |
| Model 3 | $1302.22 \pm 35.5^a$ | $770.0 \pm 24.7^a$ |
| P value | <0.0001 | <0.0001 |

***Note:*** *Values for crop models marked with different letters are significantly different according to the Least significant difference Test (LSD) at p=0.05; ± values indicate standard error.*

Significant difference was observed among yield parameters (p<.0001) according to the crop models. Crop model 3 showed the highest plant (1302.22 $g/m^2$) and root (770 $g/m^2$) weight over other two models. Model 1 gave the lowest yield. Model 2 and 3 clearly showed yield improvement over the monocrop (model 1). The climatic data indicated that the RH of the model 2 and 3 had a significant improvement over the model 1 (p<.0001). However, there was no significant difference in air temperature between models. Intercropping and wind barriers help to improve RH and microclimate around the crops that affect positively for the crop yield. Previous studies also provided evidence for intercropping improves microclimatic conditions and that effect for the yield enhancement of the crops. According to the yield performance and microclimatic evidence crop model 3 is selected as the best model for beet cultivation in Kalpitiya peninsula.

**Keywords:** Beet; Crop Model; Intercropping; Kalpitiya; Microclimate

**Acknowledgment:** *Financial assistance by AHEAD Research Grant (AHEAD/DOR/051).*

# Non-Destructive Estimation of Above-Ground Biomass of the Rice Plant (*Oryza sativa*. L) Using Drone-based Multispectral Vegetation Indices and Plant Height Model

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## Abstract

Advanced crop remote sensing methods of measuring above-ground biomass (AGB) non-destructively, outweigh the limitations of manual, destructive time-consuming tedious methods. AGB is associated with plant height and crop vigor. Traditionally on-ground measured plant height has been popularly used as an indirect assessment of AGB in rice. However, the accuracy and scale of interpretation or real AGB by on-ground measured plant height are questionable. Therefore, this study aimed to compare the performance of estimating AGB in rice crops by means of three methods; a) the traditional on-ground measured plant height, b) remotely measured plant height by Plant Height Model (PHM) derived by drone and c) remotely measured crop spectral reflectance computed as vegetation indices (VIs) from drone.

The study was conducted at controlled rice fields maintained by the Rice Research and Development Institute (RRDI), Bathalagoda, Kurunegala, Sri Lanka. Bg 300 rice variety was cultivated at Yala season, 2021 and irrigated and carefully monitored with proper agronomic practices. When rice plants reached the maximum vegetative stage, drone imagery of the field was captured at 25 m height from 10:00 h to 11:00 h using a P4 Multispectral (DJI Technology, China) drone. Immediately after the drone mission, on-ground measurements; plant height (using float disc method) and destructive biomass sampling were taken from sampling areas that were pre-marked by white Styrofoam quadrants 1 $m^2$ prior to the drone mission. Above ground parts of the sampled rice plants were oven dried at 70$^oC$ for 72 h to record

observed biomass. Drone imagery was processed using Pix4Dmapper and QGIS software (version 3.16). The PHM was generated subtracting digital terrain model (DTM) from digital surface model (DSM) which was generated during the post processing of the drone images.

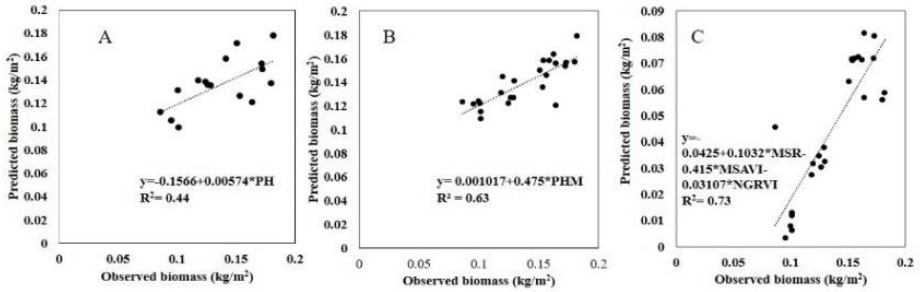


**Figure 1:** Scatter Plots for Observed AGB versus Predicted Biomass

***Note:*** *A: Manually measured height using float disc method, B: Using height derived from plant height model and C: Using VIs, at $p < 0.05$ for all $R^2$ using PLSR, LR and MLR model. PH: Plant height measured using float disc method.*

The relationship between the manually assed plant height and AGB of the rice plant showed low accuracy ($R^2$=0.42, RMSE=0.078) than the relationship between PHM and AGB ($R^2$=0.60, RMSE=0.061). Manual assessment of crop heights is time consuming; thus, only a small portion of crops can be measured, leading to inaccuracies. Also, the combination of three VIs like MSR, NGRVI and MSAVI showed higher accuracy ($R^2$= 0.71, RMSE=0.055) at $p < 0.05$. Figure 1 illustrates the prediction accuracy for observed AGB versus predicted biomass at booting stage at $p < 0.05$.

The spectral parameters were strongly correlated with rice AGB. The VIs and PHM derived from multispectral imagery were found to be significantly correlated to above-ground biomass and were used to overcome the underestimation problem. However, drone-based remote sensing platforms have become prevalent in recent years, and the findings could provide a valuable reference for crop growth monitoring with drone imagery. The findings strongly suggest that novel remote sensing techniques using multispectral drones may warrant highly accurate measurement of AGB across the field through the season, frequently.

**Keywords:** Above-Ground Biomass; Digital Surface Model; Digital Terrain Model; Plant Height Models; PLS Regression

# Discovery of a New Species of the Genus *Lagenandra* from the Wet Zone of Sri Lanka

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## Abstract

Taxonomic revisions are an important component of biodiversity conservation as it paves the way for the sustainable utilization of plants by describing new species. A new *Lagenandra* species that had not been described before was recognized and a morphometric analysis was carried out to determine the species limits of the genus and to evaluate the taxonomic position of these populations that were encountered with different character combinations. Field studies were carried out, between 2020–2022, in the wet zone including the "Indikada Mukalana" Forest Reserve, where we came across the *Lagenandra* species that had not been described before. Repeated field visits were carried out to monitor the flowering and fruiting populations. The morphological characters of the field-collected samples were studied in detail in the laboratory, at the Department of Botany, University of Peradeniya. Both quantitative and qualitative morphological characters were studied. A minimum of five mature flowering individuals from each population were selected to record data for characters, and five measurements were taken from each individual plant for a particular character. Sixteen individuals were employed in the morphometric analyses and each was denoted by an acronym (L170a–h and L171a–h). A total of 83 morphological characters (39 quantitative and 44 qualitative) were coded into a data matrix. Hierarchical Cluster Analysis (CA), Principal Coordinate Analysis (PCoA), and Principal component analysis (PCA) were carried out using the statistical software PAST (Version 2.15). The consequently recovered major clusters were identified.

The dendrogram that resulted from the CA recognized two clusters (Figure 1): cluster A (L170 a–h) and cluster B (L171 a–h). Based on the SIMPER

analysis, the number of male florets, peduncle colour, leaf shape, and the number of female florets were the four most contributing characters to the grouping. The ordination diagram from the PCoA based on the complete set of data shows a pattern similar to the cluster analyses. The first four (principal) eigenvalues recovered from the PCoA (2703.4, 214.7, 201, and 166.5) accounted for 95.6% of the total variance (78.7%, 6.3%, 5.8%, and 4.8% respectively). The individuals were well separated along the 1st Coordinate with no overlap. The results of the PCA also corroborated with the other analyses, recognizing two well-separated groups. According to loading along the 1st axis, the number of male florets, female florets, infructescence stalk length, and peduncle length were the most contributing quantitative characters. The results of the morphometric analyses support the presence of below-species-level variations warranting the recognition of two varieties of the newly discovered *Lagenandra* species. The new species was named *Lagenandra peradeniyae* Madola, D. Yakandawala and K. Yakandawala, with two infraspecific taxa; *L. peradeniyae* Madola, D. Yakandawala and K. Yakandawala var. *peradeniyae* (cluster A) and *L. peradeniyae* var. *speciosa* Madola, D. Yakandawala and K. Yakandawala (cluster B), endemic to Sri Lanka. The new discovery escalates the number of *Lagenandra* species recorded on the island to 13, out of which 12 are endemic to the country.

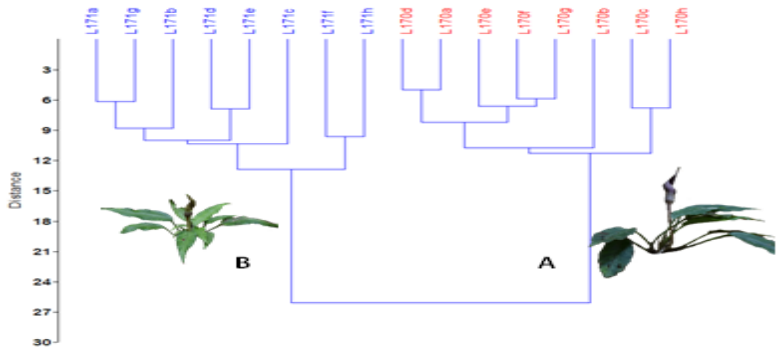


**Figure 1:** The clustering dendrogram based on morphological characters. L 170a–h: *L. peradeniyae* var. *peradeniyae* (cluster A) and L171a–h: *L. peradeniyae* var. *speciosa* (cluster B)

**Keywords:** *Lagenandra peradeniyae*, Morphometric Analysis, Wet Zone

**Acknowledgements:** *The Forest Department of Sri Lanka is acknowledged for granting permission for sample collection.*

# Mass Culturing of *Chlorella* sp. and the Potential for Biodiesel Production

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## Abstract

Global energy demand is continuously rising and a fifty percent increase is expected by the year 2050. Currently, most of the energy demand is met by fossil fuels such as petroleum and coal which are non-renewable. In addition, the burning of fossil fuels is the major source of greenhouse gas emissions leading to global warming and climate change. Therefore, many countries in the world are focusing on renewable energy sources such as solar, bioenergy, wind, hydro, and geothermal. Bioenergy, where biomass produced via photosynthesis can be converted to biofuel, biogas, heat and electricity is the most widely used form of renewable energy. Microalgae are considered as third generation biofuel feedstock and frequently used for producing biodiesel because of its high cellular lipid content e.g. *Chlorella* sp. However, utilization as well as research on microalgae-based biofuel in Sri Lanka is still at infancy. Therefore, overarching aim of the current study was to determine the potential of producing biodiesel from microalgae species in Sri Lanka. Specific objective of the study was to develop a laboratory-scale mass culture technology for *Chlorella* sp.

In this study, *Chlorella* sp. isolated from wastewater ponds in central bus stand, Negombo were used. An experiment was conducted to determine the effect of light intensity (2000 lux, 6000 lux), temperature (20 ℃, 25 ℃, 30 ℃ and 35 ℃) and aeration on the growth of *Chlorella* in liquid culture using a randomized complete block design. Four identical growth chambers with controlled conditions of light intensity and temperature were designed and developed using Arduino technology. In each chamber, six cultures of *Chlorella* sp. in 250 mL conical flasks (BG 11 media) were placed and three flasks were supplied with filtered air and the other three were kept without

aeration. A control was setup by keeping a 250 mL *Chlorella* sp. culture under room temperature, ambient light and non-aeration conditions. Flasks were shaken twice a day. The growth of the cultures was monitored by determining the cell density using a haemocytometer and the cell biomass based on absorbance values at 750 nm wavelength (Jenway 6305) at 0, 96, 192, 288, 384 hours after inoculation. The biomass of the cultures was determined by harvesting (6000 rpm 3 hours) and obtaining the oven dry weight of biomass (70 ℃ for 3 hrs) after 16 weeks. A randomized complete block design was used and the experimental data were statistically analysed using SPPS 16 software. Using the optimum growth conditions, a mass culture system that consists of four airlift photobioreactors (5 L) was developed. Inoculant (500 mL) was added to each bioreactor and cells were harvested by auto flocculation after two weeks. Total lipids of *Chlorella* sp. were extracted using a modified protocol of Bligh and Dyer (1959) method using isopropanol/ chloroform/ methanol extractions and dried using a rotary evaporator at 45 ℃. The extracted algal lipids were converted to fatty acid methyl esters (FAME) or biodiesel by transesterification with methanol and sodium hydroxide as a catalyst. The study concluded that 30 °C temperature, 6000 lux light intensity with aeration conditions as optimum conditions for culturing of *Chlorella* sp. The study has developed a laboratory-scale mass culture technology for growing and harvesting *Chlorella* sp. and to extract algal total lipids and biodiesel. Future studies on the characterization of the FAMEs and scale up of the mass culturing system are suggested.

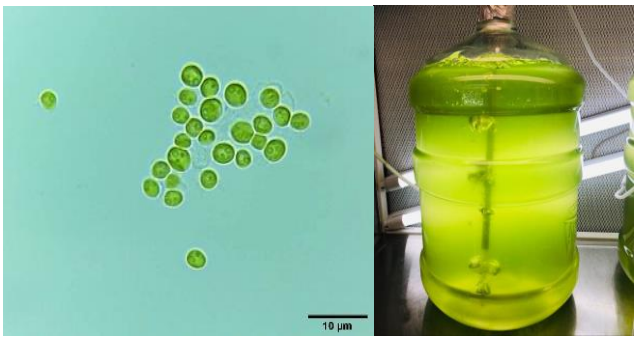


**Figure 1:** Microscopic View of *Chlorella* sp. (1000x magnification) and An Airlift Photobioreactor for Mass Culturing of Microalgae

**Keywords:** Biodiesel; Biofuel; Microalgae, *Chlorella*, Photobioreactor

# Growth and Flowering of *Nymphoides hydrophylla* under Different Light and Water Logging Conditions

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## Abstract

*Nymphoides hydrophylla* (Lour.) Kuntze, ("Kumudu") is one of the most popular aquatic ornamental species in the world. However, the current local popularity of *N. hydrophylla* in the landscape industry is low due to the extensive use of exotic aquatic ornamental species. Therefore, this study was designed to evaluate the growth and flowering of *N. hydrophylla* under different light and water logging conditions.

The study was conducted as a pot experiment from May to September 2022 at the Rajarata University of Sri Lanka. Rhizome pieces with three internodes (4-5 cm long) with the apical bud were planted in pots containing 50 kg of topsoil. The experiment was arranged as a two-factor factorial design with six treatments and four replicates (n=24). Two light levels were given using a net house with 50% shade netting and using a rain shelter located 18' apart from each other. In each house, pots were continuously maintained in three different water depths (2 cm, 10 cm, and 30 cm). Hourly changes in atmospheric temperature, relative humidity (RH), and light intensity (LI) were recorded from 6.00 a.m. to 6.00 p.m. in weekly intervals from one month until the second month when plant growth and flowering were assessed. Plant growth and flowering were evaluated using total unfurled leaves, stem number, stems with side shoots, leaf adaxial and abaxial colours, and stem colour, flower diameter, time to 50% flower opening, time to full bloom, and floral longevity, and full-bloomed flower number per plant. A mixed model and least-squares

means were used for the statistical analysis. Pooled t-test was used for environmental parameter analysis.

Among the minimum and maximum values of weekly recorded environmental parameters, the maximum LI in the rain shelter was significantly higher than in the net house. The interaction effect of light and water depth and the main effect from the light were not affected significantly on any parameter tested. Among the tested vegetative morphological characters, total unfurled leaves, stem number, and stems with side shoots showed significantly high values in 30 cm water depth (table 1). Further, brownish leaf abaxial resulted in 10 cm and 30 cm water depths. The flowering phenology was not significantly changed by the increasing water depths. Though increasing water depth has given high plant growth performance and flower production, 10 cm, and 2 cm water depths also gave a satisfactory number of full-bloomed flowers. Water is a limiting factor for dry landscapes. Further, maintenance of high-water depths requires high maintenance costs. Thus, considering water availability and maintenance cost, the 10 cm water depth can effectively be used to introduce *N. hydrophylla* in sustainable anthropogenic landscapes without compromising the aesthetic quality. Furthermore, the 2 cm water depth is also capable of producing flowers in dry landscapes.

**Table 1**: Estimate Values of Plant Growth and Flowering Parameters

| Parameter tested | Water depth (cm) | | |
|---|---|---|---|
| | 2 | 10 | 30 |
| Total unfurled leaves | $59.6^{b}\pm10.0$ | $117.6^{a}\pm13.1$ | $119.2^{a}\pm11.1$ |
| Stem number | $18.6^{b}\pm1.8$ | $30.0^{a}\pm1.2$ | $33.5^{a}\pm1.3$ |
| Stems with side shoots | $12.6^{c}\pm1.2$ | $23.9^{b}\pm1.0$ | $27.6^{a}\pm1.0$ |
| Leaf adaxial colour | $3.0^{a}\pm0.8$ | $3.0^{a}\pm0.5$ | $3.9^{a}\pm0.8$ |
| Leaf abaxial colour | $3.0^{b}\pm0.5$ | $3.6^{ab}\pm0.3$ | $5.2^{a}\pm0.6$ |
| Stem colour | $4.0^{a}\pm0.5$ | $3.7^{a}\pm0.2$ | $4.0^{a}\pm0.0$ |
| Flower diameter (cm) | $1.9^{a}\pm0.0$ | $2.0^{a}\pm0.0$ | $2.1^{a}\pm0.0$ |
| Time to 50% flower opening (min.) | $36.2^{a}\pm4.7$ | $34.6^{a}\pm5.4$ | $36.3^{a}\pm5.7$ |
| Time to full bloom (min.) | $108.0^{a}\pm8.7$ | $101.5^{a}\pm11.4$ | $121.9^{a}\pm9.1$ |
| Floral longevity (min.) | $384.8^{a}\pm7.9$ | $406.0^{a}\pm14.1$ | $390.5^{a}\pm11.5$ |
| Full-bloomed flower number | $21.1^{c}\pm5.2$ | $70.5^{b}\pm12.7$ | $106.2^{a}\pm9.1$ |

***Note:*** *Values are estimated values of parameters ± SE. The same superscript among each column is not significantly different at p=0.05.*

**Keywords:** Environmental Adaptability; Environmental Parameters; Growth and Development; *Nymphoides Hydrophylla*; Sustainable Landscapes

# Sensory Properties and Antioxidant Capacity of Butterfly Pea Flower Incorporated Herbal Tea Formulations

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## Abstract

Butterfly pea flower possesses numerous valuable bioactivities including antioxidant and antidiabetic. Hence, a number of different herbal tea formulations have been developed incorporating butterfly pea flower. Nevertheless, reports on using gotukola and curry leaves along with butterfly pea flower in the preparation of herbal tea are scanty. Also, although cinnamon and ginger have been used in butterfly pea flower-based beverages, their effects on the properties of teas have not been thoroughly investigated. Thus, the aim of this study was to investigate the variation of sensory and antioxidant properties of herbal tea formulations consisting of different ratios of gotukola, curry leaves and butterfly pea flower, with or without spices.

Herbal teas were prepared by steeping each herbal blend (2 g) in one cup of hot water for 5 min. A total of eight herbal teas, including curry leaves (C); gotukola (G); mixtures of C and G; butterfly pea flower (BPF); mixtures of BPF, C and G; and herbal teas incorporating cinnamon (Cin) or ginger (Gin) were evaluated in this study. Sensory evaluations were carried out using 30 untrained panellists in the development of the herbal teas. The assays: total polyphenol content (TPC), total flavonoid content (TFC), total anthocyanin content (TAC), and 2,2-diphenyl-1-picrylhydrazyl (DPPH) were carried out to investigate the antioxidant capacity and types of chemical constituents imparting antioxidant potential to the herbal teas developed in this study. The data from the assays were analysed using one-way ANOVA.

The most accepted ratio of C: G was 1:1, which was used in the preparation of BPF incorporated tea formulations. Favourably, results indicated that the incorporation of C and G in BPF teas may be carried out without compromising the sensory attributes of BPF tea. Interestingly, the herbal blends of 'C – G – BPF – Cin', and 'C – G – BPF – Gin' exhibited higher acceptability ($P \leq 0.05$) than the other teas for all sensory attributes (i.e. colour, appearance, taste, aroma and overall pleasantness) evaluated in this study. This result indicates that the sensory attributes of BPF tea blends may be improved significantly by incorporating Cin or Gin.

As expected, the different herbal blends exhibited significant differences in the chemical composition and antioxidant potential. Black tea and green tea showed the highest TPC and TFC, while BPF showed significantly lower values. In contrast, anthocyanins were not detected in black tea and green tea, attributable most probably to the low sensitivity of the assay, although the presence of anthocyanins has been reported in the literature. However, anthocyanins were present in BPF and BPF incorporated herbal teas. Despite the differences in the chemical composition, black tea and BPF tea showed the highest antioxidant potential according to the DPPH assay, and the percentage radical scavenging capacities were 106.99±1.57% and 105.04±0.28% respectively. The antioxidant potential of the Cin added herbal tea, which is one of the most accepted teas, was the second highest (83.58±2.20%) and was not significantly different to that of green tea (86.67±6.50%) which is known to possess a high antioxidant capacity.

Concisely, BPF herbal teas may be formulated incorporating curry leaves, gotukola and cinnamon or ginger, to show enhanced sensory attributes and high antioxidant potential.

**Keywords:** Antioxidant Potential; Butterfly Pea Flower; Curry Leaves; Gotukola; Herbal Tea

**Acknowledgements:** *Authors thank the Wayamba University of Sri Lanka for giving financial support through Grant No. SRHDC/RP/04/20-21/02.*

*Session B:*
*Applied Sciences*

# Suitability of a Mg based Redox Capacitor with a Natural Rubber based Electrolyte in the Field of Power and Energy

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## Abstract

As one measure to fulfill the high rising global energy demand, energy storage and conversion devices have become an important focus of the scientific community. Necessity for energy storage devices has been triggered with identifying renewable energy sources (solar, wind, tidal etc) for energy generation. Due to their locational and seasonal fluctuations, energy storage devices are very essential to maintain stability. Great attention has been attributed to developing and refining more efficient energy storage devices such as rechargeable cells and supercapacitors (electrochemical double layer capacitors and redox capacitors). The aim of the present study was to fabricate Mg based redox capacitor using a natural rubber (NR) based solid polymer electrolyte (SPE).

A mechanically stable and a free standing SPE was prepared by solvent casting a mixture of NR, salt (magnesium trifluoromethanesulfonate ($Mg(CF_3SO_3)_2$ - MgTF)) in tetrahydrofuran (THF). NR and salt were first mixed with THF and stirred to form a homogenous electrolyte solution. The final solution was then poured into a petri dish and left to slowly evaporate THF. This resulted a thin solid electrolyte film. Electrodes of redox capacitor were fabricated by polymerizing the conducting polymer, polypyrrole (PPy). Electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV) and galvanostatic charge discharge tests (GCD) were carried out to characterize the redox capacitor. The value of single electrode specific capacitance, $C_{sc}$ obtained from bode plot resulted a value of 30.28 F $g^{-1}$. The relaxation time constant ($\tau_0$) of about 69.1 s indicates the rate of redox reactions are taking place quite fast.

CV test was performed for the potential window from -1.2 V to 1.2 V and at the scan rate of 5 mV $s^{-1}$. Initial $C_{sc}$ value for the redox capacitor was 40.85 F $g^{-1}$ according to the present study. This is decreasing continuously during the cycling and at the $500^{th}$ cycle, it was reported as 9.86 F $g^{-1}$. Decrease of the $C_{sc}$ can be associated with the formation of passivation layer at the electrolyte electrode interface and the degradation of electrode/ electrolyte interface upon cycling. GCD test for the redox capacitor under a constant current of 5 x $10^{-5}$ A and within the potential from 0.1 V to 1.2 V resulted 12.10 F $g^{-1}$ of initial single electrode specific discharge capacitance ($C_{sd}$) value. During 1000 cycles, it reached to 3.15 F $g^{-1}$. The efficiency of $C_{sd}$ was about 25 % and this may be due to the degradation of electrode and electrolyte interface upon prolonged cycling.

**Keywords:** Mg Redox Capacitor; Natural Rubber; Polypyrrole; Solid Polymer Electrolyte

***Acknowledgement:*** *The authors would like to acknowledge the National Research Council Sri Lanka for financial assistance under the research grant NRC 17-006. Also, Rubber Research Institute, Sri Lanka is highly acknowledged for providing samples.*

# Effects of Bending Stiffness on Localized Bulging in a Pressurized Hyper-elastic Tube

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## Abstract

The problem of localized bulging in inflated thin-walled tubes has been studied by many authors. In all these studies, the membrane assumption is used and the strain energy function is dependent only on the two principal stretches in the middle surface. However, there are some applications where the cylindrical tube concerned may have walls thick enough so that the membrane theory may become invalid. In this study, the effect of bending stiffness on the initiation of localized bulging in inflated thin-walled tubes is studied. Strain energy function has been defined in terms of the curvature of the middle surface and the principal stretches. The analysis considered here is for a thin-wall incompressible, hyper-elastic and isotrophic cylindrical tube. Only axially symmetric deformations are considered from the originally axially symmetric configuration.

Therefore, when the tube is inflated by internal pressure, it can be assumed that the inflated configuration maintains the axial symmetry and the radius of the tube may be constant or vary along the axial direction. The tube is assumed to have uniform thickness and inner radius before inflation while the axisymmetric deformed configuration is represented in terms of cylindrical coordinates $(r, \theta, z)$. Further, it is assumed that the strain-energy function $U$ is a function of both stretches and curvature of the surface. More specifically, it has the form $U = \omega(\lambda_1, \lambda_2) + c\frac{1}{R^4}(\kappa_{11} - R)^2 + {\kappa_{22}}^2 + \frac{1}{R^2}\kappa_{22}(\kappa_{11} - R)$, where $\lambda_1$ and $\lambda_2$ denote the principal stretches in the latitudinal and meridional directions respectively while $\kappa_1 = \frac{\kappa_{11}}{r^2}$ and $\kappa_2 = \frac{\kappa_{22}}{{\lambda_2}^2}$ are the principal curvatures of the surface. The constant $c$ will be determined in comparison with the 3D theory in the small thickness limit.

Using the Engineering Shell Theory and the Steigmann and Ogden's variational formulation, a system of five first-order ordinary differential equations for finding fully non-linear localized bulging solutions for hyper-elastic thin-walled tubes was derived. A finite difference scheme and a shooting method were formulated to determine the fully non-linear bulging solutions numerically. All numerical computations were carried out with the aid of Mathematica. Localized bulging solutions can be found when the tube has a constant radius $r_\infty$ and constant axial stretch $z_\infty$ far away from the localized bulge if it exists. Results for shells with different aspects, such as tubes with fixed axial force or axial stretch, were presented to show how the bending stiffness affects the localization behavior. When the elastic tube is inflated by an internal pressure, the tube inflates cylindrically until the pressure reaches a critical value. At this point, where $r_\infty = r_{cr}$ , a bifurcation occurs and the cylindrical configuration becomes unstable. A weekly non-linear analysis was conducted to determine the near-critical behavior. A two term bifurcation condition $\omega(r_\infty) = 0$, was proposed and used to quantify the effect of bending stiffness on localized bulging. Compound matrix method was used to investigate the bifurcation analysis. It was shown that $\omega'(r_{cr})$ is always negative at the first bifurcation point which corresponds to the bulging solution.

The main findings are that for a tube with fixed axial force, the bifurcation point occurs at the turning points of the pressure volume curve and that for a tube with fixed axial stretch, if a bifurcation point exist, it must come before the maximum of the pressure volume curve, and localized bulging can take place even if the latter maximum does not exist at all. An expression was derived for the critical value of the pressure at which a localized bulging solution may exist. Bifurcation pressure for the membrane and cylindrical shell was calculated for some specific values of $z_\infty$. The bifurcation condition also provides a means to quantify precisely the effect of bending stiffness on the initiation pressure. It was shown that there is a significant increase in bifurcation pressure when bending stiffness is taken into account. Therefore, wall thickness becomes a key parameter for the bifurcation pressure in uniform inflation.

**Keywords:** Bending Stiffness; Bifurcation; Localized Bulging

# Image Security Method by Combining Visual Cryptography and Steganography

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## Abstract

Data security is the practice of protecting digital information from unauthorized access, corruption or theft throughout its entire lifecycle. The goal of this research work is to introduce a data security technique especially for images, by combining of cryptography and steganography to enhance the data security. In this research, we maintain security of data on the process of encryption. And to improve the quality of the shared images and the recovered secret image by using extended visual cryptography scheme. Further achieve transparency, authority and high capacity of the hidden data. In the encoding phase, we take the secret image and with the help of Visual Cryptography Algorithm we will divide the image into two shares. After that each share is encrypted, then using Steganography Algorithm this secret image hides inside the selected cover image. After hiding this secret image, the cover image becomes a stegano image. The Following flowchart explains the process of the encryption.

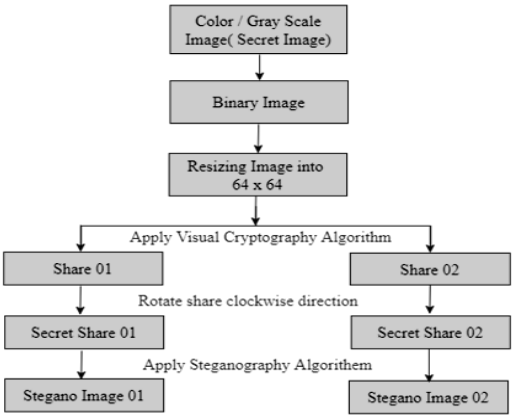


**Figure 1:** The Flowchart of Encryption Process

We used Lena image and text in an image for demonstration, after that divided those in to two shares according to Figure 2 and share 1 rotate 90 degree clock wise direction and share 2 rotate 180 degrees clock wise direction. Then by using Steganography algorithm hide those rotated images in randomly selected cover images as shown in Figure 3.

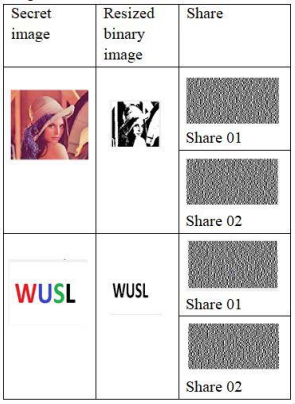


**Figure 2:** Shared Image

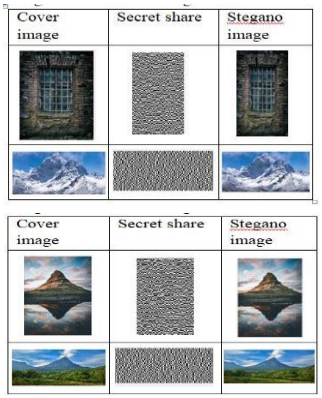


**Figure 3:** Steganography Images

Histogram analysis, Entropy, MSE - Mean Square Error, Peak Signal to Noise Ratio - PSNR and Signal to Noise Ratio - SNR will be used to assess the efficiency of encryption and decryption process using compare the encrypted image with the original binary image. After checking the security analysis, PSNR value of Lena image shares are 31.0091 and 30.5924. The PSNR values of text image shares are 30.3024 and 29.4186. According to the Histogram analysis, cover image and stegano image histograms are very similar both of image. Therefore, combination of visual cryptography & steganography technique can be used to enhance the security of the image. In now a day use of internet is widespread and personal data open to world, we need a system which can protect them. Then, proposed scheme by using Visual Cryptography with Steganography it makes high security and difficult to decrypt get hidden image. According to the analysis results, we suggested this technique durable and efficient in image protection.

**Keywords:** Mean Square Error; Peak Signal to Noise Ratio; Steganography; Visual Cryptography

# A Novel Architecture Embedded with a Temperature Sensor for an Energy Harvesting Circuit

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## Abstract

Energy harvesting circuit has a major concern on increasing the efficiency of energy conservation during the process of sensing and automation. The above circuit is mainly focused on extracting energy from Radio Frequency (RF) sources because of the high demand for consuming power. This study aims to design, develop, fabricate, and implement a low power, low-cost application embedded with a temperature sensor, operated from an energy harvesting circuit.

The main challenge in an energy harvesting circuit is the incapability of providing sufficient power to use with an application during the RF to DC conversion process. When converting from AC to DC, using a rectifier circuit, the number of stages would be selected to obtain the maximum power. According to our results, the maximum DC voltage of the rectifier is approximately 0.9 to 1.8 V and the current is 0.8 to 10 µA. The real-time temperature displaying system based on an ultra-low-power MSP430G microcontroller was proposed and to be operated with a low voltage of 3.4 V and 2 – 3 mA current. The major challenge was to operate the designed application from the generated output power of the rectifier circuit, because it was not adequate to turn on the low-power application. The application was developed on the MSP430G2553 ultra-low-power microcontroller which has a low supply voltage of 1.8 – 3.6 V and is ideal for battery-powered applications. DS18B20 digital temperature sensor operated with 3.3 – 5 V was used to measure the temperature because it can be used for low power applications compared to other temperature sensors available in the market such as the LM35 analog temperature sensor, operated in 4 V.

As the DS18B20 sensor uses one-wire technology which communicates via a single data line, it can obtain reliable data with more accuracy in less time. The measured temperature was displayed on a 1602 Liquid Crystal Display (LCD) which can be operated with a low power of 3.3 V and 1 mA without the backlight. The 4-bit display mode was used to reduce the extra power consumption by minimizing the connected number of pins in the LCD.

As mentioned above, the output of the rectifier circuit was insufficient to operate the low power real-time temperature displaying system, it was tested by boosting the output voltage up to 3.3 V from a Pulse Frequency Modulation (PFM) Control, DC to DC Booster Module, an electrolyte and a supercapacitor. In comparison to the supercapacitor, the electrolyte discharged immediately due to the low current. The supercapacitor took more charging time than the electrolyte. The supercapacitor discharged within a short period because the application draws 2 – 3 mA. Therefore, the booster was not a suitable candidate. Finally, the output was amplified from a non-inverting amplifying circuit consisting of a low power op-amp, OPA354. The OPA354 required a low bias current of 6 – 50 pA and can be amplified up to 100 mA. The input and the feedback resistance of the amplifier were selected by calculating the gain corresponding to the expected output. The output of 0.8 µA and 1.7 V rectifier circuit was designed using low turn on Schottky diodes and ceramic capacitors working in high frequency signals. This output was amplified with the non-inverting amplifier to 3.4 – 4 V. The amplified voltage was regulated by a 1N728A 3.3 V/1 W Zener diode with series and shunt load resistors to protect the application from unexpected high voltages.

The proposed real-time novel temperature displaying system is cheaper than the existing architectures. It consists of an ultra-low power microcontroller and was developed by considering the proper experimental materials and methods. Therefore, the proposed study reveals, it was possible to implement a temperature sensor application from the amplified DC power extracted from a RF to DC converter.

**Keywords:** Energy Harvesting Circuit; MSP 430G2; OPA354; RF-DC Rectifier; Temperature Sensor

# Impact of Short Text Classification Performance with Feature Augmentation

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## Abstract

Short text which has emerged with the explosion of online communication, social networks and micro-bloggings are currently widely available and need to be analyzed to create the knowledge for decision generation process. Short text is generally different compared to long text document since these are noisier, more information and less topic focused. As a result, the performance of conventional classification approach is reported as being poor in comparison with performance on longer text, the inference here is insufficient data representation within the target text. Original text augmented with features from external knowledge sources have become increasingly popular for short text classification performance improvements over the years. Feature augmentation is helpful to reduce the data sparseness issue within short text. Once the features are augmented it helps to increase the value representations of feature dimensions. Therefore, the main aim of this research is to identify the impact of short text classification performances with different feature augmentation from an ontology. This has not been evaluated well with the previous research work. Seven published datasets were used from social media sources and by previous research groups. This research uses WordNet(ontology) to identify what features are best to augment with short text datasets to improve the short text classification performances. This research work focus to extract the features that are suitable across all the seven datasets. Features were extracted from wordnet such as lemmas, hypernyms, hyponyms, homonyms, nouns, verbs, adverbs, adjectives, and different combination of

those as augmented feature set. Traditional n-grams (BOW and 2-grams were used for feature representation. Wordnet (Ontology) was used as the external knowledge source to extract the additional features. Features from wordnet was represented as 1-gram, F-measure was used for performance evaluation as it allows to represent correct accuracy irrespective of class imbalance nature. As the final validation techniques, hold out stratified training and testing set was used with 70 % to 30% split. The 70% of training data was split as 80% of training and 20% of validation set. The 20% validation dataset was used to identify the best features with feature reduction technique. Based on the identified features from validation dataset, relevant features from training and testing dataset were selected for the model building and testing. SVM (support vector machine was selected as the classifier) as it is very effective in high dimensional spaces as well as it was used extensively for text classifications. SVM was used with default settings with linear kernels.

According to this research, following augmentation techniques were identified as having higher ability to improve the short text classification performances augmenting all synset, [Aug_all] Nouns [Aug_N], hypernyms [Aug_Hyper] and Nouns with Hypernyms [Aug_N_Hyper] and omitted other augmentation techniques as it gave least performance improvements compared to baseline such as feature augmentation of adverbs, adjectives, homonyms and mixing different types of feature augmentations (Table 1). Overall, augmentation of nouns and hypernyms achieves the best classification performance improvements over the baseline with every dataset (1-3 %), as shown in Table 1. The results can be used to develop a more efficient, accurate classification model specially to assist the social media moderators to improve their classification accuracy efficiently and effectively with augmented text.

**Table 1:** Short Text Classification Performances with Different Augmentation Techniques with Wordnet Augmentation

| Augmentation Type | D1 | D2 | D3 | D4 | D5 | D6 | D7 |
|---|---|---|---|---|---|---|---|
| Baseline | 78.6 | 87.6 | 75.2 | 76.0 | 96.1 | 72.8 | 85.1 |
| Aug_All | 79.4 | 87.5 | 75.4 | 77.6 | 95.9 | 81.6 | 85.6 |
| Aug_N | 80.6 | 88.6 | 75.7 | 78.3 | 96.1 | 82.9 | 85.3 |
| Aug_Hyper | 81.2 | 88.3 | 76.8 | 78.4 | 96.7 | 83.1 | 85.9 |
| Aug_N_Hyper | 81.3 | 88.6 | 77.2 | 78.3 | 96.9 | 84.1 | 86.3 |

**Keywords**: Augmentation; Classification; Hypernyms; Short Text; Wordnet

# A Mathematical Model for Predicting the Outcome of Twenty20 Internationals in Cricket

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## Abstract

Cricket is one of the most popular sports in the world particularly in the Asian sub-continent and in Australasia (Australia and New Zealand), West-Indies, England, and South-Africa as well. Among different formats of cricket, T20I games have become more popular and competitive because of its shorter version and the excitement generated throughout a match. Because of the competitiveness at the highest level and plausible uncertainty in the outcome, the number of nail-biting finishes that go down to the wire is also on the increase.

In order to win a T20I game of cricket, the team batting second has to overhaul the target set by the team batting first. It is often difficult to predict most outcomes during the first half of an inning and even during the latter quarter due to unpredictable burst of performance from either side. However, scoring in a game can be viewed as a growth model and it was possible to identify three key stages in the second half of the games that enabled to predict which way the outcome of a match is heading towards. Using the methodology of doubling time (the amount of time it takes for a given quantity to double in size) of the score in limited over games in cricket and analyzing the outcomes of two international tournaments (T20 World Cup – 2021 and Asia Cup – 2022), which comprised of a total of 58 matches, the following thresholds could be discovered to produce the best predictions. After investigating the growth of scores in the 50-over format, it was possible to trace that on average the score in the neighborhood of the 30th over doubles at the end of the innings and it could be verified that the same ratio is applicable to the T20I format also.

All three stages identified in the T20I format were established based on the

extension of the same ratio to the latter half of the innings. If the team batting second could surpass the above thresholds at the three progressive stages in the second-half of the match, such teams stood a good chance of winning the game.

**Table 1:** Summary of the Model Developed

| Stage | Threshold |
|---|---|
| Neighborhood* of 12.0 overs | Half the final target |
| Neighborhood* of 16.4 overs | Score after 12.0 overs + (Half the balance to be chased after 12.0 overs) |
| Neighborhood* of 18.4 overs | Score after 16.4 overs + (Half the balance to be chased after 16.4 overs) |

$*$ – within about 3 balls from the particular stage

On verification, this model correctly predicted the outcomes of 56 matches (43 of T20 World Cup – 2021 and all of Asia Cup – 2022) out of a total of 58 matches, thus yielding a 96.55% (≅56/58) of accuracy in these tournaments. In the only two cases where the model predictions failed, the chasing team had to score only 13 and 14 runs in the final over, which is usually gettable in this format, but ended with the unexpected result due to some extraordinary performances of the bowler who bowled the last over. Further, this model could also be used by the team batting first to post a target it plans to set for the opposition according to a preplan by analyzing the scores at these key stages. On the other hand, it was possible to find that if the fielding team could keep the batting team under these targets by 5 to 10 runs, the team fielding second had a good chance of winning the game. The significance of these findings is that, if one of the teams is mindful of the progression according to this model then it can adapt progressive strategies according to a preplan in the latter half of the game and avoid panicking or taking unnecessary risks and record a win irrespective of batting or fielding in the second half.

**Keywords:** Cricket; Model; Outcome; Prediction; T20I

# *Session C:*
# *Management, Finance and Sustainability*

# Impact of the Modern HRM Practices to Retain Generation-Z Software Professionals in Post-Pandemic WFH Environment

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## Abstract

Since the Covid-19 outbreak, the software development industry has redefined its operational structure by embracing the work-from-home (WFH) concept. Moreover, used technology-driven new employee interaction mechanisms to empower and manage the new generational (generation-z) employees; to keep the important employees by satisfying their expectations from the organization.

In that, organizations have incorporated modern human resource management practices (HRM practices) such as "democratised learning" practices by partnering with massive open online courses platforms (MOOCs) (allowing freedom for employees to choose educational programs that suit them to succeed at the workplace), "reverse mentoring" (provide advocacy opportunities for the junior level employees over the new technologies to the senior level employees), "workplace social support" (extending the support for employees beyond the job functionalities), "new challenging work" (offering new tasks for the employees to work on that they have never done before) and "real-time feedback" (using technology give comments and suggestions seamlessly within a very short time after the task is completed by employee). Hence, this study aims to understand the effects of modern HRM practices on employees' job satisfaction and retention from the developing countries' software development employees' perspective.

This study used the disproportionate stratified random sampling technique to collect the responses of 385 Generation-Z software development employees who were employed at software development companies registered under the export development board of Sri Lanka and found within the Colombo district of Sri Lanka. Utilized fifty-three instruments based on the Likert scale which

was extracted from the literature with more than 0.7 Cronbach's alpha value. Moreover, conducted a reliability test over the content validation of the questionnaire through the pilot test before the primary data collection was conducted and received a higher alpha value (>0.7). Data collection has conducted within three months to minimize the effects of external moderating factors on the responses. Data analysis is followed by confirmatory factor analysis, multicollinearity analysis and structural equation modelling (SEM).

The study was able to prove the positive direct relationship between each HRM practice the employee retention. Among the five practices, assigning new challenging work practices is considered the most impactful practice from the generation-z employees' belief for them to remain in the same company. Real-time feedback practice has considered the least impacting HRM practice that makes employees remain in the workplace. Furthermore, found the positive mediatory effect of job satisfaction to enhance the relationship between HRM practices and employee retention. Also found that reverse mentoring, democratising learning, and workplace social support practices as the second, third and fourth most impacting HRM practices respectively in direct positive relationship towards employee retention. Analysis has highlighted that incorporating less costly policies like new-challenging work practices is much more effective in enhancing employee retention rather than incorporating costly democratize learning practices.

Apart from that identification from the SEM, the multicollinearity analysis found that there is a direct relationship between each practice and employee job satisfaction; and found out that, not only as a mediator but even job satisfaction factor can see as a separate factor that has a direct positive relationship with the employee's retention. Therefore, that has shown the importance of future research to be conducted on identifying the different other modern HRM practices that would affect job satisfaction and employee retention apart from practices that were taken into the consideration in this study; to make the proper and sound decision-making as an organization on prioritizing of investments over inculcation of the various HRM practices that are going to align with the Generation Z employee's perceptions.

**Keywords:** Democratize Learning; Employee Retention; New Challenging Work; Reverse mentoring; Workplace Social Support

# Influence of Macroeconomic Variables on the Stock Prices: A study on the Colombo Stock Exchange

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## Abstract

Sri Lanka, a developing open economy relies on the Colombo Stock Exchange (CSE) as one of the most important equity generators of the country. In Capital Assets Pricing Model (CAPM), the underlying market conditions and the market sensitivity influence the price of assets. Hence, abundant studies have aimed to determine the macroeconomic factor influence on CSE and stock price volatility. Empirical studies on CSE provide both convergence and deviations from theoretically acknowledged phenomenon. Thus, this study aims to identify the long-run relations of the selected macroeconomic factors with reference to the adjustment speeds of the CSE to be in tandem with the respective macroeconomic variables in an event of a shock. Log of closing prices of All Share Price Index (ASPI), US dollar to Sri Lankan Rupee prices (USD), Treasury bill rates (TB) and Colombo Consumer Price Index (CCPI), narrow money supply (M1, M2), broad money supply (M4) and gold prices (GP) are used in the study as proxies for the economic activity, exchange rate, interest rate, inflation rate, narrow money supply, broad money supply and other asset prices respectively. The study uses secondary monthly data published by the Central Bank of Sri Lanka and CSE from January, 2010 to April, 2022. Owing to the presence of unit roots, the study estimated a Vector Error Correction Model (VECM) in analysing the long run cointegrations and the share price adjustments upon a shock in any selected economic variable in the long run. The estimated VECM indicates that all variables except the USD and GP cointegrate with ASPI in the long run. Thus, the influence of exchange rate and other assets on the stock market performance are omitted due to the insignificance at 95% confidence level. The strong negative cointegration of CCPI on stock prices indicate that inflation does not impose a hedging effect on the Sri Lankan stock market prices in the long run. On the other hand, the strong positive cointegrations among money supply and ASPI concurs the real

activity theorists that stock prices are positively related to the money supply of an economy. The CCPI reach a positive equilibrium with ASPI at a speed of 25.4% whilst others reach an equilibrium below the initial state. Thus, a positive change in inflation allows the stock market to establish a cointegration with boosted investor confidence. Narrow and broad money supply shows rapid negative adjustments with the stock market. The negative equilibrium reached by TB and ASPI at a speed of 32.0% suggests the flight-to-quality behaviour of the investors of CSE in a disruption. However, the negative equilibrium states reached further indicates the deterioration of the confidence in stock market performance among investors during a shock in the economy through the years.

The study findings both converge and deviate with the prior empirical studies. Timely information provided on the influences of selected macroeconomic variables on the stock market performance are crucial in investor decision-making and policy development. Imperative policy changes could incorporate the study findings in strengthening the CSE performance and building confidence as the premier equity generator.

**Table 1:** Long Run Relations of ASPI and Macroeconomic Variables

| Variable | Coefficient | Standard Error | t- statistic | p- value |
|---|---|---|---|---|
| *Cointegration Matrix* | | | | |
| CCPI | -2.6739 | 0.5764 | -4.6393 | 3.50E-06*** |
| M1 | 1.02E+05 | 1.79E+04 | 5.704 | 1.17E-08*** |
| M2 | 1.70E+05 | 3.44E+04 | 4.9464 | 7.56E-07*** |
| M4 | 2.15E+05 | 6.24E+04 | 3.4407 | 5.80E-04*** |
| TB | 3.249 | 1.3422 | 2.4206 | 0.0155*** |
| *Adjustment Matrix* | | | | |
| CCPI ←→ LASPI | 0.2536 | 0.0565 | 4.4893 | 7.15E-06*** |
| M1 ←→ LASPI | -9.46E+03 | 1.75E+03 | -5.3943 | 6.88E-08*** |
| M2 ←→ LASPI | -1.44E+04 | 3.37E+03 | -4.2706 | 1.95E-05*** |
| M4 ←→ LASPI | -1.79E+04 | 6.11E+03 | -2.9235 | 3.50E-03*** |
| TB ←→ LASPI | -0.3204 | 0.1315 | -2.4358 | 0.0149*** |

***Note:*** ****- Significant at 95% confidence level.*

**Keywords:** ASPI; Inflation; Interest Rates; Long-run relations; Money supply

# Impact of Leadership Style on Organizational Effectiveness: A Systematic Review

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## Abstract

Leadership is defined as a process whereby an individual influences a group of individuals to achieve a common goal. Organizational effectiveness is the degree to which an organization meets the needs of its clientele or customers. The researchers of this study realized that there was a clear theoretical gap with regard to the precise impact of each leadership style on organizational effectiveness. Therefore, the intention of this systematic literature review was to analyze the existing theoretical gap in the leadership arena. Hence, the core objective of this research was to analyze the findings of previously published research on leadership to identify the impact of leadership styles on organizational effectiveness. The authors of the study used the systematic review method to achieve the objective of the study. This systematic review was conducted for one month duration from 15th of September 2022 to 15th of October 2022. Research articles with leadership style and organizational effectiveness or organizational performance were searched in internet databases using Google Scholar. Then randomly selected 20 articles found on well known databases and online international scientific journals with higher impact factors were reviewed. It was noted that transformational, transactional, ethical, spiritual, task oriented, people oriented, laissez-faire, autocratic, democratic, visionary, situational, participatory, bureaucratic and charismatic leadership were only considered as styles of leadership in these selected research articles, though there are many more styles of leadership that have been described in the literature. Organizational effectiveness and organizational performance were considered synonymous terms in selecting the relevant articles for this study.

The research question, objectives, research methodology and findings of each study were thoroughly analyzed and synthesized to achieve the objective of this study.

The review revealed that there is a definite impact of leadership style on organizational effectiveness which could be positive or negative. Further, it was evident that the impact is context specific. According to this systematic review, transformational leadership is the dominant leadership style which has a strong positive impact on organizational effectiveness as ascertained in 50% of the selected articles. The next important leadership style is democratic leadership which is also having a strong positive impact on organizational effectiveness as described in 45% of the selected research articles. When it comes to transactional leadership style and autocratic leadership style, it was discovered that these two leadership styles had both positive and negative effects on organizational effectiveness.

Though it was unexpected, laissez-faire leadership style had a significant positive impact on organizational effectiveness, whereas charismatic leadership style had a negative impact. Therefore, this current review was able to fill the existing theoretical gap in the concept of leadership to some extent and concluded that transformational and democratic leadership styles have a higher degree of impact on organizational effectiveness while each and every leadership style has an impact on organizational effectiveness to varying degrees of extent either positive or negative.

Hence, it would be recommended leaders to practise transformational and or democratic leadership style as appropriate to make their organizations more effective. Further it is recommended to consider the context in which leaders are practicing their leadership style because it was revealed that the impact of leadership style on organizational effectiveness is context specific. Limitation of the study is that there were less number of research articles used for this systematic review due to time constraints hence, it is recommended to conduct a systematic review with a larger number of research articles or carry out comprehensive empirical research to draw a more precise conclusion.

**Key words:** Leadership Style; Organizational Effectiveness; Transformational Leadership; Democratic Leadership; Laissez-Faire Leadership

# Disparities between Sustainability Disclosures and Practices by Sri Lankan Firms: A Case Study Using Food and Beverage Industry

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## Abstract

Sustainability is a key concern area among the business firms as a methodology to achieve long term economic growth and as a risk management tool. Sustainability has currently become a business imperative for all organizations as stakeholders expect the firms to be economically viable as well as do well for the community and environment, they operate in. There are several frameworks introduced by global institutions to guide firms on their path towards a sustainable future. However, the efforts and contribution of the firms in achieving sustainability may vary upon the country and industrial settings. Sri Lanka is a developing country and sustainability reporting of firms remains a voluntary practice. This study aims at exploring the firm's behaviour in practicing sustainability efforts in the Sri Lankan context while examining the variability of disclosure patterns and actual practices related to environmental sustainability of a particular industry sector.

A qualitative approach was employed by conducting structured interviews with managers of two selected firms in the food and beverage industry (a public company listed in CSE and a private limited company). A pre-arranged set of questions on corporate sustainability practices, activities, disclosures, issues and concerns was given to two firms. The responsible managers who are in charge of sustainability activities of the firms elaborated detailed answers and their opinions to the questions which were recorded and further analysed qualitatively using content analysis. Collected data from two firms were examined to see any variation between sustainability disclosures and actual practices.

The results showed that the two firms in the food and beverage industry identified water, energy and material usage as key focus areas creating a

significant impact towards the environment. The firms were deeply concerned with the water and energy conservation efforts and waste disposal mechanisms in disclosing their sustainability performance. The firms have introduced new manufacturing technologies and used sustainable packaging for the products as sustainability initiatives. The water usage, energy usage and carbon footprint are commonly quantified and disclosed as indicators for environmental performance. Carbon neutrality is a major milestone for the firms and efforts have been taken to reduce the carbon footprint of the facilities with respect to transportation, energy, waste and water usage. The public firm seem to follow globally acknowledged frameworks in disclosing their sustainability efforts, while the private firm has collaborated with international institutions in setting targets and disclose their performance with reference to the progress achieved on the set targets. It was observed that the public firm tend to strictly adhere to the global acknowledged frameworks and guidelines such as GRI (Global Reporting Initiative) and UNGC (United Nations Global Compact) principals.

In contrast, the private firm does not significantly consider about the global sustainability frameworks. The private firm illustrated their sustainability efforts with reference to specific targets established with collaborating with international institutions and discussed their progress towards achieving the targets. However, both firms were shown to have a wide knowledge about the SDGs (Sustainable Development Goals) by the United Nations. The public firm has a practice of disclosing their sustainability efforts in annual and standalone sustainability disclosures and these reports are available for the public community. The private firm has internal corporate reporting mechanism in addressing targeted stakeholders of the firm and these reports are not disclosed to the general public. The private firm sustainability efforts are mostly made aware to the public by releasing press releases. Behavioural divergences were observed with respect to sustainability disclosures and practises, based on the difference in stakeholder pressure involved with the firms. It was observed that the sustainability practices of firms in the same industry category varies with the ownership of the company and regulatory influences. It could be suggested that regulatory settings for mandatory sustainability disclosures under a common set of guidelines could facilitate firms' efforts towards achieving sustainable future.

**Keywords:** Food and Beverage Industry; In-depth Interviews; Qualitative Approach; Sustainability Disclosures

# Determining the Effect of Human Resources Management Practices in Sri Lankan Universities towards Organizational Performance: A Survey Conducted at the Wayamba University of Sri Lanka

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## Abstract

Human resources management practices are considerably contributing to a higher level of organizational performance. They may be influenced to a better performance of an organization. This study explores the level of contribution of human resources management practices in order to achieve organizational performance in Sri Lankan Universities with special attention to the Wayamba University of Sri Lanka. The findings of this research add new knowledge to the existing knowledge as well as new avenues for researchers for future research on this field and the organizations to adopt recommendations for the level of influencing the human resources management practices for better performance. HRM practices influence for better performance of Universities in Sri Lanka in various ways. The results of this research have indicated that HRM practices have most significant impact on the outcomes of organizational performance and that has created new ways to make decisions by the management of Universities to guide and explore new avenues to develop their organizations while improving the quality of human resources.

In Sri Lankan context, HRM is not severely addressed by the management like in developed countries. In the University system, most of the staff are not satisfied with the services they received compared to the other sectors. The main purpose of this study was to identify the factors affecting organizational performance towards HR practices.

Six factors of human resource practices namely recruitment, selection, promotion, training & development, performance appraisal, and compensation: were used to measure the effect of human resource practices on organizational performance. According to the correlation analysis, all independent variables are positively correlated with the dependent variable. Three methods namely

enter, stepwise and forward were used in multiple regression analysis to identify the most effective factors for organizational performance. This research study was developed, firstly to enable the researcher to determine the hypothesis, variable associations, conceptual limitations, and a questionnaire. Secondly, an empirical survey was done by administering the questionnaire. The target group of the research was the Heads of the Departments (academic heads and executives) at the Wayamba University of Sri Lanka. The Correlation coefficient and the multiple regression analysis were used to determine the effective factors of human resource practices towards organizational performance in the University system.

The researcher has investigated that performance appraisal, training & development and selection are the most effective human resource practices for organizational performance at the Wayamba University of Sri Lanka. Other factors namely recruitment, promotion and compensation are not highly effective according to the research.

**Keywords**: Human Resources Management Practices, Organizational Performance, Human Resources Management

# A Study on Factors Affecting Undergraduates' Attitudes to Taking Part in Sports with Special Reference to the Wayamba University of Sri Lanka

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## Abstract

It is a common understanding that undergraduates need to have a healthy lifestyle with a sound knowledge of good food habits, effective leisure time activities, etc. Sports play a pivotal role in maintaining a healthy body and mind. But not every undergraduate takes part in sports. Some studies show that most of the undergraduates who engage in active sports are the ones who represent the respective university or faculty in those particular sports events. So the lack of interest shown by the undergraduates taking part in sports has been a pertinent concern confronted by almost all the universities in Sri Lanka. Therefore, it is very useful to investigate this phenomenon as it uncovers the salient features regarding undergraduates' attitudes to sports which would ultimately help the university to design its sports-related activities as there is no previously published study found in the Sri Lankan context related to this. Therefore, a sample of 289 representing 1167 third-year undergraduates was selected from all faculties of the Wayamba University of Sri Lanka by using a simple random sampling technique. Level-three undergraduates were selected as they had two years of experience in doing sports at the university. A questionnaire was devised to gather necessary data from the subjects concerning their perception of participating in sports and it was first pilot-tested with 20 students and made some necessary adjustments before being deployed. Although a printed questionnaire was distributed among the sample only 200 questionnaires were returned and the data were analysed descriptively.

According to the results, 65.5% of the students were engaged in sports activities. Out of the reasons given, the most common reason the students cited was that they did sports 'for fitness', as 76.41% of the students claimed it.

Then the students who did sports 'for enjoyment' and 'competitions' were 56.84% and 54.82%, respectively. The least common reason 'for relaxation' was cited only by 18.77%. On the other hand, only 34.5% of the students did not engage in sports activities. Out of the reasons given, the most common reason the students cited was that they did not have enough time to engage in sports, as 69.78% of the students claimed it. Then students who did not do sports due to health problems and lack of interest stood at 30.1% each. The least common reason, 'lack of nutrition', was cited only by 10.8%.

Finally, according to the results obtained, it can be decided that most of the students (65.5%) were engaged in sports activities and did them for their physical well-being. Therefore, the results show a good tendency of the students of the Wayamba University of Sri Lanka as most of them involve in some kind of sports activity and do it for their physical well-being, which is a very good sign. It is also important to note that women's participation in sports is greater than men's, and a majority of them do sports to enjoy themselves. However, when the students who do not like to engage in sports are concerned, it is clear that most do not have enough time to participate. They might also engage in sports if some respite is given from their heavy academic schedules.

As a result, while the academic workload cannot be reduced, it is critical for the university to discover ways and means of influencing the mindsets of students who do not participate in sports. However, while the results suggested a favourable inclination to participate in sports at the Wayamba University of Sri Lanka, it may not be realistically observable at the grassroots level. This might have something to do with the sample of the study. The sample may not be a true representation of all students at the university. As a result, the outcomes may have been different if this had been done with the entire student population.

**Keywords**: Perception; Physical well-being; Sports participation; Undergraduates

# *Session D-1:*
# *Food Production Systems*

# Distribution of Wild Elephants and Human-Elephant Conflict in Maduruoya Area, Sri Lanka

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## Abstract

Wild elephants are distributed in intermediate and lowland dry zone which include wildlife protected areas, forest reserves and other state forests in Sri Lanka. Last elephant census in 2011 estimated the total wild elephant population in Sri Lanka is about 6 000.

Continual loss of elephant habitats due to the establishment of irrigation projects, settlement schemes, plantations of sugar cane, rice, teak and other cash crops in traditional foraging areas and migratory/linkages routes of elephants is a major problem for their long-term survival, whilst increasing the Human Elephant Conflict (HEC) in Sri Lanka.

Maduruoya National Park is in Eastern wildlife region and bounded with about 26 Gramaniladhari divisions in five Divisional Secretary Divisions (DSD) spanning over Ampara, Polonnaruwa and Badulla districts of Sri Lanka. The park holds five reservoirs, dominated by grasslands and secondary shrub forest patches, which are the most preferred habitats of the elephants. It is estimated that 1573 wild elephants live in this area thus, increasing the chances for encounters inevitably leading to high rates of HEC. The purpose of this study was to obtain data on the distribution of wild elephants and their encounters with the adjoining villages to identify areas of high HEC, to better understand the leading causes and to find appropriate methods in mitigating HEC around Maduruoya area. The study was carried out from January 2018 to May 2022. The HEC data in the study area were collected from the Department of Wildlife Conservation (DWC) and the village survey was conducted among the peripheral villagers who were willing to provide information. Houses were selected randomly. The direct and indirect signs of elephants were geo recorded. The movement records of collared elephants in the study area were also

obtained. The movements of elephants, their food and food habits were observed. HEC is relatively low in February to May but occurs throughout the year. Most crop damages were found to be by solitary male elephants, followed by three to five membered male elephant groups (bachelor herds) and small female groups in that order. Evenings and nights recorded the peak time for elephant movements into the villages. The main cash crops the farmers cultivated and elephants most prefer were paddy, banana, cowpea, and maize. Based on the DWC data from 2018 up until September 2022, areas with highest HEC included Dimbulagala DSD in Polonnaruwa District with 36 human deaths and 81 elephant deaths followed by Mahinyanganaya DSD in Badulla District with 18 human and 63 elephant deaths, respectively. Lowest HEC was recorded from Padiyathalawa DSD and Mahaoya DSD of Ampara District with 6 human and 14 elephant deaths followed by 6 human and 38 elephant deaths, respectively. Based on the data gathered from the village survey, the villages with high HEC were recorded in Bogamuyaya, Aranthalawa, Tampitiya, Medarakka villages in Mahaoya DSD, and Maldeniya in Dehiaththakandiya DSD (Ampara District) followed by Kekulawala, and Muwapetikewela villages in Dimbulagala DSD (Polonnaruwa District). Mahiyangana in Badulla district and Padiyathalawa in Ampara district where the village boundaries lay beside Maduruoya National park show the lowest incidence of HEC. Three major elephant corridors have been identified linking Maduruoya National Park with Galoya, Somawathi- Floodplains and Wasgomuwa National parks that act as highways for elephant movements between the aforementioned protected areas. Data support the overlap of high incidence of HEC to villages adjacent to the elephant corridors.

In conclusion to mitigate HEC in these areas, it is important to clear the linkages of any interference by the settlements in and around the elephant corridors whilst managing the corridors that supply fodder for the elephants that move through them to avoid the elephants from wandering out of the corridors in search of food and water.

**Keywords:** Maduruoya; Human-Elephant Conflict; Elephant Corridors

# Assessing Phosphate Solubilizing Ability of *Aspergillus* sp.

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## Abstract

Phosphorus is an essential macronutrient needed for overall plant growth and crop productivity. The global agricultural sector is majorly dependent on the synthetic phosphate (P) fertilizers, which is associated with a high cost of synthesis. Those synthetic fertilizers have negative impact on humans and the environment. The frequent precipitation and immobilization of P in the soil make a requirement to look for alternative strategies that maintain a soluble phosphorus pool in the soil. In Sri Lankan context, Eppawala Rock Phosphate (ERP) deposit is the wealthiest P source, has the potential to fulfill the requirement for P fertilizer in the country. But the low bioavailability of ERP limits the maximum utilization of the source. Chemical and physical methods to solubilize ERP are not eco-friendly and economical. Biological methods to solubilize minerals are trending due to its sustainable approach. The objective of this study is to isolate P solubilizing fungi as a sustainable alternative.

P solubilizing fungus was isolated from soil samples collected from various locations using NBRIP media, which comprises $Ca_3PO_4$ as the sole P source. P solubilizing ability of isolated fungus was evaluated qualitatively using P solubilizing index (PSI) and HD/CD value. High-graded Eppawala Rock

Phosphate (HERP) solubilizing ability of fungi was identified qualitatively by replacing P source with HERP in the modified NBRIP media, which contain bromophenol blue. The quantitative analysis of HERP solubilization by the fungus was done using UV spectrophotometer according to the molybdenum blue method. Fungal spore solution ($1\times 10^7$ spores per mL) was added to NBRIP broth (1:9) containing HERP as the sole P source. The effect of the pH on the solubilization of HERP by the fungus was determined by using two broth samples that maintained the optimum growth pH (5.5 pH) in the broth media for the isolated fungi and without maintaining the pH of the media. The experiments were performed for six days and readings were obtained after each 24 hours from the inoculation. Isolated fungus was characterized by morphological and microscopic analysis. Data analysis was done by using two-sample t-test of MINITAB 19 software.

Halo zone forming fungus has isolated as P solubilizing organism. According to the colony morphology, light microscopic observations, and SEM imaging, the isolated fungi was identified as *Aspergillus* sp. The formation of a yellow color zone around the colony confirms the acid production and HERP solubilization of *Aspergillus* sp. in modified NBRIP media. PSI of isolated *Aspergillus* sp. was 2.464 and HD/CD value was 1.5, which indicated a strong ability (HD/CD of strong P solubilization $\geq$1.5) to solubilize P. The results of quantitative analysis for HERP solubilization was shown a significant difference between control samples and *Aspergillus* sp. inoculated samples ($p<0.05$). Maximum P solubilization was recorded at the fourth day after the inoculation and the pH of the medium was parallelly decreased with P solubilization. pH-controlled (at 5.5 pH) inoculated and non-inoculated samples reported lower P solubilization than the non-pH-controlled samples. According to the results, it can be concluded that *Aspergillus* sp. has an ability to solubilize HERP for sustainable utilization of the Eppawala P deposit.

**Keywords:** *Aspergillus* sp.; Fungus; HERP; Phosphate; Solubilization

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# Improving Phosphorus Solubility of ERP by Acidulation and Calcination with $Na_2CO_3$

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## Abstract

Eppawala Rock Phosphate (ERP) is a far-reaching mineral reservoir in Sri Lanka. The primary apatite crystals of ERP were described as having compositions intermediate to a fluoro- chloro apatite. $P_2O_5$ content of the ERP is ranging from 33.0 to 36.0%, hence classified as a high-grade rock phosphate. High Cl content (0.8 to 1%) and combined $A1_20_3$ + $Fe_20_3$ or $R_20_3$ content (8 to 10%) present in ERP. The higher F contents of about 4-5% resulted in poor solubility of P in the ERP. Therefore, ERP can be used for other value-added products by improving the solubility of P. Several methods have been used to defluorinated the rock phosphate in the world. This study aimed to increase the solubility of ERP by defluorination by calcination.

Rock phosphate samples collected from the mining site located at Eppawala, Anuradhapura and cleaned to remove external contaminants. Then crystals were crushed and sieved to obtain fine particles. Prepared apatite powder was mixed with the phosphoric acid($H_3PO_4$) in the ratio of 1:.0.25,1:0.5,1:0.75, and 1:1 respectively. Then the samples were grounded and heated at 1100 $^oC$ for 1 hour in a muffle furnace. Next, ERP was mixed with $H_3PO_4$ in a weight ratio of 1:0.25.

Then the samples were mixed with $Na_2CO_3$ in the ratio of 0.25,0.5,0.75 and 1 respectively. Finally, the samples were heat treated at 1100 $^oC$ for 1 hour and cooled to room temperature. The citric acid solubility of P was measured using a UV spectrometer and F content using an ion-selective electrode. All the analyses were conducted according to the AOAC guidelines. According to the findings acidulation of ERP before fusion with electrolyte increase the P solubility. The addition of $H_3PO_4$ in all rations increased the citric acid solubility of P by 8.5 %. Increasing the ratio of $H_3PO_4$ doesn't improve the P solubility with many variations., the best ratio of ERP and $H_3PO_4$ is 1:0.25 for defluorination. Fusion of acidulated ERP with $Na_2CO_3$ further increased the Citric acid solubility of P. The highest solubility (10.50 %) was obtained in the sample with a 0.75 ratio of $Na_2CO_3$. Defluorination of ERP has improved the solubility of P. The highest defluorination was obtained in the sample fused with a $Na_2CO_3$ weight ratio of 1: 0.75. $Na_2CO_3$ improves the P solubility but is not a significant increase. The sample calcined with the addition of ERP: $H_3PO_4$: $Na_2CO_3$ in the ratio of 1:0.25:1 has resulted in maximum defluorination (1.24 %) and the highest P solubility 10.51 %. When compare the P solubility of African low-grade rock phosphate is higher than the calcined ERP. The solubility of P from calcined low-grade African rock phosphate ($P_2O_5$-11-25 %) with Na and K carbonate is about 80-100%. This mainly may be due to the highest Al and Fe content in the ERP than the other low-grade rock phosphate. From the results of this study, it can conclude that the calcination of ERP with acidulation and fusion with $Na_2CO_3$ can improve the defluorination of ERP and citric acid solubility of P by 10.5 %. This kind of calcined RP can be utilized as fertilizer for paddy and maize cultivation with further improvements. Chemical purification should be done to remove the major contaminants like Fe and Al to optimize the ERP for other purposes than the fertilizer.

**Keywords:** Animal Feed; Bioavailability**;** Calcination; Rock Phosphate; Supplement

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# Effect of Temperature on Extraction of Acid-Soluble Collagen from the Skin of Yellowfin Tuna

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## Abstract

The yellowfin tuna *Thunnus albacares*, a warm-water fish species is one of the most processed fish species in the world. Even in Sri Lanka annual yellowfin tuna production accounts for 44,710 Mt targeting the export market. The skin of yellowfin tuna, which is a potential source for the extraction of Acid Soluble Collagen (ASC), is one of the main by-products generated during commercial fish processing. Collagen is the main protein present in animal connective tissues and type - I collagen is the most abundant in the skin. Type-I collagen has a high aggregated value for a wide range of industrial applications. However, the poor thermal stability of fish collagen restricts its applications. The sensitivity of collagen to temperature is associated with the content of imino acids (hydroxyproline and proline) present in the collagen molecule. The cold-water fish species have much lower imino acid content than the warm-water fish species. The collagen processing methods from cold-water species are therefore conducted mainly at 4 ºC to avoid denaturation. In most of the published literature, low-temperature processing conditions are commonly applied to warm-water fishes though it is not cost-effective at the industrial scale. Therefore, optimum collagen processing conditions for warm-water fish species should be studied separately. Collagen processing mainly consists of three steps; (i) pre-treatment to remove impurities such as non-collagenous proteins and fat; (ii) collagen extraction; (iii) fibril formation. In this study, four temperature conditions (4, 12, 20, 28 ºC) were experimented with the above three processing steps to study the effect of temperature on each step and to establish the optimum temperature condition.

Skin off-cuts of yellowfin tuna were obtained from a seafood processing plant located in Western Province, Sri Lanka. A modified method by Ampitiya et al., (2021) was used to extract collagen. The stability of collagen triple-helical structure under different temperatures was investigated by analysing the Fourier Transform Infra-Red (FTIR) spectra and X-Ray Diffraction (XRD) spectra. Further, yield, Ultra Violet (UV) spectra and Scanning Electron Microscopy (SEM) images were compared for collagen extracted under different temperature treatments. The collagen processed at 28 ºC pre-treatment temperature and 28 ºC extraction temperature have recorded a negligible amount of yield and it may be due to the denaturation of collagen by high temperature. These two samples were therefore excluded from the analysis. For other samples (Pre-treatment at 4, 12, 20 ºC, collagen extraction at 4, 12, 20 ºC and fibril formation at 4, 12, 20, 28 ºC), the absence of a peak at 280 nm in UV spectra confirmed the efficient removal of non-collagenous proteins by pre-treatment. The SEM images confirmed the pore structure of all collagens. The absorption ratio calculated from the FTIR spectra confirmed that all extracted collagens have preserved the characteristic native triple-helical structure without denaturation, except the sample in which fibril formation occurred at 28 ºC. For this sample, the absorption ratio was 0.51 indicating the denaturation of collagen. The same result was evident from the XRD spectra by the presence of characteristic two peaks. In the sample in which fibril formation occurred at 28 ºC only the first peak was present indicating the denaturation. Therefore, 28 ºC was excluded, and the best processing temperature was selected from the other three temperatures based on the collagen yield. The highest yield of 61.5 ± 0.45% was obtained for the collagen processed at 4 ºC for pre-treatment, extraction and fibril formation. Results showed the suitability of the 4-20 ºC temperature range for collagen processing from the skin of yellowfin tuna. However, the 20 ºC processing temperature was selected based on the cost-effectiveness and, convenient and feasible set-up at an industrial scale.

**Keywords:** Denaturation; Temperature Optimization; Warm-water Fish; Yellowfin Tuna Skin

**Acknowledgements***: This work was funded by the development-oriented research grant (AHEAD/DOR-80/AQF/WUSL) through AHEAD grant scheme.*

# Spatiotemporal Distribution of Benthic and Pleustonic Jellyfishes in Coastal Waters of Sri Lanka, with Respective to Physicochemical Parameters

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## Abstract

There are about thirty jellyfish species that can be considered the most abundant in the coastal waters of Sri Lanka. Their spatiotemporal distribution is unknown to evaluate their economical importance. Therefore, the abundance and distribution of the most common four cnidarian jellyfish species, one upside-down jellyfish (*Cassiopea andromeda*), and three pleustonic species namely Portuguese man of war (*Physalia physalis*); blue button (*Porpita porpita*), and by-the-wind sailor (*Velella velella*) were estimated and mapped for four monsoonal periods from March 2017 to April 2018, off the waters around Sri Lanka. *Cassiopea andromeda* is a zooxanthellate scyphozoan, which inhabits clear shallow waters, and hydroid colonies of the other three species generally drift on the water surface. Individuals were counted and the abundance was calculated per unit area (number of individuals per 1 000 $m^2$). In collected samples, numbers and dimensional characteristics were recorded. On each sampling day, physicochemical parameters (temperature, dissolved oxygen, pH, salinity, total dissolved solids, electrical conductivity, resistivity, and turbidity) were recorded with a digital multi-parameter and a hand-held turbidity meter for each sampling site. Estimated abundance and respective distribution were mapped using ArcGIS software, and the Generalised Additive Model (GAM) was used in determining the effect of physicochemical parameters on the abundance and distribution of jellies using R software.The influence of physiochemical parameters on the abundance of four species varies among each other. Residual analysis of *C. andromeda* data shows that salinity and electrical conductivity (EC) influence the abundance of the jellyfish positively, while temperature, dissolved oxygen (DO), and total dissolved solids (TDS) have a negative relationship. Correlation analysis shows all environmental parameters have a significant correlation with

abundance ($p < 0.029$), except for DO and resistivity. *Physalia physalis* shows that salinity, resistivity and turbidity have a positive influence over its abundance individually but TDS and EC have a negative relationship. The pH ($p = 0.000$) and turbidity ($p = 0.003$) have a significant correlation with abundance. Interestingly, only TDS has a positive influence over *P. porpita* abundance but temperature, pH, salinity, resistivity and turbidity have a negative relationship. However, correlation analysis reviled abundance of *P. porpita* was not significant for environmental parameters tested, except for DO ($p = 0.002$). Residual analysis of *V. velella* data shows that DO, pH, salinity and resistivity have a positive influence over abundance individually but TDS, EC and turbidity have a negative relationship. The environmental parameters, except pH and turbidity, have a significant correlation with abundance ($p < 0.004$).

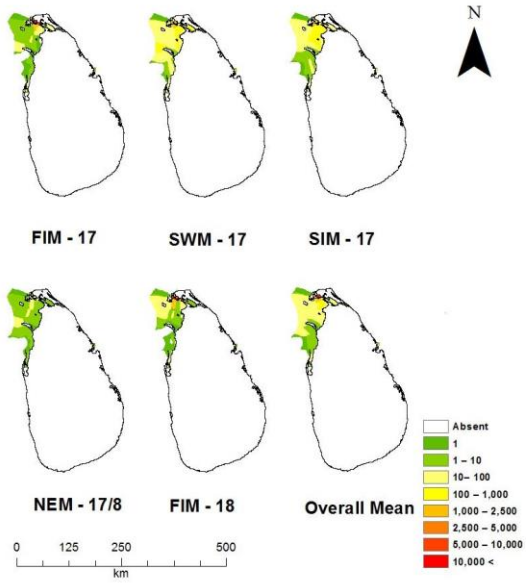


**Figure 1:** Seasonal Variation of the Benthic Jellyfish *Cassiopea andromeda* (number of individuals per 1 000 $m^2$). FIM: First Inter-Monsoon; SWM: Southwest Monsoon; SIM: Second Inter-Monsoon; NEM: Northeast Monsoon.

Three pleustonic jellyfish species studied are dispersed mainly because of the directions of monsoon winds, i.e. *P. physalis*, *P. porpita* and *V. velella* occur along the southwest coast and northeast coast during the respective monsoon periods. Meanwhile, *C. andromeda* seems to disperse around the northern region of the country (Figure 1) respective to the movements of ocean currents, which occur towards different directions in different monsoonal periods. According to the findings of the present study, as well as based on the literature, the occurrence of benthic and pleustonic jellyfish is highly influenced by the temperature and salinity of the water.

**Keywords:** Abundance; Hydrozoa; Monsoons; Seasonality; Scyphozoa

# A Comparative Integrated Approach of Mangrove Vegetation Mapping Using Remote Sensing Data

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## Abstract

The mangroves are productive, complex, and dynamic coastal ecosystems impacted by tidal variation, sedimentation, freshwater influx and rapid alternation of temperature and salinity. The detailed studies of spatial and temporal variation of mangrove distribution up to species level is extremely difficult. Therefore, remote sensing applications enriched with machine learning algorithms is a novel approach used to map spatial-temporal variation of mangrove distribution. To pilot test the application, spatial variation of different mangrove species in Kala oya Estuary, Sri Lanka were studied both remotely and insitu. The Google Earth Engine (GEE) was used for extracting selected scenes of Landsat Surface Reflectance Tier1. Extracted images were further enhanced using cloud mask and Spectral indices (Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI). Finally, median reducer was used to narrow down the final products to the study area and SRTM data were used to narrow down to low elevations, which occurs in mangroves in the coastal area. The final composite output is created based on NDVI bands and classified into 10 colour classes based on the NDVI values. The classified output (Figure 01) was used as the baseline grid map for the ground truthing process. Species composition, canopy structure, and canopy cover were recorded by laying 10m,1m transacts in each colour grid. A total of 276 transects were laid. Linear Discriminant Analysis (LDA) was performed to find out the discrimination between the assigned colour class and variability created by species composition, presence of the

canopy (upper, middle and ground), level of openness and canopy structure.

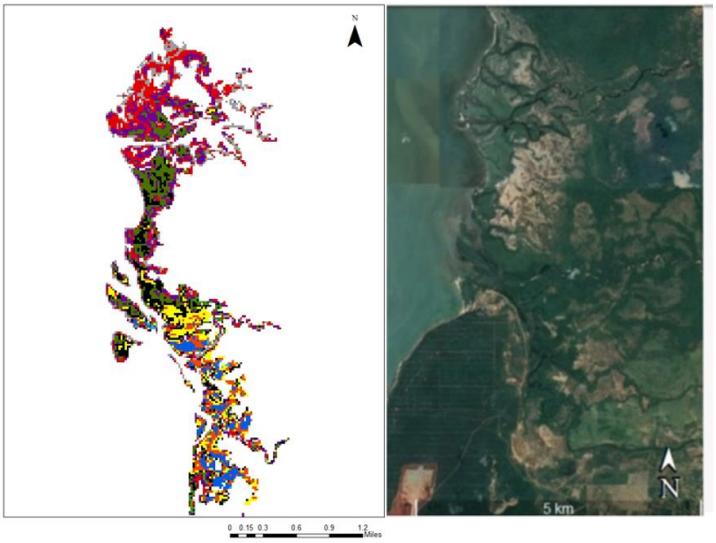


**Figure 1**: Classified Map; White, Grey, Pink, Red, Purple, Green Black, Yellow, Brown, Orange, Blue and Base map (WWW.GoogleEarth.com)

According to the result, 33.0% of the observations were placed into the correct colour class by the ground variables. White and blue colour classes were 100% categorized to the same. Grey, pink, red, green, black, brown, orange were categorized to their own classes 61.54%, 42.86% 29.82%, 26.67%, 38.64%, 50.00%, 54.55% respectively. In purple 16.67% of observations were placed in to purple 16.67% into pink, and 16.67% into black. In the prepared map, purple colour class usually was associated with purple, black, pink. The analysis also disclosed that pink, red, black were usually distributed as neighboring pixels. Black colour grids were represented by dense *Avicennia marina* mono stands with a closed canopy, usually in the waterlogged middle areas of the mangroves. Further the highest proportion (25%) of yellow colour was placed under black which highlighted the likely associated distribution of yellow colour at the inner margin of black regions where dense *Avicennia marina* mono stands thin out and mix with other species. The results provide a pathway that can be further enhanced to use the colour classes to determine mangrove cover and possibly the species composition remotely.

**Keywords:** Mangrove Mapping; Kala Oya Estuary; Canopy Structure; Species Composition

# *Session D-2:*
# *Food and Nutrition*

# Tools to Examine the State of Junior Secondary School Food Literacy Education in Sri Lanka

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## Abstract

Food literacy is a broad concept that covers individual, social and environmental aspects related to food. The increasing food-related health problems and the diminishing of food skills over generations warrant the importance of formal food literacy education as an urgent intervention for the promotion of health and well-being of the people. School curriculum and the teachers' confident in teaching food literacy concepts are main determinants in food literacy education. Assessment of food literacy level of the students is utmost important in the examination of the current status of food literacy education. Food literacy concepts are integrated in several subjects (science, home economics, health, physical education, agriculture, and food technology, and practical and technical skills) in junior secondary schools in Sri Lanka. However, a systematic, in-depth study has not been conducted in Sri Lanka to examine the current status of food literacy education in terms of curriculum, teaching and learning and the level of food literacy of the school children. The aims of the study was to identify the components of food literacy in junior secondary school (grade 6 to 11) curriculum, assess teachers' confident in teaching food literacy concepts and assess the food literacy level of the adolescent school children in Sri Lanka. First, the components and sub-components of food literacy expected to be included in the curriculum were identified through a qualitative study involving 17 experts in food, nutrition and education sectors. The learning outcomes extracted from teachers' guides of the lessons in related subjects were mapped against these subcomponents. Then, two self-assessment tools were developed to assess the food literacy level of the adolescent school children and to assess the teachers' confidence in teaching food literacy.

Students' tool was designed to assess knowledge, skills and behaviors related to food literacy and field tested. In the tool development phase, 105 questions were initially generated covering food literacy competencies identified based on literature and food and nutrition experts' opinion. Then it was tested for validity and reliability. Content validity was tested using 11 in-service teacher advisors and the face validity was tested by conducting focus group interviews with two groups of students. Then, construct validity was tested with a maximum variation sampling of the 282 students selected from schools in Bandarawela Education Zone. The reliability of the tool was tested using a sub-sample (n=85) of students. Another tool was developed to evaluate the teachers' overall confidence in teaching food literacy, confidence in specific subject areas, confidence in using modern technology in teaching, the support they have, school food environment, teachers' opinion on teaching food literacy, teaching methods, the strengths and barriers they encounter and the resources used in food literacy teaching. The cognitive interview method was used in the validation of this tool. The experts identified 33 sub-components important in school food literacy education within 3 major food literacy components; (1) food system from farm to plate (n=12 subcomponents), (2) food, nutrition, and health (n=10), and, (3) broad context of the food system including social, economic, cultural, environmental and political aspects of food (n=11). The curriculum analysis revealed that most of these sub-components were already included in the school curricula from grades 6 to 11. The content validity index (CVI) of the students' tool was 0.78. This validated tool with 34 questions was finalized to assess the food literacy level of students between 13 to 15 years old. Using the teachers' tool, teachers' confidence in teaching food literacy can be assessed and it would help to identify the areas to be addressed to improve in teaching food literacy in secondary schools.

**Keywords**: Curriculum; Evaluation Tool; Food Literacy Education; Secondary Schools; Validation

**Acknowledgements:** Wayamba University Research Grant (SRHDC/P/04/19-11) and NRC, Sri Lanka (NRC-19-006) are acknowledged.

# Blending of Ginger (*Zingiber officinale*) and Coriander (*Coriandrum sativum*) Oleoresins to Uniformly Disperse in a Beverage Product

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## Abstract

Oleoresins are naturally occurring viscous combinations of oil and resin extracted from plant-based raw materials. Oleoresins impart identical properties to dried plant materials, without altering sensory attributes like aroma, flavour, texture and aftertaste. Statistical reports of the beverage industry highlight the massive consumption of ginger and coriander oleoresins in diverse applications. However, the records on blending the two oleoresins are rare due to the challenges posed by instant layer separations of available hydrophilic and hydrophobic compounds. Emulsification is the most productive unit operation to improve the homogeneity of the blend and can be achieved chemically and physically by incorporating emulsifying agents during homogenization.

The study focused on blending oleoresins of ginger and coriander using soy lecithin as an emulsifying agent comprising polar and non-polar groups that exhibit uniform binding affinities. The emulsion stability was calculated based on the creaming index. When the emulsion is stable, the molecules are dispersed homogenously, and the tendency to particle aggregation or serum separation is minimum; thus, the creaming index is low. The oleoresins of ginger and coriander were blended in 1:1 proportion with 1-3% oleoresin concentrations in water to prepare the beverage. Food-grade soy lecithin diluted (0.75-1%) in water was added in different concentrations (0.5-1%) as the emulsifier. The pH of the beverages was stabilized by incorporating 0.1% citric acid and 0.2% malic acid as a premix. The emulsion stability was determined by creaming index and the three most stable emulsions were screened by homogenization speed at 5000 rpm for 1 minute. All beverages having 1-2% oleoresin showed low creaming indices below 17%. When the oleoresin concentration is 3%, the phase separation is high and soy lecithin content is insufficient for emulsification. However, the soy

lecithin concentration cannot be exceeded 1% based on food regulations. The stability of the emulsion was further determined by changing the homogenization speed from 10000 - 30000 rpm for the best three emulsions. The most stable creaming index of 12.54 ± 0.53% was achieved by homogenization at 20000 rpm. When applying 10000 rpm, distinct layer separation was observed and particle aggregation occurred at 30000 rpm. The oil and resin droplets are disintegrated by homogenization and the surface area of the particles increases proportional to the homogenization speed. So, the particles acquire a wide surface to interact with soy lecithin and enhance the homogeneity. When homogenizing at 30000 rpm, tiny particles are produced and the number of particles in the dispersed phase is increased. The interactions with similar compounds lead to particle aggregation and increase the density to form thick precipitation at the bottom. The most three stable beverages were stored at different temperatures (4 ℃, 25 ℃ and 35 ℃) for 15 weeks and pH was measured to determine the stability of the beverage. The sensory attributes of flavour, colour, aroma, after taste and overall acceptability, were evaluated by an untrained sensory panel of 30 participants based on the nine-point hedonic scale. Aroma is the mostly rated sensory attribute and the presence of strong volatile compounds such as linalool and zingiberene may impact impressively. A distinct offensive aftertaste was observed in soy lecithin concentrations of 1% and therefore, 0.75% was selected as the maximum soy lecithin concentration that does not affect sensory attributes. The storage at refrigerated conditions (4 ℃) displayed the lowest pH fluctuation while a significant pH increment was observed at 35 ℃ storage after 12 weeks leading to a visible colour change and quality degradation. The study conclude that the most effective blending conditions are 0.75% soy lecithin, 2% oleoresin, and 20000 rpm homogenization and storage at refrigerated conditions (4 ℃).

**Keywords:** Coriander; Emulsifying; Ginger; Oleoresin; Sensory Attributes

# Physical Properties of the Pomegranate (*Punica granatum* L.) Fruit cv. Kalpitiya Hybrid during Growth and Development

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## Abstract

Pomegranate (*Punica granatum* L.), which belongs to family Punicaceae has gained high popularity in recent years due to its notable nutraceutical properties. Kalpitiya Hybrid - released in the year 2017 by the Department of Agriculture, Sri Lanka having orange-pink peel colour with soft seeds enclosed by sweet red arils is a better competitor for imported pomegranates. However, no studies have been performed to develop maturity and quality indices that could be utilized in fresh fruit trade and processing industries. Hence, as an initial step, a study was conducted to examine physical properties of the pomegranate fruit cv. Kalpitiya Hybrid during its growth and development. The research was executed at Agriculture Research Station, Kalpitiya (DL3). Thirty-four plants at three-year old were selected by observing uniformity in general plant vigour and health. During peak blooming period (May-June, 2022), fruitlets at 15-16 mm diameter were tagged with different coloured polythene strips and consecutive time was counted as weeks after fruit set (WAFS). Two randomly selected fruit per tree (total - 20 fruit per interval) were harvested at 14-day intervals and analysis of physical properties namely fruit weight, length, diameter, shape index, fruit circumference, surface area, volume, surface area to volume ratio, specific gravity and fruit firmness were carried out. This paper reports data collected up to 20 WAFS. Variation in physical properties of pomegranate fruit over a period of 20 WAFS is shown in the Figure 1. Fruit weight (Figure 1a), length, diameter (Figure 1b), volume and surface area (Figure 1c) exhibited a slow rate of growth from 0 to 6 WAFS and thereafter showed a dramatic increase in growth rate up to 20 WAFS. Increase in fruit size could be attributed to development of arils, increase in aril size and juice content as well as development of peel structures during fruit development. Shape index (SI), which is the ratio between length and diameter (L/D) of the fruit decreased with time (Figure 1b). At the beginning, the fruit was

more elongated in shape having higher length (5.10±0.13cm) and lower diameter (3.02±0.04cm) indicating the SI of 1.69±0.05. With the progression of growth, the fruit conformed more closely to a sphere shape (length/diameter ~1). Fruit surface area: volume (SA: V) ratio (Fig.1c) demonstrated a declining trend during growth as the fruit grows bigger, the volume increases leading to reduced SA:V ratio. Specific gravity of the fruit increased gradually, came to a plateau at 12 WAFS and then showed a declining trend.

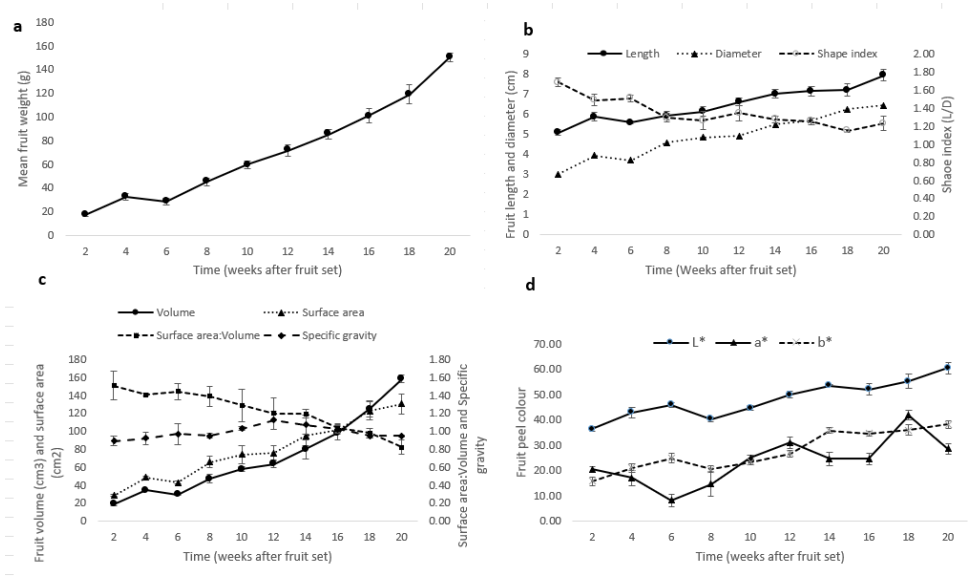


**Figure 1:** Variation in Fruit Weight (a); Length, Diameter, Shape Index (b); Volume, Surface Area, Surface Area to Volume Ratio, Specific Gravity (c); and Fruit Peel Colour (d) during Growth and Development.

***Note:*** *Vertical bars represent standard deviation of the means of five replicates (n=20).*

Pomegranate fruit peel colour measured as L* (lightness: varied from 0 – black to 100 – white), a* {varied from green (-) to red (+)} and b* {(varied from blue (-) to yellow (+)}is shown in the Fig.1d. At 2 WAFS, the fruitlets were brick red in colour having L*, a* and b* values of 36.46 ±1.08, 20.60±1.17 and 15.80±1.58, respectively. At the end of 20 WAFS, the L* and b* increased while a* value dropped giving the fruit its distinct orange pink peel colour.

**Keywords:** Diameter; Length; Peel Colour; Weight; Volume

**Acknowledgement:** *Financial assistance provided by university research grant (SRHDC/RP/04/20-21-05) is gratefully acknowledged.*

# Impact of Dietary Fat Intake on Vascular Function, Blood Pressure and Other Cardiometabolic Risk Markers in Healthy Adults

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## Abstract

Cardiovascular disease (CVD) is the biggest health burden in the globe including Sri Lanka. Diet, in particular dietary fatty acid (FA) composition, has been identified as one of the cornerstones in the aetiology and the progression of the disease. Sri Lankans have a very unique traditional eating pattern consisting with higher proportion of easily digestible carbohydrate and saturated fatty acid (SFA) basically derived from coconut fat. As vascular function is an early surrogate marker of CVD, this study aimed to find out the impact of dietary fat intake on vascular function, blood pressure and other associated CVD risk markers among Sri Lankan adults. In a cross-sectional study 401 healthy adults aged between 30-60 yrs (Mean±SD, 42.5±8.3) were recruited. An interviewer administered health and lifestyle questionnaire was used to obtain the information on socio demographic, health and dietary fat consumption pattern. A 3-day diet diary including two weekdays and one weekend day was used to assess the usual nutrient intake. Height, body weight, waist and hip circumferences were taken as per the standard procedures. Body composition parameters were assessed using a multi-frequency segmental body composition analyser. Vascular function i.e. arterial stiffness was measured in terms of pulse wave velocity (PWVc-f) using an oscillometric Mobil-O-Graph® PWA Monitor device. A 3.5 mL of fasting blood sample was taken for the biochemical analysis of serum lipid profile, blood glucose, and C-reactive protein. Findings from the present study revealed that based on the multiple linear regression model, vascular function was independently predicted by age (ß=0.808, $r^2$=0.724), visceral fat level (ß=0.147, $r^2$=0.745), and percentage of total fat intake (ß= -0.078, $r^2$=0.751). Systolic blood pressure was independently predicted by visceral fat level (ß= 0.266, $r^2$=0.116), fasting total cholesterol level (TC) (ß=0.169, $r^2$=0.151), age (ß= -0.124, $r^2$=0.168), fasting blood glucose

level (BG) (ß= 0.114, $r^2$=0.176) while visceral fat levels was independently determined by male gender (ß= 0.412, $r^2$=0.275), fasting BG (ß= 0.191, $r^2$=0.311), fasting Triacylglycerol (TAG) (ß= 0.133, $r^2$=0.327), age (ß= 0.137, $r^2$=0.342), and fasting High density lipoprotein levels (HDL) (ß=- 112, $r^2$=0.352). Further, body weight (P≤0.001), BMI (P=0.028), waist circumference (P=0.009), total body fat% (P≤0.001) and visceral fat level (P=0.002) showed significant gradual rise with increase intake of total fat percentage across four quartiles Q1 to Q4 in ANCOVA analysis adjusted for age and gender. The associations postulated through above findings are summarized in the Figure 1.

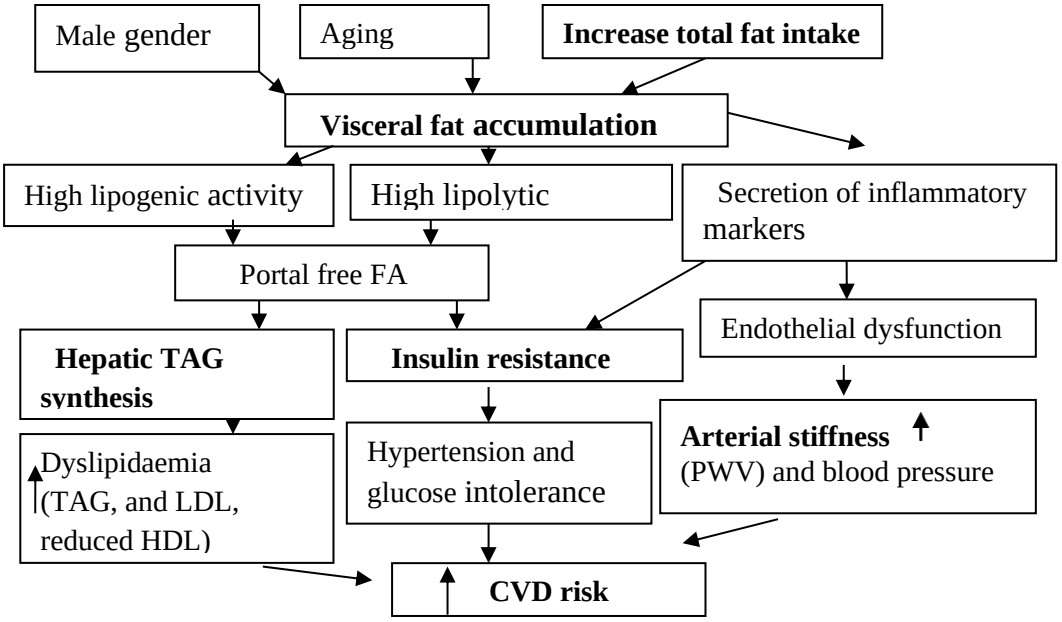


**Figure 1:** Potential Mechanism for the Association between Percentage of Total Fat Intake and Increase Risk of CVD among Study Population

In conclusion, increase intake of dietary fat elevates the CVD risk among Sri Lankan adults through several mechanisms particularly vascular dysfunction, hypertension and insulin resistance mediating via visceral adiposity.

**Keywords:** CVD; Dietary Fat; SFA; Vascular Function; Visceral Fat Level

**Acknowledgements:** *This study was supported by the Wayamba University Research Grant (SRHDC/RP/04/19/05).*

# Development of Frozen Probiotic Fruit Sherbet Incorporating *Phyllanthus emblica, Elaeocarpus serratus* and *Pouteria campechiana*

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## Abstract

The present study was aimed at developing a probiotic fruit sherbet with a unique flavor of fruit blends whilst exerting numerous health benefits to consumers. The product was developed using freshly obtained fruit mesocarp of three underutilized fruits available in Sri Lanka: *Pouteria campechiana* (Canistel), *Elaeocarpus serratus* (Ceylon olive) and *Phyllanthus emblica* (Indian gooseberry), mixed with skimmed dairy, fermented using probiotic cultures: *Bifidobacterium* and *Lactobacillus.* Two frozen sherbet formulae series were developed as "without added probiotics-series 1" and "with added probiotics-series 2 (P)", each series having three different fruit flesh ratio combination ($T_1$, $T_2$, $T_3$) and sweetened with three types of sweeteners ($S_1$, $S_2$, $S_3$). Formulae series-2 was tested organoleptically by a trained sensory panel to identify the best fruit-ratio incorporation and the acceptance of low-calorie sweeteners. Selected products from formulae series-2 were subjected to further analysis with comparison to frozen fruit sherbet ($T_2S_1$) having the equivalent fruit incorporation ratio and sweetened with sugar, from the formulae series-1: without added probiotics, to compare the effectiveness of added probiotics at frozen storage. The proximate composition, crude fibre content, total solids and the overrun of frozen fruit sherbet were determined. The changes in pH, titratable acidity and the probiotic viability of the product were evaluated throughout the frozen storage (-18°C) for 30 days. The *in-vitro* anti-diabetic activity were assessed in terms of α-amylase and α-glucosidase inhibition activities.

The fruit flesh-ratio incorporation ($T_2$) of 5% from *E. serratus* and *P.*

*emblica* and 10 % from *P. campechiana* on frozen fruit sherbet with added probiotics, which was sweetened with either stevia ($S_2$) or diabetasol ($S_3$) was rated with the highest sensory scores.

**Table 1**: Proximate Composition and Total Solids of Frozen Fruit Sherbet without Added Probiotics and Frozen Fruit Sherbet with Added Probiotics

| **Parameter** | **Fruit sherbet without added probiotics ($T_2S_1$)** | **Fruit sherbet with added probiotics** | |
|---|---|---|---|
| | | **$T_2PS_2$** | **$T_2PS_3$** |
| Moisture (%) | 75.90 ± 2.21[a] | 73.25 ± 5.63[a] | 76.88 ± 1.94[a] |
| Ash (%) | 2.15 ± 0.09[a] | 1.98 ± 0.28[a] | 2.35 ± 0.33[a] |
| Crude protein (%) | 3.39 ± 0.18[a] | 3.62 ± 0.71[a] | 3.51 ± 0.13[a] |
| Crude Fat (%) | 0.90 ± 0.12[a] | 1.11 ± 0.31[a] | 1.28 ± 0.51[a] |
| Crude fiber (%) | ND | ND | ND |
| Total solids (%) | 33.02 ± 3.52[a] | 35.26 ± 2.19[a] | 32.16 ± 1.77[a] |

***Note:*** *Average values of three measurements (For n=3 ± SD), All data reported on dry basis, Values followed by the same letter in each row are not significantly different (p<0.05) by Tukeys test.*

Although there were no any significant differences in proximate composition, the crude protein (3.51-3.62 %) and crude fat content (1.11-1.28 %) of both stevia and diabetasol added frozen probiotic fruit sherbet showed slightly higher values than that of fruit sherbet without added probiotics. The probiotic viability on the 15$^{th}$ day of frozen storage at -18 °C was recorded as (1.3-2.0)*$10^6$ CFU/mL. Both $T_2PS_2$ and $T_2PS_3$ exhibited 34.75% and 34.50% of α-Amylase inhibition and 60.75% and 60.20% α-Glucosidase activities, respectively. A fruit sherbet with added probiotics and sweetened with stevia or diabetasol could be a healthy alternative for frozen dessert cravings of obese and overweight community to minimize the diet-associated health risk.

**Keywords:** Aalpha-Amylase; Fruit Sherbet; Probiotic; Stevia

**Acknowledgements:** Financial support provided by the *AHEAD/RA3 /DOR/WUSL/FST grant is acknowledged.*

# Formulation of a Functional Noodle Incorporating Underutilized Millets and Root Flours

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## Abstract

Large varieties of food products prepared using wheat are available in local and foreign market and noodle is one of the major convenience foods prepared through cold extrusion technique. Noodle industry has shown consistent development over the last several years. However, the customer demand for nutritional and healthy foods has been increased with the prevailing of non-communicable diseases (NCDs) which directly connect with the diet. Therefore, the aim of this study was to evaluate the feasibility of utilization of two root flours (*Lasia spinosa* and *Nelumbo nucifera*) and three millet flours (*Panicum millaceum*, *Paspalum scrobiculatum* and *Setaria italica*) were explored in noodle preparation with five different substitution levels (10, 20, 30, 40 and 50%). After incorporating of root and millet flours, the alterations in physicochemical, compositional, cooking properties, anti-diabetic activity, in vitro starch digestibility and sensory properties were observed. All analyses were conducted according to standard analytical methods and statistical analysis was done.

The results revealed that the total dietary fiber, resistant starch and ash contents were significantly ($p<0.05$) higher in the formulated samples compared to control wheat flour noodle. Related to the functional properties water absorption index and water solubility significantly increased while swelling power decreased with the increase in proportion of root and millet flours in the blend. Cooking time and cooked yield which were measured for evaluating cooking quality increased with millet and root flour incorporation levels. The

α amylase and amyloglucosidase inhibition action were ranged as 28.5-88.75% and 25.00 to 89.54% in control to 50% incorporation level and the significantly highest α amylase and amyloglucosidase inhibition actions were observed in 50%, the maximum substitution level. Glucose release was measured as the reducing sugars degraded from starch by digestive enzymes. Overall, starch hydrolysis sharply increased up to 15 min, and then gradually increased at a slow, steady rate for 180 min. The glucose release curves shifted down for all noodles with millet and root flours compared to control noodle. Significantly lower rate of starch digestibility pattern was observed in 50% substituted noodle. In terms of overall sensory acceptability of formulated noodles, 20% and 40% incorporation levels had significantly highest values. However, 40% millet and root flour incorporated noodle had significantly higher dietary fiber, resistant starch and anti-diabetic activity meanwhile with low rate of starch digestion compared to 20% incorporation. Therefore, 40% millet and root composite flour with 60% wheat flour contained noodle was selected as the best functional noodle formulation. Incorporation of millet and root flours to formulate noodle could increase the dietary fiber, resistant starch and mineral content of the product while decreasing starch content. Both cooked yield and cooking loss were increased with increase incorporation level and high cooking loss may be due to high dietary fiber content in millet and root incorporated noodles. Anti- diabetic activity through α amylase and amyloglucosidase inhibition actions was observed and the inhibition effect was increased with level of substitution. Considering sensory acceptability along with nutritional, physicochemical and functional properties, 40% substituted functional noodle with root and millet composite flour was selected as the best formulation for further studies.

**Keywords**: Anti-Diabetic Activity; Functional Food; Millet; Root Crops

**Acknowledgements**: *Authors acknowledge the financial support from the AHEAD World Bank Grant (Grant No: AHEAD/RA3/DOR/WUSL/FST).*

# Comparative Study on the Fatty Acid Composition and Health Lipid Indices of Processed Edible Plant Oils Available in Sri Lankan Market

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## Abstract

Edible plant oils are one of the major contributors of fat in our diet and provides good sources of unsaturated fatty acids, like linoleic and linolenic acid. Fatty acid (FA) composition in lipids is an important factor to determine the health effects of fats and oils. In some of the processing steps of plant oil/ oil-based products, i.e., deodorizing, refining, and partial hydrogenation, fatty acids may convert from their naturally occurring *cis* form into *trans* form with the change in fatty acid structure and composition. These alterations can adversely and differentially affect on human health causing cardiovascular diseases, diabetes, inflammations, and cancers. Thus, the current study was conducted to investigate the fatty acid profiles of processed edible plant oils and compare their health lipid indices. A total of 24 processed edible plant lipids samples, including palm oil, mustard oil, sunflower oil, soybean oil, peanut oil, olive oil, coconut oil (refined), virgin coconut oil, gingelly oil, blended sesame oil, almond oil, corn oil, eight margarine samples, peanut butter, garlic butter spread, coconut butter spread, and vegetable ghee were used in this study. Oil was extracted from samples using a mixture of normal saline, chloroform, and methanol (2:1 V/V), then extracted oil samples were methylated using the $BF_3$-methanol method. Fatty acid methyl esters were analyzed in triplicates using Gas Chromatography fitted with Flame Ionization Detector for the determination of total FA composition and peaks were identified using the Restek 37 component food industry FAME standard. FA data were used to calculate the selected health lipid indices. Results revealed that tested samples contain variable content of fatty acids. Virgin coconut oil showed the highest amount (91.80%) of total saturated fatty acid (SFA) and mustard oil reported the highest amount (85.84%) of total unsaturated fatty acid (USFA). With a few exceptions, in most of the samples, Palmitic acid (7.28% - 36.24%) (C16:0) was

the predominant SFA followed by stearic acid (C18:0), Oleic acid (C18:1) (10.54% - 69.70%) was the major monounsaturated fatty acid (MUFA) and linoleic acid (C18:2) was the main polyunsaturated fatty acid (PUFA). The USFA/SFA (unsaturated fatty acid/saturated fatty acid) ratio, P/S (polyunsaturated/saturated) index and *cis* PUFA/SFA (6.64, 4.58 and 4.58, respectively) were higher in sunflower oil indicating good quality / healthy lipids. From tested margarine samples, one brand had a good lipid composition, with a high amount of total USFA (77.42%) including total polyunsaturated fatty acid (PUFA) (50.37%) and high P/S index (2.23). Results indicated that the fatty acid profiles of different types of margarine are comparable to the ingredients or the type of oil used in the preparation of margarine. Further processing of plant oil into semisolid products such as margarine/ fat spread has resulted in higher percentage of saturated fatty acids. The Atherogenicity index (AI) (0.09 – 17.44) Thrombogenicity index (TI), and nutritive value index (NVI) (0.96 – 5.67) were also varied considerably among tested samples showing their differential effect on the health-related ailments. Some samples such as partially hydrogenated oil containing products and vegetable ghee (vanaspati) showed the presence of *trans* fatty acid (TFA), thus need to limit their intake.

Among the tested samples, sunflower oil and one brand of margarine show a good fatty acid profile and better-quality indices. In conclusion, the fatty acid composition and the health-related lipid indices vary in the commercially available plant-based lipids. Thus, further studies are suggested to investigate the quality of edible plant oils available in the market and to take measures to minimise undesirable changes in fatty acid profiles during processing.

**Keywords:** Edible Plant Oils; Health Lipid Indices; Partial Hydrogenation; Saturated Fatty Acid; Unsaturated Fatty Acid

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# *Session E–1:*
# *Medicine and Medical Education*

# Association between Awareness and Attitudes on Patient Safety and Medication Errors among Medical Students: A Descriptive Cross-Sectional Study done in Wayamba University of Sri Lanka

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## Abstract

Medication error and lack of patient safety have become a global problem. It has contributed to a high number of disabilities and deaths in the world. Pharmaceutical errors are the commonest but preventable types of medication errors caused during prescribing, dispensing, administration and consumption. They often result in adverse drug reactions in patients. It is vital to minimize medication errors in order to improve patient safety and patient satisfaction. Medical students being the future medical professionals need to be aware of patient safety and medication errors. The aim of this study was to determine the awareness and attitude towards patient safety and medication errors among the 3rd and 4th year undergraduate medical students, Wayamba University of Sri Lanka.

A descriptive cross- sectional study was carried out in May 2022 among one hundred five 3rd and 4th year medical undergraduates of Faculty of Medicine, Wayamba University of Sri Lanka. Purposive sampling method was used and data was collected from self-administered questionnaire using a Google form. Demographic data, data on the awareness on patient safety and medication errors, awareness about safety at hospitals, and attitude towards patient safety and medication errors were collected. Data processing was done using Statistical Process for Social Sciences (SPSS) software version 26.0. Frequencies and percentages were calculated for all responses in each section in the questionnaire. For the assessment of awareness on patient safety and medication errors, marks were given in the Likert scale of 1-5 in which total marks were ranged from 7-35. Moreover, to assess awareness on safety at hospitals and attitude on patient safety and medication errors; marks were

awarded in a Likert scale of 1-5 in which total marks were ranged from 4-20. Total scores of each section were calculated for each participant. Those who were above the average marks for a given section considered to be good in awareness or attitudes. Association between awareness and attitude was assessed using the Chi-Square test while considering P value < 0.05 is significant.

Among 105 medical students, 64.8% (68) was female and 35.2% (37) was male. The average age of participants was 24.23 (SD±0.99). 75.2% (79) of participants have heard about patient safety and 79.0% (83) of participants have heard about medication errors prior to the study. Participants have heard about patient safety from different information sources such as internet (73.4%), academic curriculum (57.0%) and books (39.2%). Moreover, they have heard about medication errors from academic curriculum (68.7%), internet (67.5%) and books (41.0%). The majority of participants had a low level of awareness on patient safety and medication errors with a mean score of 19.56 (SD± 4.59). Additionally, majority of participants were known to be aware of safety at the hospital with a mean score of 13.96 (SD± 2.33). Majority of participants had a positive attitude towards patient safety and medication errors (mean score of 15.31 (SD± 2.78)). There was a positive association between awareness and attitudes (P= 0.017) on patient safety and medication errors. Also, there was a positive association between safety awareness at the hospital and attitudes (P<0.001) towards patient safety & medication errors.

According to the study results, medical students had good attitudes on patient safety and medication errors. However, their awareness was not sufficient about patient safety and medication errors. Therefore, educational intervention, curricular modifications, and interactive clerkships for medical students will help to increase the awareness and attitudes toward reporting adverse drug reactions and reducing unnecessary prescription errors in their future practice. Currently only 2 batches of student have started studying Pharmacology and only they were recruited in the study. Hence that can be identified as a limitation of the study. Authors recommend to replicate the study in other medical and health faculties in Sri Lanka to evaluate their awareness and attitude regarding patient safety and medication errors.

**Keywords:** Medical Students; Medication Errors; Patient Safety

# A Descriptive Study of Learning Strategies of High and Low Performers as Assessed at the End Semester Examination in Microbiology

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## Abstract

In Sri Lanka, usually, students who achieve very high marks in the advanced-level examination are selected for medical education. However, their examination performance varies widely once they commence the medical study programme. There are several factors that could affect their wide-ranging performance. In this study, we are evaluating the learning strategies and perceptions regarding learning, among medical students.

The objective was to determine differences between learning strategies and perceptions on learning among high and low-performing medical students. The study was carried out as a qualitative study using focus group discussion among medical students of the Advanced Level 2018 batch, Faculty of Medicine, Wayamba University of Sri Lanka. Students were arranged from high to low scorers as per the results sheet. The first 10 high-scoring students and the last 10 low-scoring students on the list were separately interviewed using a semi-structured open-ended questionnaire and a detailed discussion was held. The questionnaire dealt with the following aspects; learning strategies, study materials used, the utility of LMS and E-learning methods, attendance at lectures, learning at clinical/applied settings, perception of studying with regard to satisfaction and enjoyment, availability of support from other parties, stress relieving methods and happiness scale. Two trained and skilled medically qualified interviewers conducted the sessions. The two groups were interviewed separately. Each discussion was one hour long. Discussions were audio recorded, transcribed, and analyzed. Recurring themes and patterns were identified among both groups and a thematic analysis was done.

The evidence suggested that the following strategies were common to both high and low performers, which includes listening to lecture recordings, referring lecture notes, utilizing LMS to obtain study materials, engaging in clinical work actively and receiving satisfactory support from families, seniors and teachers. Also, in both groups perception on studying with regard to satisfaction and enjoyment varies depending on the subject and teachers.

The additional strategies used by high performers were; regular studying with the aim of completing day-to-day targets on the same day, active participation in lectures (either onsite or online), using reflective learning strategies, developing mind maps with lecture objectives, conducting group discussions using past papers, obtaining peer support and engaging in a variety of stress coping methods such as engaging in sports, cooking, watching movies, listening to music. The average happiness score in low performers was lower than that of higher performers when assessed using a 1-10 scoring system. Also, high performers made suggestions to implement methods for self-evaluation of their performance. The suggested methods were online quizzes, model questions, and case discussions at the end of the clinical appointment instead of portfolio viva.

In conclusion, the learning styles of high and low performers showed considerable differences, which should be promoted as good practices. However, there were similar learning methods common to both groups.

It is recommended that students should explore active and effective learning methods to enhance their examination performance. Teachers need to update and change their teaching methods that would improve student learning as shown by this study.

**Keywords:** Focus Group Discussion; High Performers; Learning Perceptions; Learning Strategies; Low Performers

# Self-Medication Practices among Medical Undergraduates in Wayamba University of Sri Lanka

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## Abstract

Self-medication is an integral part of a patient's health. Patients consider self-medication as the first option in treating any illness, especially in the early stage. Self-medication can't be avoided; thus, educating public to be responsible is vital. Development in patient's awareness and level of education has contributed to the safe practice of self-medication. Internet and media have effects on adolescents and young adults in use of self-medication. Thus, they are vulnerable in self-medication related decisions. Self-medication practices are seen commonly among university students. Medical undergraduates, as future doctors, are having the responsibility of monitoring and educating people for better self-medication practices. The study aims to investigate attitudes on self-medication & self-medication practices among medical undergraduates of Wayamba University of Sri Lanka (WUSL).

A cross sectional study was conducted in medical students of all academic years in WUSL in which pharmacology is taught in the third- and fourth-years. First and second year students were considered as Before Pharmacology Education (BPE) group, third- and fourth-year students as With Pharmacology Education (WPE) group. Data collection was done through an online self-administered questionnaire (Google form) which was developed using previous validated questionnaires. Demographic data, data on self-administered medicine, indications, the place of obtain medicines, the way of determining dose and their attitude regarding self-medication were collected. For questions regarding view about safety and reasons for self-medication, scores were given in a Likert scale of 1-7 and mean values were calculated. SPSS version 25.0 was used in data analysis. Associations among study groups were assessed using the t test ($p<0.05$ considered as significant).

Out of the 419 students invited, total of 295 students (70.41%) participated in the study of which 81(27.5%) were males and 214(72.5%) were females. Among them, 188(63.7%) belonged to the BPE group, 107(36.3%) belonged to the WPE group. Mean age of the participants was 23.12(SD±1.38) years. Self-medication was practiced by 287(97.3%) students. The most frequently self-medicated drug was Paracetamol (92.7%) followed by antihistamines (50.2%) and antacids (36.9%). Commonest indications to use self-medication were headache (84.7%), fever (65.5%) and common cold (64.5%) respectively. Pharmacy (91.3%) was the highest reported place to buy self-medication. Most students (61.3%) determined the dose by previous experience in similar illness. Statistically more BPE group students wanted to play an active role in their health ($t(286) = 3.045$, $p = 0.008$), more WPE group students didn't want to burden their physician ($t(286) = -0.525$, $p = 0.015$) and didn't want to go to physician due to long waiting period ($t(286) = -1.764$, $p = 0.001$). Regarding the view about safety of the self-medication, WPE group statistically significant than BPE group to believe that self-medication can mask the symptoms and signs of diseases ($t(293) = -2.646$, $p = 0.032$).

The prevalence of self-medication was high among medical undergraduates of WUSL. Students with the pharmacology education is more cautious in self-medication. University as a health care facility should develop easy access to medical services to minimize long waiting period. This study helps the medical education authorities in tailoring learning objectives regarding self-medication in the medical undergraduate curriculum. It will minimize risky self-medication patterns in medical students and help students in educating the public as a doctor in the future.

**Keywords:** Medical Undergraduates; Self-Medication; Sri Lanka; Wayamba University

# Effects of Online Learning on the Academic Performances of Medical Undergraduates in Wayamba University of Sri Lanka

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## Abstract

Online learning has been around for more than 50 years. It started with the introduction of the intranet in 1960, when a linked computer system was used to provide students with academic material. Since then, digital literacy has played a critical role in knowledge sharing, utilizing a wide range of devices and platforms. Online learning can be continued during periods when travel restrictions are enforced. Furthermore, online learning has the distinct advantage of providing users with the most up-to-date, evidence-based content. Even though the rest of the world has caught up with e-learning, there are some limitations in the Sri Lankan setting. According to the Asian Development Bank report on Sri Lankan online higher education published in May 2022, 81% of the students had a poor internet connection and 45% stated that there was a lack of interaction with teachers and classmates. In medical education, the use of online learning is a relatively new field that is growing rapidly. Therefore, it is vital that medical schools, postgraduate training institutes, and their staff are aware of the challenges and solutions to the development and implementation of online learning. As medical faculties in Sri Lanka had to suddenly move from in-person teaching to online teaching for the first time due to the COVID-19 pandemic it is an institutional requirement to assess the effectiveness of the newly introduced online teaching method in the Sri Lankan setting. Although there is a lot of encouraging evidence at the global level about online medical education, in the case of Sri Lanka, there is a lack of data.

The main objective of this study was to assess the effects of online learning on the academic performance of medical undergraduates in the second MBBS examination in the Faculty of Medicine, Wayamba University of Sri Lanka (WUSL). The study was designed as a cross-sectional study. Ethical approval was obtained from the Ethical Review Committee of the Faculty of Medicine,

WUSL. The study was conducted by comparing the marks of students in two batches who have so far sat for the second MBBS examination in the Faculty of Medicine, WUSL. For the 2017/2018 batch(n=71) pre-clinical teaching activities were done in person and for the 2018/2019 batch (n=74) teaching activities were done online due to the COVID-19 pandemic. Information on methods used to access online materials was collected using a questionnaire from the batch engaged in online learning. Data analysis was conducted using the Statistical Package for the Social Sciences version 26. The mean marks of the in-person taught batch were 59.97 for Anatomy, 63.23 for Physiology and 57.85 for Biochemistry. The mean marks of the online taught batch were 57.10 for Anatomy, 58.42 for Physiology and 57.19 for Biochemistry.

**Table 1**: Marks Obtained by the In-Person Taught Batch and the Online Taught Batch

| | **Mean** | | **Median** | | **SD** | | **IQ Range** | |
|---|---|---|---|---|---|---|---|---|
| | In-person | Online | In-person | Online | In-person | Online | In-person | Online |
| Anatomy | 59.97 | 57.10 | 60.00 | 59.68 | 8.13 | 12.61 | 13.00 | 17.04 |
| Physiology | 63.23 | 58.42 | 63.08 | 60.06 | 8.40 | 10.42 | 11.69 | 15.17 |
| Biochemistry | 57.85 | 57.19 | 58.47 | 58.63 | 8.06 | 11.31 | 09.76 | 13.62 |

Batch taught online, scored lower mean marks for all three subjects. The mean marks of the two batches were compared by using independent samples t-test. There was a significant difference (p value<0.05) between the Physiology subject marks between the two batches and other subjects did not show a significant difference. Among the questionnaire respondents(n=68) of the online conducted 2018 /2019 batch students, 43 (50.75%) students accessed online material mainly through laptops or desktop computers. Tablet devices were used by 20 (29.85%) students and smartphones by 13 (19.40%) students as the primary device. The questionnaire identified challenges faced by students during online education, such as lack of connectivity, and reduced peer group discussions. The majority of students felt in-person learning was more effective. Significant reduction in Physiology subject marks may be due to the inherent difficulty of the discipline. International literature suggests that complex Physiology principles are challenging to learn online. Further studies are needed to investigate the effects of online learning more comprehensively.

**Keywords:** Academic Performance; In-person Learning; Online Learning

# A Preliminary study on Female Undergraduates' Awareness regarding the Importance of Preconception Folic Acid Supplementation for Prevention of Neural Tube Defects

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## Abstract

Neural tube defects (NTDs) are congenital defects or anomalies of the central nervous system resulted from interruptions in the process known as neurulation, which occurs at the initial stages of pregnancy.Pre-conception folic acid supplementation is vital to achieve the optimal red blood cell folate levels ensuring adequate trans-placental folate transferring for the prevention of NTDs. Therefore, World Health Organization (WHO) also recommends to take 0.4mg daily during the periconception period (two months prior and 12 weeks after the conception).

Despite these recommendations, the prevalence and public health burden of NTDs are still remaining high, necessitating the need to identify the knowledge gaps and factors limiting the optimal supplementation. Community awareness is vital to obtain the compliance for optimum folic acid supplementation. Comparatively high level of awareness about preconception folic acid supplementation has been observed in educated populations globally. However, the awareness on NTDs and the folic acid supplementation has not been widely assessed among educated populations in Sri Lanka. Therefore, this study aimed to determine the awareness NTDs and the importance of preconception folic acid among educated population in Sri Lanka.

The study was a preliminary study to evaluate the scope, acceptability and feasibility of the topic. A descriptive cross-sectional study design was used. The study population was all the non-medical female undergraduates in Sri Lanka. Snow ball sampling method was used to recruit participants due to limitations in accessing the population during the Covid-19 pandemic. Students from

randomly selected faculties were asked to recruit their colleagues to the study. Participants were given a link to an electronic version of consent form along with the internet-based self-administered questionnaire. 120 non-medical female undergraduates, age ranging 21-28 (mean age 22.05 ±1.81) years representing different faculties of different universities (university of Peradeniya, university of Sri Jayewardenepura, university of Kelaniya and University of Ruhuna) volunteered to participate the study after giving the informed consent. The confidentiality of the participants was strictly maintained.

Sample consisted of participants who represent all educational streams of Advanced Level. Majority (n=55, 45.83%) of the participants had followed the art stream. Among the participants, 68 (56.66%) reported that they had heard about the NTDs, but only 27 (22.2%) correctly described the NTDs. The majority (55.8%, n=67) were unsure about the correct gestational period where NTDs occur, and 45.8% (n=55) were unaware of the proper timing to start the folic acid supplementation. Among the participants, 72.9% (n=86) reported that they had heard about peri-conception folic acid intake, but only 30% (n=36) knew the correct dosage frequency and 9.96% (n=2) knew the correct dose. Books (43.33 %, n=52) and health care workers (21.66 %, n=26) were the most common sources of information regarding NTDs and preconception folic acid supplementation. However, participants had concerns about the reliability of those information and the existence of unrevealed potential side effects.

This study concludes that awareness on the importance of preconception folic acid in the prevention of NTDs seems to be relatively low in the participants. The results of this study emphasis the fact that proper preconception counselling focused on NTDs and folic acid and awareness programmes with the inclusion of the young educated female population is essential in the Sri Lankan context. However, as this study was conducted with the participation of small number of participants as a preliminary study with a non-probability sampling method more research should be carried out to substantiate the findings.

**Keywords**: Neural Tube Defects; Preconception Folic Acid; Undergraduates

# Impact of Class/Lecture Attendance and Learning Management System (LMS) Utilization on the End Semester Examination Results of Microbiology, among Second Year Medical Undergraduates of Faculty of Medicine, Wayamba University of Sri Lanka

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A notable number of factors influence the academic performance of medical undergraduates. Lecture attendance and enrollment in e-learning using the Learning Management System (LMS) is of uttermost importance. Number of international studies have shown that there is a positive correlation between examination scores of medical undergraduates with attendance to lectures and the use of e-learning. There is scarcity of studies in Sri Lanka looking into this aspect, therefore, we hoped by this study to identify the impact of this variable on students' performance. The objective was to identify the relationship of the end semester examination Microbiology results, with the attendance to class/lecture or utilization of the learning management system (LMS).

The study population was the medical undergraduate students who faced the year 02 semester 02 (Y2S2) end-semester examination of Faculty of Medicine, Wayamba University of Sri Lanka. The sample was the students of 2018/2019 batch who sat for the end-semester examination infection module I (n=66). The independent variables were the attendance to both online and in-person lectures and LMS utilization frequency (Number of days logged in the respective module during the semester). Dependent variable was Microbiology results in infection module I of end-semester examination, including total marks, and marks of multiple answer questions (MCQ), structured essay questions (SEQ) and objective structured practical examination (OSPE). Data was analyzed manually and using Statistical Package for Social Sciences (SPSS). Descriptive statistics were used for the data analysis. Pearson's correlation coefficient was used to determine the statistical significance and associations between the two continuous variables.

There was a moderate positive correlation between LMS utilization frequency and end-semester examination results with regards to total microbiology marks (r=0.487). The correlation (r) of LMS use with multiple choice question, structured essay question and objective structured practical examination marks were 0.484, 0.371 and 0.510 were respectively.

There is a low positive correlation between lecture attendance and end-semester examination results with regards to total microbiology marks (r = 0.315). The correlation (r) of lecture attendance with multiple choice question, structured essay question and objective structured practical examination marks were 0.278, 0.248 and 0.344 were respectively.

There is a strong correlation between utilization of LMS and student performance in OSPE of end-semester examination of microbiology. However, there is only a weak correlation between utilization of LMS and student performance in MCQ, SEQ and total marks of end-semester examination. Also, there is only a weak correlation between lecture attendance and student performance at MCQ, SEQ, OSPE and total marks of end-semester examination.

**Keywords:** Examination Results; Learning Management System; Lecture Attendance

# Case Report: Successful Management of Cardiac Toxicity of an Acute Yellow Oleander Poisoning Patient at a Tertiary Care Hospital, Sri Lanka

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## Abstract

Oleander poisoning in Sri Lanka is common. Yellow oleander (*Thevetia peruviana*) is a plant containing high concentrations of cardiac glycosides such as theveridoside, thevetoxin, peruvoside. Cardiac glycosides cause significant cardiovascular effects including vagotonic effects like bradycardia and heart blocks. Patients developed with brady arrhythmias are often treated with temporary cardiac spacing which has a good prognosis.

A 32-year-old male presented to the Base hospital, Muthur following a suicidal attempt of ingesting 10 crushed yellow oleander seeds with sugar. He developed nausea, vomiting and abdominal pain after 1 hour and was brought to the Base hospital, Muthur. Gastric lavage was done within 3 hours of the ingestion. Since he developed bradycardia, he was transferred to the Teaching Hospital Batticaloa, Eastern Province, Sri Lanka for further management. At the emergency treatment unit his blood pressure was 122/60 mmHg and pulse rate was 40 beats per minute (bpm). His Glasgow Coma Scale was 15/15 and respiratory rate was 20 cycles per minute. 12 lead ECG revealed first degree heart block with reverse tick sign of digoxin toxicity. Other than that, no other arrhythmias were present. Intravenous Atropine 0.3mg was given for bradycardia. Multiple dose activated charcoal was continued with 4mg Magnesium Sulphate 6 hourly for 24 hours. 0.9% Sodium chloride was started

and continued for 24 hours. Blood for serum potassium, sodium, magnesium, calcium and creatinine were taken and the values were 5.3 mmol/l, 142 mmol/l, 0.36 mmol/l, 1.08 mmol/l, 77 µmol/l respectively. His blood investigations revealed hyperkalemia. He was started with soluble insulin 5U in 50 % dextrose 50 ml over 15 minutes as an infusion to correct hyperkalemia. Serum potassium was repeated every 2 hourly and hyperkalaemia was corrected with insulin infusion. He developed dizziness and chest discomfort after 8 hours of ingestion of yellow oleander. His ECG was suggestive of 3$^{rd}$ degree heart block with mild ST sagging suggestive of toxicity (Figure 01). Patient was transferred to the coronary care unit and temporary cardiac pacing was done. His pulse rate was maintained around 80pbm.

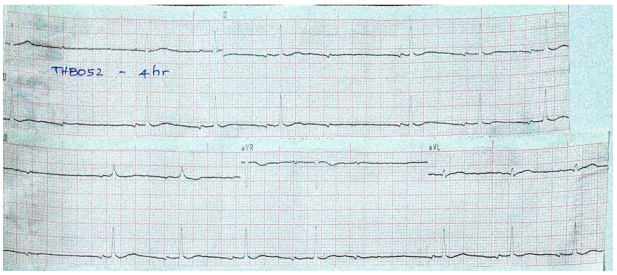


**Figure 1**: ECG of the Patient After 4 hours of Admission
(8 hours of Oleander Ingestion)

He developed hypotension 82/40 mmHg and started on dopamine boluses along with 0.9% Sodium chloride boluses until blood pressure is corrected. As the patient maintained intrinsic rhythm and he was hemodynamically stable, temporary cardiac pacing was removed after 24 hours of insertion. Patient was sent to the medical ward and a psychiatric referral was done. Patients with acute oleander poisoning should be closely monitored as they can develop problems such as bradycardia, hypotension, Atrio Ventricular heart blocks and hyperkalaemia. Digoxin-specific antibody fragments have been tested and is an effective antidote in the management of life-threatening cardiac arrhythmias and hyperkalaemia. However, it is not currently used in the Sri Lankan healthcare system due to its high cost and unavailability of proper guidelines to use it. Authors emphasized the importance of developing guidelines to use Digoxin-specific antibody fragments in patient management for the oleander poisoning in Sri Lanka. Authors thank the support from the Research council, University of Sri Jayewardenepura, Sri Lanka.

**Keywords:** Heart Blocks; Hyperkalemia; Poisoning; Yellow Oleander

# Variability of the Incidence of Necrotizing Fasciitis with the Local Rain Pattern in Mahiyangana; Is it a Seasonal Killer?

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## Abstract

Lower limb Necrotizing fasciitis (NF) contributes significantly for sepsis related mortality and morbidity including limb loss. Further it increases hospital expenditure owing to prolong period of stay, medication and frequent wound debridement. Moreover, being a rural and agriculture based society, loss of work force is a major concern in Mahiyangana area as the significant proportion of patients are being farmers and laborers. Despite here are well recognized host related risk factors such as comorbidities, immunosuppression and trauma, we have observed that there was a surge in admission due to lower limb NF after the rainy weather.

The aim of this descriptive study was to determine whether there is an association between the incidence of lower limb NF and the local rainfall pattern at Mahiyangana area. A retrospective analysis was performed from January 2018 to March 2020. All patients admitted with lower limb NF to surgical unit, Base Hospital (BH) Mahiyangana were included. Necrotic patch of more than 1 cm with or without cellulitis and sepsis were included. The NF cases complicated following major trauma and surgery were excluded. Monthly numbers of admissions were compared with the monthly average rainfall over the respective period.

231 patients were included in the study. Age ranged from 36-74 years with a mean of 55 years. Information about average monthly rainfall pattern in the area was gathered from en.climate-data.org. Pearson's Correlation Coefficient was calculated as 0.76 which suggested a moderate to high correlation between number of admissions with NF and average rainfall.

An association is observed between the average rain fall and the surge in number of admissions with lower limb NF. Future studies aim to determine the causative factors for the demonstrated association will be of great value. By using this data, the hospital can plan and allocate limited resources accordingly. Moreover, the public need to be made aware about the proper foot hygiene during the rainy season.

**Keywords:** Necrotizing Fasciitis; Weather Pattern, Rainy Season, Resource Allocation, Mahiyangana

# Dispensing Practices of Oral Medications to Children in Kuliyapitiya Teaching Hospital

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## Abstract

The goal of this research is to describe the pattern of paediatric drug dispensing in Teaching Hospital Kuliyapitiya. Owing to the heterogeneity of its population, paediatric drug dispensing needs special concerns compared to the adult drug dispensing. Previous researches on the paediatric drug dispensing practices in Sri Lankan hospitals have made it clearly evident that the resource-constrained pharmacy setup in Sri Lankan government hospitals as the primary cause for the paediatric drug dispensing errors. Thus, this study was designed to assess the pattern of paediatric drug dispensing and the labelling techniques used at the hospital pharmacy of the Teaching Hospital Kuliyapitiya. The ethical approval for the study was taken from the Ethics Review Committee, Faculty of Medicine, Wayamba University of Sri Lanka under the reference number PW/2021/09/13. A cross sectional descriptive study was conducted to assess drug dispensing practices of 383 paediatric patients who got drugs dispensed at the Hospital Pharmacy of Teaching Hospital Kuliyapitiya over a period of 2 months from first January 2022 to first March 2022. A purposive sampling method was used where all paediatric clinic patients who got oral drugs dispensed from the hospital pharmacy 2022 were selected as participants. Required data were extracted through a prospective data collection by observing the prescription and the dispensed drugs. The dispensing practices in the study setting were assessed on several indicators which were validated by Nadeshkumar et al. The indicators which decide the dispensing practices as appropriate and inappropriate are; the frequency of dispensing alternative oral dosage forms, frequency of manipulation of oral dosage forms before or after dispensing and the frequency

of adequate labelling of oral dosage forms. Data analysis was done using R Studio software. Descriptive statistics were used when analyzing the indicators.

A total of 333 paediatric patients were recruited in the study. Out of them 1 (0.3%) was a neonate, 11 (3.3%) were infants, 21 (6.3%) were toddlers, 140 (42%) were preschool children and 160 (48%) were school children. 754 oral drug forms were dispensed for 333 patients with an average of 2.26 oral drug forms per patient. Out of the 754 oral drug forms dispensed, 494 (65.5%) were solids and 262 (34.5%) were liquids. Out of the 754 drug forms dispensed none were irrationally manipulated by the pharmacist before dispensing. However, 290 (38.46%) oral medication forms required preparation before administration, such as splitting, crushing, or opening capsules. Out of the evaluated oral dose forms, none were correctly labeled. The most important details such as name of the drug and name of the patients were available in only 694 (92%) and 640 (84.9%) ODFs respectively. According to the labelling criteria, the total score, if labeling is accurately done according to the guidelines is 80. However the mean score for the 754 medicines that were assessed was 46.4. In 640 (84.88%) instances the name of the patient had been included. In 694 (92%) instances the name of the drug had been indicated. Instances where the quantity of medicines dispensed had been indicated was 393 (52.12%). None of the labels contained name or the address of the pharmacy or hospital and none contained the signature of the pharmacist. However, all the labels contained the dose frequency and the specific directions to use the medicine. Compared to the reported literature on the dispensing practices of oral medications to children in Sri Lankan hospital sectors, the research findings of this study confirm that the hospital pharmacy of Teaching Hospital Kuliyapitiya maintains dispensing practices of oral medications to children at a level that is close to satisfactory. Since proper dispensing procedures are a necessary prerequisite for children to use medications rationally, this practice is suggested to improve further by giving pharmacists access to ongoing professional training in paediatric pharmacy topics like forecasting needs, labeling, storage, and communicating with parents.

**Keywords:** Children; Dispensing Practices of Oral Medications; Kuliyapitiya Teaching Hospital

# The Knowledge and Associated Factors of Contraceptive Methods after Delivery among Women Attending to the Antenatal Clinic at Teaching Hospital Kuliyapitiya

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## Abstract

Post-partum family planning focuses on the prevention of unintended and closely spaced pregnancies through the first 12 months. Pregnancies with close spacing are linked to a higher risk of bleeding, anaemia, abortions, premature births, suboptimal nutritional supplements, hyperemesis gravidarum, bladder urinary infections, postpartum stress and intrauterine development limitations etc. In order to promote the health and wellbeing of women, newborns, and children, it is crucial to enhance postpartum contraceptive usage. The goal of national family planning program is to enable all couple to have a desired number of children with optimal timing and spacing. Counseling for family planning is done for newly married couples and for post-natal mothers through preventive sector Medical Office of Health. The aim of this study was to assess the knowledge and associated factors of contraceptive methods after delivery among antenatal mothers. This research would aid in reconsidering and improving the support for family planning which is supplied by health care setting in the country in order to help the mothers for determining the extent to which family planning services and programs are covered, access to the utilization of an effective method of preventing pregnancy aids, women and their partners in asserting their freedom to choose the number and spacing of their children freely and responsibly, as well as to have the information and education. This study was conducted in antenatal clinic of Teaching Hospital Kuliyapitiya. The study population represented most of the population who lived around Kuliyapitiya. A cross sectional study on 385 third trimester antenatal mothers was carried at Teaching Hospital Kuliyapitiya (THK) using an interviewer administered questionnaire. Pregnant mothers in the third trimester (27 to 40 weeks), those were willing to participate in the study who

attended the antenatal clinics in Kuliyapitiya were recruited to the study. All the third trimester pregnant mothers were included as a convenient sample until reached to the expected sample size. The sampling method was chosen considering the time period and accessibility of the study setting. Majority (30.91%) of studied women were in between 25-29 ages. Level of knowledge regarding post-partum family planning was above average in 57.66%. Most of the participants (88.31%) have heard about post-partum family planning before to the study. 51.17% had practiced contraceptive methods prior to pregnancy and the commonest method was oral contraceptive pills (38.58%). Future practice of post-partum family planning methods was significantly associated ($p<0.05$) with age of mother ($p=0.00$, $X^2=23.372$), religion ($p=0.02$, $X^2=7.627$), ethnicity ($p=0.03$, $X^2=7.165$), number of children ($p=0.00$, $X^2=41.014$) and previous practice of contraception ($p=0.00$, $X^2=53.793$). Nearly a half of mothers (51.17%) had used contraceptive methods prior to pregnancy and most used method was oral contraceptive pills (38.58%). 75.06% expected to focus on post-partum family planning methods and their most preferable method was dermal implants (24.57%). Majority of mother's source of knowledge (77.95%) was health care professionals.

Knowledge on contraception is inadequate but willingness to practice post-partum family planning methods was higher to prevent unwanted pregnancies or to keep gap between pregnancies. Nearly a half of mothers had practiced a post-partum family planning prior to this pregnancy. Among them most used method was oral contraceptive pills. Dermal implants were the most preferable method to use after delivery as it was a long term reversible contraceptive method while the fear of adverse effects was the main barrier of using post-partum family planning methods among non-users. Most of the participant discuss about methods of contraception with their spouse. This is due to the fact that couples who discuss post-partum family planning together are more likely to get acceptance and support as decision regarding its applicability may made together. Factors that influenced post-partum family planning uptake among antenatal mothers were age of mother, religion, and ethnicity, number of children and previous practice of contraception. Health care professionals in hospitals, MOH and pharmacies had been the main source of knowledge.

**Keywords:** Contraception; Family Planning; Knowledge; Perception; Post-Partum Family Planning

# Attitude and Behaviour Towards Snakes and Their Determinants among Medical Undergraduates in Wayamba University of Sri Lanka

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## Abstract

Snakes are regarded as sources of fear and anxiety among different communities worldwide. However, the existence of snakes is vital in maintaining the balance of ecosystems. Human activities, including intentional killing, threaten the existence of snakes worldwide. Fear, disgust, knowledge, myths and beliefs towards snakes appear to be the determinants of human behaviour towards snakes. Understanding human attitudes and behaviours towards snakes are important to plan snake conservation activities.

Sri Lanka is a place for frequent snake-human interactions. Out of 85 land snake species in Sri Lanka, 20 are endangered or critically endangered. Destructive behaviours towards snakes, including irrational killing, were observed in Sri Lanka. However, attitudes and behaviours towards snakes among Sri Lankan communities have not been well understood. This study aimed to assess the attitudes and behaviours towards snakes and their determinants among the medical undergraduates in the Faculty of Medicine (FOM), Wayamba University of Sri Lanka (WUSL). This study was conducted as a cross-sectional descriptive study. A sample of 240 students was selected from all the medical undergraduates in FOM, WUSL using simple random sampling. A self-administered questionnaire was used to obtain details on fear, disgust, basic knowledge, common myths, and details on previous encounters and behaviour towards snakes. Negativistic and scientistic attitudes were assessed using a validated snake attitude questionnaire.

A total of 231 undergraduates (males = 67, 29%, females = 164, 71%) in 20-

26 year range (Mean = 22.9) participated in the study. 60.4% (140) of the participants had encounters with snakes during the previous month. Among the participants, only 9 (3.9%) had a history of a snakebite. In most encounters, participants (102, 44.6%) had let the snake escape on its own. 78 times (34.1%) participants had run away from the snakes due to fear. On 26 occasions, (26, 11.4%) participants had chased the snake away. Eight times (3.5%) participants had killed the snake.

Most participants rated their fear of snakes as "very much" (median = "much"). Fear was associated with the female gender (p=0.001). However, fear was not associated with experiencing a snakebite history (p=0.266) or experiencing a death due to a snakebite (p=0.905) in their community. Victims of snakebites showed lower fear (p=0.014). The majority (58, 25.6%) rated their disgust towards snakes as "very much". However, disgust was not associated with gender (p=0.11). Knowledge was expressed out of '7 marks' (Mean=4.03, SD=1.36). Knowledge was not significantly differed with gender (p=0.916), and was not associated with negativistic (r= -0.052, 95%CI= -0.179-0.079) or scientistic (r= -0.062, 95%CI= -0.190-0.067) attitudes. 138 participants (59.7%, 95%CI = 53.1%-66.1%) believed that the common cobra is a sacred snake. 44 participants (19.4%, 95%CI= 14.4%-25.1%) believed that some common cobras have a gem inside their bodies. 34 (14.9%, 95%CI=10.6%-20.3%) believed that Forsten's cat snakes drink human blood at night. 31.2% (95%CI=25.1%-35.7%) of participants believed Russell's viper spread a smell. 73 (31.9%,95% CI=25.9%-38.3%) participants believed that green whip snake attacks human eyes. 30 participants (13.2%, 95%CI=9.1%-18.3%) believed that snakes do not bite following a rat snakebite. The negativistic attitude (Mean=3.06, 95% CI=2.97-3.15) and scientistic attitude (Mean=3.13, 95% CI=3.04-3.22) were expressed out of '5 marks'. Females showed a higher negativistic attitude than males (p=0.03). This study concludes that medical undergraduates at the Wayamba University of Sri Lanka have a high level of fear, and disgust with a moderate level of negative and scientistic attitudes towards snakes. However, they demonstrate non-destructive behaviour towards snakes. The belief in myths is also concerning considering the education level of the population. This study suggests the need of community-level evaluations for planning education and snake conservation programmes.

**Keywords**: Disgust; Fear; Negative Attitude; Snake Myths; Sri Lanka

# Snakebite Exposure Patterns in Dry Zone Farmlands; A Descriptive Study in Anuradhapura District, Sri Lanka

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## Abstract

Snakebite is a serious health hazard in Sri Lanka. More than 80,000 annual snakebites and 400 deaths are estimated to occur annually in the country. Snakebites in dry zone farmlands are common due to the overlapping of human and snake habitats, and activities. It is an underestimated, yet important burden, considering the socioeconomic consequences. Precise identification of snakebite exposure patterns is key for the effective prevention of snakebites in farmlands. This study aims to identify recent snakebite exposure patterns at farmlands in Anuradhapura district by analysing the data of Anuradhapura Snakebite Cohort.

Primary data of the Anuradhapura snakebite cohort (an electronic database) were used in this descriptive study. The study population was patients who had been admitted to Teaching Hospital, Anuradhapura from August 2013 to December 2021 following snakebites which occurred in farmlands (paddy, chena or other cultivated lands). Details of 986 snakebite victims were analysed to identify snakebite exposure patterns in farmlands, their seasonal and geographical variations and other associated factors.

Most of the victims were males (840, 85.2%), and the mean age of a victim was 44 years (IQR= 18). The majority were full-time farmers (693, 70.3%). Most snakebites occurred at the paddy fields (685, 69.7%) and the chena cultivations (257, 26.1%). Small percentages of snakebites occurred at coconut estates (9, 0.9%), fruit orchards (5, 0.5%) and other farmlands (24, 2.5%). Monthly snakebite incidence showed two peaks in a calendar year with peaks in February to March and October to November. The highest number of bites

was recorded during November. At the paddy fields, peak incidences were seen during March and November, whereas at chena cultivations it peaked during January and October.

Although the majority of the bites occurred in the daytime (6 am to 6 pm: 613, 62.6%, whereas 6 pm to 6 am: 366, 37.4%), 306 (22.3%) bites occurred in a 3-hour period from 6 to 9 pm. Russell's viper (*Daboia russelii*) (306, 70.5%) was the offensive snake of most bites, while the Merrem's hump-nosed viper (*Hypnale hypnale*) (89, 20.5%) was the second among the 434 instances, in which the offending species was identified. Common cobra (*Naja naja*) (7, 1.6%), Indian krait (*Bungarus caeruleus*) (12, 2.7%) and non-venomous snakes (20, 4.6%) contributed to a small percentage of bites. The highest occurrence of Russell's viper bites was seen from 9 am to 12 pm (76, 24.8%), whereas the most hump-nosed viper bites occurred from 3 pm to 6 pm (27, 30.3%). Russell's viper bites were predominant in both paddy fields (226, 74.6%) and in chena cultivations (71, 61.7%) and were followed by hump-nosed viper bites (paddy fields: 60, 19.8%; chena cultivations:24, 20.8%). Out of all snakebites, 87.2% (860) bites were unprovoked incidents. Most bites occurred while engaging in harvesting activities (170, 54.1%). Preparing the ground for farming (45, 14.3%), irrigating the farmland (35, 11.1%) and cleaning the farmlands (33, 10.5%) were the other common circumstances of snakebite. Foot (74.8%) was the predominantly bitten site, followed by the hand (8.7%) and leg (8.2%). Of all victims, 419 (42.5%) had seen the snake biting them and 205 (20.8%) victims had brought the snake specimen to the hospital.

This study shows that the average snakebite victim in farmland in Anuradhapura is a middle-aged male, bitten by a viperine snake over the foot, while harvesting, irrigating or land preparation. Monthly snakebite incidence shows a bimodal pattern with slight variations in the different agricultural settings. The findings of this study can be considered when improving existing preventive guidelines and educating the community on snakebites. Further research is needed to identify the perception of the stakeholders of the snakebite regarding the applicability of these findings to the existing preventive strategies for snakebites.

**Keywords:** Agricultural Field; Chena Cultivations; Paddy Field; Snakebite Epidemiology; Sri Lanka

# Physicochemical Properties, Total Phenolic Content, Antioxidant and Anti-Inflammatory Activity of Fresh Virgin Coconut Oil and Copra Derived Coconut Oil

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## Abstract

Coconut oil has been used extensively for both culinary and non-food applications. It constitutes the most important source of dietary fat in many Asian countries. Virgin Coconut Oil (VCO) and Copra Oil (CDCO) are two major types of coconut oil that follow different production processes. While CDCO is recovered using the dry method of pressing copra, VCO is extracted from fresh, mature coconut kernels using either wet or dry procedures. Depending on the extraction method, both the physicochemical properties and the amounts of the bioactive components available in oil can differ. It is well recognized that the bioactive substances included in coconut oil provide a wide range of health advantages. The aim of this study was to compare the physicochemical characteristics, content of phenolic compounds, antioxidant capacity, and anti-inflammatory activity of VCO and CDCO.

Fresh CDCO samples were obtained from the Coconut Research Institute, Sri Lanka and fresh VCO samples extracted by cold pressing method were obtained from a registered commercial local producer. Physicochemical characteristics; Iodine Value (IV), Peroxide Value (PV) and Free Fatty Acid (FFA) value were determined following American Oil Chemists' Society's (AOCS) methods. Phenolic fraction of test oils were prepared using methanol/water (60:40 v/v) and hexane. Total phenolic content (TPC) was determined using Folin-Denis colorimetric assay and expressed as Gallic Acid Equivalents (GAE). Antioxidant capacity was determined by DPPH (2, 2-

diphenyl-1picryl-hydrazyl) radical scavenging assay and total antioxidant capacity by phosphomolybdenum method. The results were expressed as Alpha-Tocopherol Equivalents (ATE). Anti-inflammatory activity was determined by protein denaturation inhibition method and membrane stabilization method. The drug diclofenac sodium was used as the positive control to determine anti-inflammatory activity. All the measurements were performed in triplicates.

According to the results obtained, FFA content was significantly higher (p value<0.05) in CDCO (0.45% ± 0.04) compared to VCO (0.16% ± 0.04). IV of CDCO and VCO were 6.07 ± 0.64 g $I_2$/100 g oil and 5.70 ± 0.50 g $I_2$/100 g respectively. PV of CDCO and VCO were 0.003 ± 0.001 meq $O_2$/kg and 0.037± 0.047 meq $O_2$/kg. TPC was significantly higher (p value<0.05) in CDCO (11.15 ± 0.22 mg GAE per kg of oil) compared to VCO (4.74 ± 0.33 mg GAE per kg of oil). Antioxidant activity is significantly higher (p value <0.05) in CDCO compared to VCO. $IC_{50}$ value of DPPH radical scavenging activity in CDCO and VCO were 702.47 ± 15.33 mg/ml and 910.02 ± 22.75 mg/ml respectively. Total antioxidant capacity of CDCO and VCO were 48.94 ± 2.42 mg ATE per kg of oil and 28.04 ± 1.22 mg ATE per kg of oil respectively. Anti-inflammatory activity was significantly higher (p value <0.05) in CDCO compared to VCO. $IC_{50}$ value of protein denaturation inhibition activity in CDCO and VCO were 350.39 ± 0.74 mg/ml and 444.11 ± 6.76 mg/ml respectively. $IC_{50}$ value of red blood cell membrane stabilization activity in CDCO and VCO were 268.25 ± 2.27 mg/ml and 279.33 ± 1.49 mg/ml respectively. Results indicate that free fatty acid percentage was significantly higher in CDCO compared to VCO. There was no significant difference in iodine value and peroxide value of two types of coconut oil. All the determined physicochemical parameters were within the standards established by Codex Alimetarius Commission and Asian and Pacific Coconut Community (APCC). These findings demonstrate that fresh CDCO has significantly higher total phenolic content, antioxidant and anti-inflammatory activities compared to fresh VCO.

**Keywords**: Antioxidant Activity; Anti-inflammatory Activity; Coconut Oil; Physico-Chemical Properties

# Renal Involvement in Dengue Fever; A Baseline Study

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## Abstract

Dengue fever is considered as the major mosquito-borne disease in Sri Lanka. According to the World Health Organization, Dengue cases have been reported since the 1960s and dramatically increased in Sri Lanka. The main clinical features observed during leaking phase of the dengue are haemoconcentration, an fall in platelet count, and decreased urine output. Renal involvement in dengue fever is one of the identified complications. It can range from mild proteinuria to severe dengue hemorrhagic fever with acute kidney injury. This study aims to identify the phase at which renal function is compromised in dengue fever by detecting changes in urine and serum.

A descriptive cross-sectional study was conducted in the three internal medicine units of Teaching Hospital, Kurunegala. All the patients diagnosed with dengue fever were recruited in the sample over a period of 12 months. Patients who are in febrile phase of dengue fever were included and patients who have entered into the critical phase at the admission and the patients with comorbidities were excluded. Demographic data of the patients, history of the illness, presenting symptoms, co-morbid conditions, and dengue contact history were recorded using interviewer administered questionnaire. Physical examination findings and other routine investigation data were obtained from the clinical records (bed head tickets) of the patients. On admission, all the patients with dengue fever were investigated for baseline tests of serum creatinine, urine osmolality, urine protein, and urine glucose after confirmation of diagnosis with serological testing. Six hourly urine samples were obtained to investigate for urine osmolality and proteins. A sample was obtained for serum creatinine at the onset of leaking from the patients who enter into leaking phase. On discharge, a urine sample and a serum sample were obtained for follow up tests.

Total of 135 diagnosed dengue patients were recruited and, among them were 27 patients in leaking phase. Majority of the leaking patients (66.7%, n = 18) were in adult category (25 years – 64 years) and were males (66.7%). There was a significant increment in the serum creatinine value at the time of admission and at the beginning of leaking phase (Mean difference – 0.071 mg/dl SD – 0.148 with a p = 0.035). It had been settled by the time of discharge (Mean difference – 0.103 mg/dl SD – 0.151 with a p = 0.005). At the same time there had been a transient proteinuria in 65% (15) patients who had fluid leak. The behaviour of urinary osmolality is exemplified in the osmolality against urine output chart of patient 5.

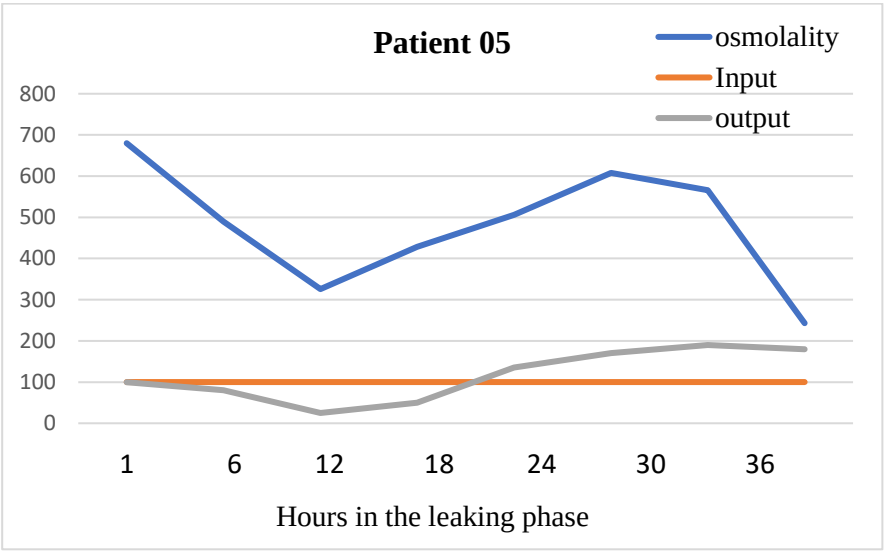


**Figure 1**: Changes of the Urine Output and the Osmolality during the Critical Phase

Renal concentration ability had also been affected in the initial stage of the leaking phase, as 17 leakers out of 27 patients who entered into leaking phase showed deranged physiology with the input output and osmolality relationship. It can be concluded that the kidneys are affected in the initial stage of leaking phase of the dengue infection and further studies needed to confirm this finding.

**Keywords**: Critical Phase; Dengue Fever; Renal Involvement; Leaking Phase

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# Development of a Risk Prediction Model to Predict the Risk of Hospitalization due to Exacerbated Asthma among Asthma Patients Aged ≥20 Years in the Gampaha District

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## Abstract

Exacerbations of asthma is a leading contributor to asthma hospitalizations. Identifying and managing asthma patients at risk of hospitalization due to exacerbation is vital to reduce the high cost incurred by the disease. The use of a simple, risk prediction tool offers a low-cost mechanism to identify high-risk asthma patients for specialized care. The study aimed to develop and validate a risk prediction model to identify high-risk asthma patients for hospitalization due to exacerbations.

Hospital-based, case-control study was conducted among 466 asthma patients aged ≥20 years, recruited from four tertiary care hospitals in the Gampaha district. Patients who have been diagnosed with asthma for more than 1 year and are presently hospitalized due to an exacerbation with an on-admission respiratory rate of > 30/min, pulse rate of > 120 bpm, (on air) $O_2$ saturation of < 90% and required both regular nebulization and systemic steroids on admission were selected as cases (n=116), consecutively from the medical wards of the selected hospitals. Patients who have been diagnosed with asthma for more than 1 year, without any hospitalizations for an exacerbation during the past year were selected as controls (n=350; 1:3ratio), randomly from asthma/medical clinics of the same hospitals. Data was collected by pre-intern Medical Officers via a pre-tested interviewer-administered questionnaire (IAQ). Information on asthma control, asthma co-morbidities, risk behaviours, and physiological and sociodemographic factors were obtained with verification through medical records.

Multiple Logistic Regression (MLR) analyses by the backward elimination method were performed to develop the model. The variables that emerged as risk factors in bivariate analysis with statistical significance at $p<0.05$ were selected as candidate predictors for the MLR model. The Events Per Variable (EPV) rule of thumb was applied in shortlisting the candidate predictors. The consensus from a panel of experts was also obtained in selecting candidate predictors for the model. Out of the thirteen candidate predictors included in the MLR analysis, only ten variables retained significant in the final LR model. The 10 predictors selected for the final model were given their regression coefficients (Log odds) as weighted scores, rounded up to have no decimals. These weighted scores were summated into a single summary score to predict the individual risk of an asthma patient for hospitalization due to exacerbations. Receiver Operator Characteristic (ROC) curve analysis was performed to refine the model. A second case-control study was conducted to assess the new model's criterion validity (158 cases, 101 controls) recruited from the same hospitals. Data was collected using an IAQ based on the newly developed risk prediction model. The final model consisted of ten predictors; age more than 60 years, educated up to GCE O/L or less, having Diabetes Mellitus, family history of asthma, having ever smoked, ever intubated/given ICU care, having previous hospitalizations due to asthma exacerbations, having uncontrolled asthma, having Gastroesophageal Reflux Disease (GORD) and Body Mass Index (BMI) >25 kg/$m^2$. The final model gave an AUC of 0 .83 (95% CI= 0.78-0.88). The summary risk score of the risk prediction model ranged from 1 to 11. The summary risk score of 4.5 was found to be the optimal cut-off value to categorize each participant into 'at risk' of getting hospitalized due to exacerbated asthma or 'not at risk' of getting hospitalized due to exacerbated asthma. At the 4.5 cutoff level, the model gave a sensitivity of 69.0% (95% CI= 61.7-76.2) and a specificity of 86.1% (95% CI=79.4-92.8). The newly developed model based on history and BMI was proven valid to identify asthma patients at risk of hospitalization due to exacerbations. The model should be promoted as a simple, low-cost tool for identifying and prioritising high-risk asthma patients.

**Keywords:** Asthma; Hospitalization; Risk Prediction Model; Validation

# *Session E-2:*
# *Anatomy and Surgery*

# Assessment of Overweight and Obesity Status of the Purana (Old) Population Residing in Sigiriya, Sri Lanka

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## Abstract

Overweight and obesity can be defined as abnormal or excessive fat accumulation in body tissues that presents a great health risk. Overweight and obesity are becoming significant global health issues. Body Mass Index (BMI) is a common and widely utilized measurement technique used all over the world to determine obesity. The "Purana" (old) population of Sri Lanka is a small group of indigenous people whose origin goes back to the Sinhalese Kings of the 5$^{th}$ century A.D. (1,450 YBP). They live in four villages near the Sigiriya Bolder Garden complex in the Sigiriya suburbs. It was reported that they are genetically and morphometrically different from the rest of the local Sinhalese residing in the area. The incidence of overweight and obesity in the "Purana" population is not supported by any literature. Studying the prevalence of overweight and obesity among the adult "Purana" individuals in the "Purana" population residing in Sigiriya, Sri Lanka was the goal of this investigation. "Purana" villagers who were residing in :-Talkote, Pidurangala, Diyakepilla, and Nagalaweva near the Sigiriya Bolder garden coplex were selected for the study. 107 men and 169 women who were adults (defined as those over the age of 18) were recruited in the study. "Purana" individuals were chosen based on their "Purana" ancestry as documented in a 1981 study of Purana communities in the environs of Sigiriya. The chosen pedigrees, which represented the “Purana” population in the villages of Talkote, Pidurangala, and Diyakepilla, were traced back at least three generations. These pedigrees included following surnames Gamagedara, Aluthgedara, Undiyagedara, Liyanagedara, and Beddegedara. The three pedigrees representing the “Purana” population in Nagalaweva village by these surnames: Millagahagedara, Kongahagedara, and Aluthgedara were likewise traced back three generations. Villagers without the

aforementioned surnames were not included in the population. The study included participants who provided their informed permission only.

The height, weight and mid-waist circumference were recorded with reference to WHO standards by a single observer. All the measurements were taken three times. The mean value of each three measurements was taken as the final height, weight and mid-waist circumference value. The Body Mass Index (BMI) of each individual was then calculated using measured values. Then the participants were categorized as underweight, normal weight, overweight and obese based on the global and south Asian cut-off values of BMI and mid-waist circumference.

33.6%, 55.1%, 9.3% and 1.9% of males were underweight, normal weight, overweight and obese respectively with reference to global BMI cut-offs. 33.6%, 43%, 20.6% and 2.8% of the male adult population were underweight, normal weight, overweight and obese respectively with reference to Asian BMI cut-offs. 28% of males had central obesity according to mid waist measurement. 17.6%, 62.3%, 17.6% and 2.5% of female adult population were underweight, normal weight, overweight and obese respectively with reference to global BMI cut-offs. 17.6%, 49.7%, 24.1% and 8.5% of the female adult population were underweight, normal weight, overweight and obese respectively with reference to Asian BMI cut-offs. 47.2% of females had central obesity when mid-waist measurement was considered. The results show that a large fraction of the "Purana" (old) population is underweight. Furthermore, obesity and overweight appear to be an emerging health issue amidst lifestyle transitions in the "Purana" community.

**Keywords:** Obesity; Overweight; “Purana” population; Sigiriya; Sri Lanka

# A Comparison of *Nila* Point Locations in Selected Indigenous Medical Texts

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## Abstract

*Nila Vedakama* is a Sri Lankan indigenous medical practice that manipulates specific points in the body to relieve ailments. The ability to precisely locate *Nila* points on the body surface is critical for the *Nila Vedakama*. The location of *Nila* points varies among traditional practitioners and in literary resources. This study aimed to compare similarities and differences in information about the *Nila* point locations in the selected indigenous medical textbooks.

All printed indigenous medical textbooks, which included the information of *Nila Vedakama*, available in the GWUIM library, were reviewed. In these books; namely *Sārārta Saṃgrahaya, Yōga Ratnākaraya, Sadēśa Agnikarma Cikitsā, Talpatē Piliyam, Yōgārṇawaya, Warayōgasāraya, Bhēsajja Manjusāwa, Dēśīya As Vedakama, Vaidyaka Hastasāraya,* and *Vaidya Cintāmaṇī Bhaisajya Saṃgrahaya*, the "*Salla Vidiya*" and "*Śara Vidiya*" chapters that described the *Nila Vedakama*, were systematically scrutinized to identify the locations of the *Nila* points, the relevant diseases relieved, and treatment techniques used. The data were extracted and recorded in a pre-designed matrix. The *Nila* point locations that were described exactly the same in more than two books, were separately tabulated and analysed. A manual analysis was conducted by identifying the frequency of appearing the same point locations, and treatment methods for illnesses in the matrix/table. The medical text revealed two types of *Nila* points; *Suva Nila* (healing

points) and *Maru Nila* (vulnerable points). A total of 67 common *Suva Nila* points and a total of 107 common *Maru Nila* points, which have been present in more than two books, were identified. The *Suva Nila* points were mainly located in; the head and neck-24 (35.8%), lower limb-23 (34.3%), upper limb-12 (17.9%), pelvic and back-06 (8.9%), and abdomen and chest-02 (2.9%). *Maru Nila* points were observed in the head and neck-37 (34.5%), lower limb-22 (20.5%), upper limb-22 (20.5%), pelvic and back-14 (13.0%), and abdomen and chest-12 (11.2%). It was observed that the "*Kammula bubula*" (prominence of the cheek) location has been used to treat "*Abhiṣyandaya"* (conjunctivitis), and "*Hisaradaya"* (headache) diseases. The "*Yaṭi patula meda*" (middle of the sole location has been used to treat "*Bhagandara*" (fistula-in-ano), and "*Tunaṭi rudāwa*" (back pain) diseases. Several other examples of this nature were observed. Further, it was observed that the "*Vilumba*" (the heel), "*Ura piṭa"* (shoulder tip), and "*Kenḍa*" (the calf) locations have been used to treat the "*Kora Sanniya*" (deformed limbs and swollen joints).

All textbooks described the identification method of *Nila* point location by using "*Anguli pramāna*", which indicates the length of the patient's middle phalanx of the middle finger measured from a fixed point of the body. The "*Isa muduna*" (the top of the head) *Suva Nila* point is located twelve *anguli* from the top of the patient's nose upwards in the midline. The depth of the *Nila* point location from the surface of the body has been measured using different seed varieties; this was the only method accepted in all textbooks. For instance, it was observed that the size of a rice grain and sesame seeds depths have been burnt at the "*Kammula bubula*" to treat a swollen knee, and "*Bema uḍa*" (above the eyebrows) to treat headaches, respectively.

Study findings show that the selected indigenous medical textbooks have mentioned a total of 67 exactly common *Suva Nila* points, 107 *Maru Nila* point locations, and various other *Nila* point locations unique to each. Single *Suva Nila* point locations were used to treat different diseases. On the other hand, different *Nila* point locations have been used to treat the same disease. It was also noted that the patient's anthropometrics and natural seeds were used to identify and treat the exact *Nila* point location.

**Keywords:** Indigenous Medicine; Location; *Nila* Points; Sri Lanka

# Study of Mandibular Foramen in Dry Adult Human Mandibles in Sri Lankan Population

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## Abstract

The mandibular foramen (MF) is the entrance to the mandibular canal and serves as a reference point for procedures such as inferior alveolar nerve block, mandibular implant treatment, and mandibular osteotomies. Maxillofacial surgeons oncologists and radiologists benefit greatly from knowing the location of the mandibular foramen during these procedures. Several studies have been done around the globe to identify the exact location of mandibular foramen but there is no recorded research evidence of exact location of mandibular foramen in Sri Lankan population. Thus the objective of this study was to determine the exact location of the mandibular foramen according to sex in Sri Lankan population and the incidence of accessory mandibular foramen, using dry adult mandibles.

Dry adult mandibles obtained from the Department of Anatomy, Faculty of Medicine, Wayamba University of Sri Lanka were used in this study. Mandibles with sockets for third molar teeth, regular shape, and free of deformities were chosen. Damaged bones and those with pathological abnormalities were excluded. The gender of each selected mandible for the study was determined by comparing their morphological characteristics with the recorded standard morphological characteristics. A total number of 40 mandibular foramina were observed in the twenty dry adult mandibles. Then the following distances from the mandibular foramen were measured on both sides of the mandible with 0.1 mm accuracy by using digital vernier caliper . The distance between the mandibular foramen and the anterior and posterior borders of the ramus, the mandibular notch, the base, the third molar, the apex of the retromolar trigone, the condyle and the angle were measured. A single observer did all the

measurements and every measurement was taken twice and calculated the mean.

According to their morphology, there were 11 male mandibles and 09 female mandibles. Among the observed 40 mandibular foramina there was only one accessory MF (2.5%). The mean distance + standard deviation (sd) from mandibular foramen to various locations was calculated.From the anterior border of the ramus, distance was 17.69±2.46 (Right-R) and 17.96±1.52 (Left-L) in males and 16.54±2.39 (R) and 16.38±2.28 (L) in females. It was positioned 13.51±1.08 (R) and 13.83±1.03 (L) in males and 11.88±2.47 (R) and 12.56±1.42 (L) in females from the posterior border of the ramus. From the mandibular notch the distance was 22.69±3.85 (R) and 22.53±4.25 (L) in males while it was 21.69±0.80 (R) and 20.58±1.93 (L) in females. The distance was 27.68±2.75 (R) and 27.60±3.15 (L) in males and 26.99±1.37 (R) and 27.21±1.48 (L) in females from the base. From the third molar the distance was 27.74±4.56 (R) and 27.61±4.86 (L) in males and 28.34±3.69 (R) and 27.83±3.42 (L) in females. The distance from the apex of the retromolar trigone was 14.99±2.13 (R) and 14.53±2.66 (L) in males and 14.47±1.73(R) and 14.15±1.53 (L) in females. From the condyle the distance was 41.66±2.88(R) and 41.05±2.71 (L) in males and 41.85±2.16 (R) and 40.56±2.13 (L) in females. The distance was 24.48±2.72 (R) and 24.50±3.31 (L) in males and 19.92±3.13 (R) and 20.24±1.73 (L) from the angle.

Male values were higher than female values from the anterior and posterior borders of the ramus, the mandibular notch, the base, the apex of the retro molar trigone, and the angle in both the left and right sides and from the left mandibular condyle. Female values were higher from the right mandibular condyle and from the third molars in both sides. These findings provide evidence that the positions of the mandibular foramina on the right and left sides of the mandible differ between individuals and between genders. The location of the MF analyzed was generally similar, with less variances when compared to documented locations of MF in other ethnic groups around the world.

**Keywords:** Mandibular Foramen; Dry Mandibles; Morphometric Analysis; Sri Lankan Population

# Feasibility of Conducting Online Surveys among Histopathologists Currently Practicing in Sri Lanka

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## Abstract

Over the past few years, the feasibility of conducting online surveys/studies has reached new grounds with the introduction of interactive newer versions of online data collecting systems. With the globalization trends and the improving computer literacy among Sri Lankans, online surveys can be attempted, despite being a third-world country. In the current context of restricted funding for research in Sri Lanka, online surveys need to be encouraged considering the fact that it enables contacting a wider population using minimal resources. The main aim of the initial phase of the study is to ascertain the possibility of successfully conducting an online study. A highly educated group of professionals (currently practicing Histopathologists in government hospitals) were invited to participate in the survey. An island-wide survey on the histopathological profile of endoscopic gastric biopsies was conducted using an online data-capturing portal REDCap. Almost all the main hospitals island-wide are equipped with endoscopic facilities and, manned by qualified histopathologists. There are seventy-two (72) consultant histopathologists currently practicing in Sri Lanka. All the hospitals issue a printed histology report and maintain a soft copy of the document in the department.

An open invitation was sent to all the government histopathologists in Sri Lanka, excluding those working in centres in which endoscopies are not performed routinely. The communications were made via e-mails only. This initial e-mail contained the information sheet, consent form and a webpage containing a fill-in-form survey form for data capturing. All the eligible histopathologists were included in this study without adopting a specific

sampling method. Therefore, this study did not require a sample size calculation.

Out of the sixty-one eligible Histopathologists, 13 responded as willing to participate in the survey. The following points were taken into consideration: Province of the hospital, category of the hospital, number of upper gastrointestinal (GI) biopsies received per month and work experience in years as a histopathologist. In the second phase of the study, the histopathologists who agreed to participate in the study were requested to submit gastric biopsy reports up to 50 during the six months of the study period. The response rate for this initial phase of the online study was 21.31%. The majority of the respondents were from district general hospitals in the peripheral areas of the country (n=4, 33.3%). The work experience of the majority fell between 5-10 years (n= 10, 76.92%). As we have targeted educated computer users the response rate was slightly higher than that observed globally for online surveys which is 17.6%. In Sri Lanka, the web-based survey methodology is still in its initial phase. The busy work environment and the attitude of the individual may have contributed to the decision to or against participation. The majority of respondents were histopathologists working in peripheral stations.

This study highlights the problem of conducting online studies and surveys in the current Sri Lankan context despite having selected educated computer literate. Although online data capturing should theoretically provide immense and versatile potential in collecting data, it does have its limitations. The popularity of web-based data capturing is increasing as a convenient low-cost method worldwide. In planning online studies, particular attention must be paid to the relevance of the study problem to the potential participants. It is our observation that this modality can be used effectively in conjunction with direct verbal or written communications with the participants. This might improve the participation rate further, than using e-mail-based communications only.

**Keywords:** Category of Hospital; Computer Literacy; Histopathologist; Online Data Capturing Form; Work Experience

# Distance Measuring Device to Calculate the Height and Width of the Human Ear Lobe

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## Abstract

Unique morphometric characteristics of human ear lobes are widely used in recognizing and identifying individuals. The currently employed traditional anthropometric instruments take more time and demand direct touch with the subject. Health care instructions to maintain physical distances which limit close contact with the individual is a major obstacle in morphological and morphometric analysis of human ear. Therefore, the aim of this project was to develop a device that can be mounted on any smart mobile phone and allows the user to measure the height and width of the external ear without touching the individual itself.

For this project, a laser-based time-of-flight (TOF) camera; a range imaging camera system employing TOF techniques to resolve the distance between the camera and the subject for each point of the image, by measuring the round-trip time of an artificial light signal provided by a laser or a light emitting diode (LED) was used. These TOF cameras are also a part of a broader class of scanner-less Light Detection and Ranging (LIDAR), in which the entire scene is captured with each laser pulse, as opposed to point-by-point with a laser beam such as in scanning LIDAR systems. During the process of designing this device, two TOF sensors were used to develop the module and attached to a device where it can be measured and adjust the distance of the two sensors. Two lasers were used to identify the points of the surface and to get the convenient position of the surface that needed to be measured. Then the camera sensor was used in the smartphone provided to capture the image. The camera sensor was accessed using the droid cam extension and transmitted through Wireless Fidelity (Wi-Fi) to a computer in order to view the frame. The frames were

acquired using the OpenCV library and computed the pixel values using the NumPy library. The distances were drawn using the line function provided in the library.

When using this device, it requires a separate custom-made software where it takes values wirelessly (Wi-Fi) and where the custom-made device sends the data to the personal computer (PC) custom-made software using python programming language where connects with a smartphone camera to acquire the image. For the smartphone the droid Cam application is one of the examples we can use to act as a remote camera. Once an image is taken, the image will be preprocessed and displayed in the software with the measurements. Then the two measuring devices, one to align the camera module with the test subject and one to measure the distance from the test subject will be used to take the final measurement with an accuracy of 1mm.

In conclusion, this device can be used for anthropometric measurement of human ear lobes with an accuracy of 1mm and without having close contact with the subjected individual. Further, as this allows the user to measure the width and height of a flat surface using vision recognition, the device can be repurposed according to the needs of the project. The programs can be added to the embedded device using various devices.

**Keywords:** Human Ear Lobe; Measuring Device; OpenCV; ToF; Vision

# Laparoscopic Appendicectomy in Peripheral Hospital: Is it safe Option for Basic Baparoscopic Training?

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## Abstract

Laparoscopic appendicectomy has advantages over open surgery in terms of complications, postoperative pain and the length of hospital stay. It is considered as a preferred basic laparoscopic procedure for surgical trainees based on the studies performed at teaching hospitals.

The aim of this study was to determine whether laparoscopic appendicectomy can safely be carried out by surgical trainees in a peripheral hospital. A retrospective analysis was conducted at a base hospital in Uva province of Sri Lanka including all laparoscopic appendicectomies performed from July 2018 to December 2018. Duration of procedure, complications, postoperative pain, and duration of hospital stay were compared between the surgeries performed by surgeon (group A) and by a supervised trainee (group B). All information required was obtained from bed head tickets.

53 laparoscopic appendicectomies, 15 (28.3%) were included in group A and 38 (71.7%) were included in group B. Demographics including age, intraoperative findings and histology were comparable between two groups. There were no significant differences observed between group A and B for the duration of procedure (34.67 min vs. 41.18 min, $p = 0.30$), deep surgical site infections (0 vs. 2.6%, $p = 1.0$), median postoperative numeric pain score (1 vs 1, $p = 0.23$) and duration of hospital stay (2.27 days vs. 2.58 days, $p = 0.11$). However, group B (5%) had a higher conversion rate to open surgery compared to group A (0).

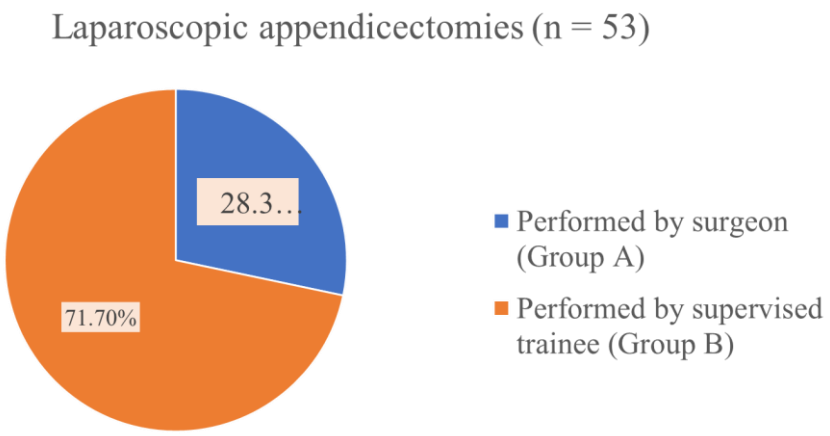


**Figure 1:** Number of Laparoscopic Appendicectomies Used as Sample

**Table 1:** Outcome Variables of Group A and B

| Outcome variables | Group A | Group B | P value |
|---|---|---|---|
| Duration of the procedure | 34.67 min | 41.18 min | 0.30 |
| Post-operative pain score | 0.8 | 1.45 | 0.20 |
| Duration of hospital stay | 2.27 days | 2.58 days | 0.11 |
| Surgical site infection | 0 | 2.6% | 0.53 |

Apparently; compared to open, laparoscopic appendicectomy deems equally safe procedure for supervised trainees to perform in peripheral resource limited hospital setting. But this needs to be verified further, by conducting the study in multiple peripheral centers with trainees having different learning curves.

**Keywords:** Appendicectomy; Laparoscopic Training; Surgical Trainee; Complications; Sri Lanka

# Valentino's Syndrome: A Case of Rare and Lethal Differential Diagnosis for Acute Appendicitis

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## Abstract

Due to the rarity of the condition, Valentino's syndrome is an unappreciated differential diagnosis for acute appendicitis. We describe a clinical case with Valentino's syndrome (VS) in which pre-operative and intraoperative diagnoses were challenging due to misleading clinical, investigative, and morphological findings. If there is a delay in the diagnosis of VS, this could even result in mortality.

A 31-year-old female, who was on methylprednisolone for sensory radiculopathy presented to the emergency department with acute right lower quadrant pain for 2 days duration associated with low grade fever and nausea. On examination she was tender in her right iliac fossa (RIF). The clinical diagnosis of acute appendicitis was supported by neutrophil leucocytosis and raised CRP (67). The ultrasonography revealed RIF inflammation, 8 mm thick appendix, small amount of free fluid in the right para-colic gutter and pelvis. There was a small (4 cm) ovarian cyst on the right. An open appendectomy and an ovarian cystectomy were performed jointly by surgical and gynaecological teams. There was some brownish free fluid in the RIF which was washed before the drain was placed. Unfortunately, laparoscopic facility was out of order.

Postoperatively, over the next 2 days she developed peritonitis with worsening sepsis. She produced a purulent bile-stained discharge from the drain, surgical site and per-vagina. Contrast-enhanced computed tomography (CECT) of the abdomen showed a retroperitoneal collection at the 2$^{nd}$ lumbar vertebral level

extending along the right para-colic gutter to the pelvis. And there were intraperitoneal fluid collections in right lower quadrant and pelvis.

It was decided by the surgical team to proceed with an emergency exploratory laparotomy. The collection was confirmed and bile stained fluid leak from the perforation at the posterior aspect of the duodenum was identified. The duodenum was not mobilized due to fragile nature of tissues. Therefore, it was covered with an omental patch with a covering drain. She was kept nil-oral and total parenteral nutrition was given for 5 post-operative days. She did recover well in the surgical high dependency unit. While on the fifth day of recovery the drain started to produce faecal matter. Subsequent CECT revealed a drain perforating in to the ascending colon. Unfortunately, she had to undergo a re-laparotomy, limited right hemicolectomy and end ileostomy. Later she made an uneventful recovery and was discharged home on post op day 6. Twelve weeks later she underwent successful ileostomy reversal.

The clinical presentation was not unusual for acute appendicitis. Investigations also favoured the clinical diagnosis. Therefore, suspicion on Valentino syndrome at the beginning was absolutely zero. We had completely ignored the fact that she was on methylprednisolone. Only thing against was the brownish fluid in RIF with minimally inflamed appendix. But this was further masked by the presence of 'chocolate cyst' on the right side. Nevertheless, if we could do a laparoscopic assessment or the CECT at the beginning, the course of management would have been different. On first laparotomy we have come to the definitive diagnosis of Valentino Syndrome. But we made a mistake by inserting rigid 24 F gauge tube to the para-colic region to drain the acid-enzyme rich duodenal fluid, which eventually lead to iatrogenic bowel perforation.

The present study emphasizes the importance of having; a high degree of suspicion of Valentino Syndrome during initial clinical assessment, low threshold for CECT in suspicious cases and laparoscopic intraoperative evaluation to recognize this lethal mimicker of acute appendicitis.

**Keywords:** Acute Appendicitis; Duodenal; Gastric; Valentino's Syndrome, Laparoscopic Assessment

# A Pilot Study on Screening "Hidden" Adult Pelvic Floor Dysfunction (PFD) and its Impact on Quality of Life (QOL) among Patients Presented to Outpatient Department (OPD) of Teaching Hospital Kuliyapitiya (THK)

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## Abstract

Pelvic floor dysfunction (PFD) has wide spectrum of symptoms and signs due to the aberrant function of the pelvic floor muscles and other supportive structures with which it interacts. The symptoms of PFD typically have a negative impact on a person's QOL. Unfortunately, most of the symptomatic patients do not seek medical opinion. We have conducted a pilot study to understand the gravity of this problem.

This cross-sectional study was aimed to find the prevalence of clinical features of pelvic floor dysfunction and its effect on QOL in adults, coming to THK for other health problems. People who already presented or diagnosed with PFD were excluded. The targeted age ranged from 18 and 65 years. Convenience sampling was done from the patients presented to outpatient departments and clinics at THK during the first month (September 2022) of the study. Ethical clearance was obtained from ethics review committee (ERC) of Faculty of Medicine, Wayamba University of Sri Lanka and Ethics Review Committee of THK. Data was collected through a self-administered questionnaire and the interviewer assisted in clarifying doubts if and when needed. The questionnaire included questions on urinary incontinence, bowel incontinence, sexual dysfunction and effect of those on QOL of the participant.

Results of mean age was 41 years. In females, only 1 participant's sexual life was affected by urinary incontinence, while 12.3% experienced pain during

intercourse. When assessed for differences in median, females showed to have more urinary symptoms than males (Mann-Whitney Test, $p = 0.016$). There was no difference in delaying defecation among genders, or no intra gender difference in delaying passing urine and defecation ($p > 0.05$). This data indicates the hidden problems people suffer from due to pelvic floor dysfunction and its' impact on quality of life. This pilot study is still at early phase and will continue till the target sample size is reached.

**Keywords:** Bowel Incontinence; Pelvic Floor Dysfunction (PFD); Sexual Dysfunction; Urinary Incontinence; Quality of Life (QOL)

# An Unusual Instance of Large Bowel Obstruction due to Sigmoido-Rectal Intussusception: A Success Story in Resource Limited Setting!

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## Abstract

Adult bowel obstruction (BO) is an infrequent presentation to a surgical casualty. Out of all BOs the large bowel obstruction (LBO) is relatively uncommon. LBO is associated with comparatively higher mortality rate, which further increases with delay in intervention. A LBO due to intussusception is even extremely rare. An intussusception is diagnosed when one portion of the gut becomes invaginated into another immediately adjacent; almost always it is the proximal into the distal.

A 67-year-old otherwise healthy man presented (to Teaching Hospital Kuliyapitiya) with constipation for 7 days and obstipation (absolute constipation) for 3 days. It was associated with an on and off intermittent colicky abdominal pain mostly in the left lower quadrant. He had no history of per rectal bleeding, fever or vomiting. He had no diagnosed comorbidities. His past surgical history was unremarkable. No past or family history of bowel diseases.

On examination he was afebrile, pulse rate was 76 beats per minute and the blood pressure was 150/90 mmHg. The abdomen was soft and slightly distended. There was mild tenderness in the left iliac fossa region without peritonism. Bowel sounds were normal. On digital rectal examination there was a large polypoidal mass involving whole circumference, felt at about 8cm from the anal verge. There was suspicious nodular irregularity on the upper surface. Blood stained mucus was present. His blood investigations revealed haemoglobin count of 9.0 g/dl, WBC-5.6 and platelet counts of 182. Other pre-

operative investigations were normal. ABG and lactate levels were normal.

An erect chest x-ray and an abdominal x-ray were unremarkable. An urgent lower intestinal endoscopy was performed. It revealed a large polypoidal mass with a central invagination accounting for the most likely sigmoido-rectal intussusception. The visible bowel was viable. On the upper surface of the mass there was an irregularity suspicious of malignancy. Contrast Enhanced Computerized Tomography (CECT) Imaging wasn't carried out due to the unavailability to the facility. As the patient was haemo-dynamically stable and there was painful, absolute constipation for 3 days it was decided to proceed with an emergency laparotomy. Informed written consent was obtained for Hartmaan's procedure after discussion with the patient and relatives. Pre-operative anaesthetic assessment done, ICU bed booked and stoma site marked.

The intraoperative findings were of an obvious sigmoido-rectal intussusception with a distended proximal colon. Rest of the peritoneal survey was negative. No palpable metastatic lesions noted in the liver. The intussusception was reduced manually with difficulty. The bowel wall was congested and unhealthy, however there were no perforations. After reduction, an obvious mass was felt in the mid sigmoid colon. Subsequently, it was decided to proceed with Hartmann's procedure. An end colostomy was created at the left iliac fossa. Specimen sent for histopathological examination.

Patient recovery was uneventful and discharged on post-operative day 7. Later the case was discussed in the Cancer MDT (multi-disciplinary team) meeting and it was decided to arrange CECT to identify hidden metastatic disease. No oncological treatment recommended till the CECT report becomes available.
Histology findings: Pathological staging- pT1 N0.

Higher degree of clinical suspicion and abrupt endoscopic diagnosis lead to prompt surgical intervention (Even without supportive radiological evidence) which culminated in good surgical out come in a resource scarce setting.

**Keywords:** Emergency Laparotomy; Sigmoido-rectal Intussusception; Large Bowel Obstruction; Hartmann's Procedure; Surgical Casualty;

# Development of a Psycho-Behavioural Intervention to Enhance Resilience among Grade 10 School going Adolescents in Sri Lanka

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## Abstract

Resilience is the ability of bouncing back to normal position after being exposed to adverse events in our life. Latter comprises five core characteristics. They are 1) evenness of mind especially after stress (Equanimity), 2) quality of being useful or important (Meaningfulness), 3) continued effort to do something despite difficulties, failure, or opposition (Perseverance), 4) belief on one's own efforts and abilities (Self- reliance) and 5) awareness that every person is unique (Existential aloneness). As resilience is a dynamic process and not a trait, interventions have been developed to enhance resilience in developed countries. Penn Resilience Programme in USA and United Kingdom and Adolescent Resourceful Programme in Australia are two such interventions which are currently being practiced.

Adolescents are defined as a group of persons in the age category of 10–19 years. They are subjected to several physiological and psychological changes during this period. Lack of resilience makes them vulnerable to taking many risks which threaten their development and grow into adulthood with negative mental well-being. Therefore, it is imperative that remedies are sought to help them build up resilience and make them capable of bouncing back to normal state in the face of challenges, obstacles and adversities. Resilience enhancing intervention need to focus on developing assets and resources for coping and bouncing back in the presence of adversities among adolescents who are exposed to risk rather than risk amelioration. Hence, the cornerstone of this intervention was to provide and guide the grade 10 adolescents' resilience enhancing skills through enhancing their own assets and resources. Development of a psycho-behavioural therapy based intervention to enhance resilience among grade 10 school going adolescents in Sri Lanka. The intervention chosen was a psycho-bahavioural

therapy of which development consisted of following steps.

First, a thorough literature search was conducted to identify all the relevant aspects of enhancing resilience among adolescents. Secondly, the conceptual frame work was developed based on above. Thirdly, five key informant interviews comprising psychologists (2), educationists (1), psychiatrists (1), school teachers (2) and community physicians (1) were conducted based on a semi structured format. This was followed by preparation of the draft intervention which was subjected evaluation using classic Delphi technique. Experts of the Delphi technique comprised psychologists (2), psychiatrists (1), educationists (1) and school teachers (1). Based on the comments received, necessary modifications were made and submitted for re-evaluation, after which it was finalized. Resource persons involved in delivering the intervention were, school teachers (2) and principal investigator. Modes of delivery comprised lectures, role plays, scenario-based discussions, psycho dramas, distribution of information, education and communication (IEC) materials and group activities. Areas covered under the final intervention comprised self-regulation, improving ability of problem solving, building supporting networks around adolescents and making and keeping peace related to day today life. The final intervention package which consisted of 10 sessions were held once a fortnight. Each session lasted over a duration of 40-50 minutes. The sequence consisted of introduction to the programme, ice breaking, building self-esteem, training to listen to inner voice (self-talk), introduction to the ABC (activating agent, beliefs, change) model, thinking resourcefully, method of carrying out negotiations, problem solving and decision making, identification and building up of supportive networks, improvement of coping skills related to life challenges, considering other persons' perspective/s, and finally summary of the contents discussed. Utilization of an in-depth literature review, key informant interviews and the classic Delphi technique enabled in designing a valid and reliable psycho-behavioural intervention to enhance resilience among grade 10 school going adolescents.

**Keywords:** Adolescents; Cognitive Behavioral Therapy; Intervention; Resilience

# Evaluation of the Effect of Continuous Education to Doctors, Nurses, and Patients on the Improvement in Care Quality and Clinical Outcomes of Diabetic Patients of Base Hospital Nintavur, Sri Lanka

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## Abstract

The goals in treating and caring for patients with diabetes mellitus are to achieve normal or near normal plasma glucose level and to prevent the development or progression of complications. A varying degree of paucity in the quality of care received by diabetic patients, and poor clinical outcomes as a result, have been observed frequently. To evaluate this observation, and to propose remedial solutions, a clinical audit was conducted during 2018 to 2020 at Base Hospital Nintavur, Sri Lanka. In the first stage, the audit assessed the awareness and practices by doctors and nurses in delivering guideline-based care to these patients. The quality of patient care and the control of diabetes was evaluated as a baseline.

Continuous professional development activities including evidence-based education on national and international guidelines were conducted for doctors and nurses. Regular and repeated diabetic health education sessions were conducted for clinic patients on diet, exercise, and medication adherence. The improvement in the knowledge among doctors and nurses, and the quality of care received by patients and their clinical outcomes were evaluated as the second stage one year later allowing for new clinical stability. All doctors and nurses of the hospital were recruited in the audit as their numbers were small. A randomized group of patients was selected statistically. A descriptive observational study method was employed. Validated separate questionnaires including 40 questions each on the knowledge of guideline-based care for doctors and nurses were used. The questions covered diagnosis, treatments, control of diabetes, screening and control of associated diseases, and screening for diabetic complications. The research team collected relevant patients' data from clinic records. The quality of care received by patients was assessed by

observing plasma glucose level, plasma lipid levels, blood pressure, the state of screening for complications, and standards of prescription for medications. The same questionnaires and the patient records were used in the second stage. The numbers of patients dropped to 80% in the patient group due to absences at clinics. The numbers of doctors and nurses remained the same at the time of second phase. The answers to the questions by doctors and nurses at the first stage revealed significant inadequacies in awareness about current guidelines, but promisingly, their knowledge improved significantly after educational activities. In the doctors' arm, in 28 out of 40 (70%) questions a statistically significant improvement in answering was noted. The performance by nurses was even better at the second phase as, in 32 out of 40 (80%) questions, a statistically significant improvement in answering was noted.

Patients' clinic notes showed poor documentation and inadequate screening for plasma glucose control, associated diseases and diabetic complications. Improvement was noted in all evaluated headings above and a statistical significance was observed among a majority. Notable improvements were seen in screening for complications and proper medication prescriptions. Post prandial plasma sugar and glycosylated haemoglobin testing were employed newly after updates. The average fasting plasma glucose level among patients fell from 160 mg% (SD37.06, range 89-271) to 122 mg% (SD22.36, range 76-204). An improved control of blood pressure (BP) (controlled BP in 54% and 76% respectively) and lipid levels were also observed.

The quality of care received by diabetic patients in the remote base hospital was not satisfactory initially. There was a deficiency in the knowledge on current diabetes management guidelines among doctors and nurses. It could be improved significantly following educational activities, which reflected in an improved care offered to patients with statistically significant clinical outcomes. Strengthening patients' awareness on diet, physical activity and medication adherence could have contributed to the enhanced outcome. This limited audit hints the possible poor state of care offered at other health care institutes in the country. The potential for improvements in care quality encourages devising plans to regularly update knowledge and practices of doctors and nurses, for the benefit of patients to achieve good control of diabetes and to avoid or delay the appearance of complications.

**Keywords:** Complications; Diabetes; Education; Management; Screening

# Profile of Gastric Histopathology Reports among Patients Who Undergo Upper Gastrointestinal Endoscopy for Dyspeptic Symptoms in Sri Lanka

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## Abstract

The heartburn and dyspeptic-related complaints are common among Sri Lankan patients turning up at the general practice, medical clinics, surgical clinics, and even as inward patients. They are generally given symptomatic treatments and only the resistant cases are further evaluated with endoscopic biopsies. The over the counter antacid treatment is freely available in Sri Lanka. There are several studies published on *H. pylori* in the Sri Lankan literature, mostly looking at the microbiological point of view. An island wide study on histopathological profile of endoscopic gastric biopsies has not been attempted. It would be useful to assess the distribution of gastric pathologies among the Sri Lankan population to understand the magnitude of the problem. All most all the main government hospitals island wide has endoscopic facilities and an in house Histopathologist. The online data capturing was used to facilitate participation by maximum number of Participants Island wide.

The updated Sydney system 1994 for reporting gastric biopsies is recommended to be practiced in Sri Lanka by assessing the following features: The active inflammation, chronic inflammation, glandular atrophy, intestinal metaplasia and *H. pylori* density. This is recommended as it is accepted worldwide and a uniformity is given to the biopsy reports throughout. So, one of the aims of this study was to look at the degree of adherence to the updated Sydney system while reporting gastric biopsies. An open invitations were sent to the Histopathologists via emails and thirteen responded as willing to participate in the study. These thirteen Histopathologists were asked to submit the first fifty gastric biopsies or the maximum number of gastric biopsies each

came across from the date of the commencement of the study up to six months. In this study, we collected data on age and sex of the patient, macroscopy and microscopy (reported according to the Sydney system). The histological evaluation was done by the Histopathologist of the relevant centre and the macroscopy and microscopy was entered to an online data capturing form.

However, only nine Histopathologist completed the survey and submitted upper Gastrointestinal (GI) biopsy reports which cumulated to three hundred and two reports out of which two hundred and seventy two (272) were gastric biopsies. The gastric biopsies overall showed, 272 (Male: Female = 17:13, mean age: 57.82 years). Of these, 50% (n=139) were classified as chronic gastritis. Of the remaining (n=37, 13.3%) were categorized as reactive gastropathy followed by n=33, 11.9% of fundic gland polyps. The prevalence of malignancy in this biopsy cohort is 8.3% (n =23). The Sydney system for gastric biopsy reporting was used in 129 of chronic gastritis cases (92.8%). The most commented feature is the degree of chronic inflammation (n=128, 99.2%) followed by active inflammation (n=85, 65.9%). The intestinal metaplasia was commented in (n=73, 56.6%), a comment on the presence or absence of *H. pylori* is seen in (n=88, 68.2%). However, in this biopsy cohort there was only one biopsy showing mild density of *H. pylori* and the prevalence is 0.7. Special methods for detection of the *H. pylori* infestation was not employed in any of the biopsies. The least commented upon feature in the gastric biopsies is glandular atrophy n=13, 10.1%).

It was observed that the majority of the reports are not reported in accordance with the updated Sydney system, in which there should be comments on chronic inflammation, active inflammation, glandular atrophy, intestinal metaplasia and *H. pylori* density. If a uniform reporting system is used island wide, it will assist research in this field. The actual prevalence of atrophic gastritis and *H. pylori* induced gastritis is unknown in Sri Lanka. This needs to be highlighted, and the histopathology trainees should be encouraged to use the proper grading system during reporting. And also, the prevalence of *H. pylori* may be falsely low as, this feature was not actively sought in this biopsy series.

**Keywords:** Chronic Gastritis; Gastric Biopsy; *H. Pylori*; Malignancy; Sydney System of Reporting

# Accidental Poisoning of a Family Due to Ingestion of 'Binthamburu' (Ginger-Leaf Morning-Glory, *Ipomoea asarifolia*), Misidentified as 'Kankun' (Water spinach, *Ipomoea aquatica*)

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## Abstract

Different types of plant poisoning are common health problems in Sri Lanka. Misidentification of plants with similar characteristics is not uncommon. 'Binthamburu' (Ginger-leaf morning-glory, *Ipomoea asarifolia* (Desr.) Roem. & Schuil.) and 'Kankun' (Water spinach, *Ipomoea aquatica* Forssk.) are vines which are naturally distributed in the wet, intermediate and dry zones of the country where they prefer wet habitats such as canals, paddy fields and riverbanks (Figure 1). They belong to the same genus of the family Convolvulaceae. Even though the flowers of binthamburu and kankun are similar, leaf morphology is different. Yet in the presence of bright daylight, binthamburu leaves fold at the centre mimicking kankun. Animal studies have shown that neurotoxins are present in *I. asarifolia* in the form of lectins. Foregoing is a clinical encounter of poisoning due to ingestion of *I. asarifolia*. A previous similar poisoning event has been reported earlier in an adjacent geographical area of Sri Lanka. A family from Namal-anga, Melsiripura in Kurunegala district was admitted to the local divisional hospital and later transferred to Teaching Hospital Kurunegala following an incident of accidental ingestion of *I. asarifolia* in their lunch. Among the family members affected were, grandmother (58), father (33), mother (26), sibling of the mother (19) and the elder daughter (13) of a same family. The two youngest daughters have refused the dish (7 and 3.5 years) and were not affected. *Ipomea aquatica* leaves have been plucked by the adult women from the bank of the near-by water compound and the yield has mistakenly included *I. asarifolia* due to misidentification. After 1-2 hours of ingestion, family

members have experienced lethargy, syncope and vomiting. The severity represented the amount consumed. The dietary survey did not reveal any other culprit food poisons in the three recalled prior meals. The patients did not show any other skin, respiratory, gastro-intestinal or neurological symptoms or signs. Blood investigations were negative for renal, hematological and hepatological involvement. Electrocardiograms were free from cardiac arrhythmias or heart blocks. Symptomatic management was carried out including intravenous fluids as life-threatening hypotension and dehydration were observed. All patients symptomatically recovered by 48 hours of the admission and returned their home. The adult male was the breadwinner of the family earning daily on manual labour. The family was affected financially due to loss of work. The children lost a few school days. As all adult members were affected family faced numerous social and economic hardships. The two young daughters had to spend vulnerable two days with relatives. The poisoning resulted in a preventable bed occupancy at hospital and a health cost.


**Figure 1:** Morphological Features of 'Binthamburu' (*Ipomoea asarifolia*), and 'Kankun' (*Ipomoea aquatica*)

Toxicity due to *I. asarifolia* has been reported in veterinary practice but is uncommon among humans. Hypotension, tremors and vomiting have been the frequent signs and symptoms. No deaths from its poisoning have been reported. Literature is available for its use in native treatments both orally and topically. It is essential to identify the profiles of clinical manifestations and the toxins of *I. asarifolia* to maintain increased awareness among both the health care personnel and the public. Misidentification with *I. aquatica* can continue to encounter among rural communities in all three climatic zones of the country. It is of significant concern that the toxicity involves entire families. The general public must be informed of the danger of *I. asarifolia* toxicity and the knowledge must be disseminated on identifying this poisonous plant to avoid accidental ingestion.

**Keywords:** *Ipomoea aquatica*; *Ipomoea asarifolia;* Misidentification; Plant Poisoning

# A Glimpse of Childhood Cancers in Sri Lanka

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## Abstract

Abnormal cell proliferation of cells in any organ of the body is called 'Cancer'. Cancers occurring up to the age of 19 years are considered as childhood cancers. Even though the prevalence of childhood cancers is lower than the adult cancers, they are considered as a leading cause of deaths among children worldwide. Annually, about 400,000 childhood cancers are being diagnosed. The childhood cancer burden is rising in trend globally. World Health Assembly in 2017, identified childhood cancer as a public health priority and further emphasized on the necessity of taking timely actions to counteract the situation. First consultation on childhood cancer was held at Geneva in 2018 and established the Global Initiative of Childhood Cancer (GICC). The childhood cancer registry in Sri Lanka is formulated by National Cancer Control Programme (NCCP) in 2021 by revisiting the national cancer registry programme, population based cancer registry of colombo district, hospital based Cancer Registry of National Cancer Institute of Sri Lanka, pathology laboratory based cancer registries and civil registration system. The objective of this study was to describe the childhood cancer epidemiology in Sri Lanka from 2005 to 2019. National cancer registry database at NCCP was revisited. Data was categorized with regard to the age, sex, types of tumours, districts and top five cancers.

The childhood cancers account for 2.5% (n=780) out of all newly diagnosed cancers (n =31848) in Sri Lanka in 2019. Since 2005 to 2019, there were a total of 10276 childhood cancers reported. Majority (51.9%, n = 5337) were reported from male children. The crude incidence rate (CR) per 1000,000 was 67.9 in 2005 and raised up to 146 in 2019. The age standardized incidence rate (ASR) per 1000, 000 reported as 73.1 in 2005 and 108.4 in 2019. Out of total cases from 2005 to 2019, majority (32.1%, n =3295) were reported from the 0 – 4 year age group. One thousand nine hundred ninety-nine (n = 1999, 19.4%) cancers

reported from 5 – 9 year age group, 1961 (19.1%) from the 10 -14 year age group and 3021 (29.4%) reported from the 15-19 year age group.

There were 780 new cases of childhood cancers reported in the year of 2019. Out of these, the majority (27.2%, n= 212) were reported from Western province. The Central province accounted for 85 (10.9%). North Western province (9%, n= 70), Southern province (7.1%, n= 55), Sabaragamawa province (6.9%, n= 54). Eastern province (4.9%, n=38) and 4.2% from Uva province (n= 33). Least reported from Northern and North Central provinces, 32 from each district (4.1%). The district or province was not mentioned almost one fifth (21.6%) of childhood cancer cases.

According to the 2019 data, top five cancers among male children are, Leukaemia (22.1%), CNS and brain tumours (13.2%), Lymphomas (11.2%), soft tissue tumours (10.7%) and bone tumours (7.5%), In female children, Leukemia (30%), soft tissue tumours (10.1%), CNS and brain tumours (7.7%), Germ cell tumours and Lymphomas (6.9% each) and bone tumours (4.5%). In accordance with World Health Organization – Global Initiative of Childhood Cancers, six index cancers have been identified. After analyzing the data between 2015 and 2019, number of children affected with these six index cancers in Sri Lanka were as follows; Acute lymphoblastic leukemia 627, retinoblastoma 211, Hodgkin's lymphoma 172, Wilm's tumour 146, low grade glioma 75 and Burkitt lymphoma 17.

Analysis of the national cancer registry database in Sri Lanka revealed that the CR and ASR of childhood cancers are increasing in trend. Male preponderance could be seen in the childhood cancers in Sri Lanka. The information on mortality and survival of childhood cancers in Sri Lanka is in dearth.

**Keywords**: Childhood Cancers; Cancer Registry; Sri Lanka

# Neonatal and Maternal Outcomes of Pregnant Mothers Who Were on Antipsychotics during Gestational Period in Selected Hospitals in Sri Lanka

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## Abstract

Medication use for various illnesses during pregnancy is on the rise. The safety and knowledge regarding medication use during the pregnancy is yet to be studied. Knowledge about the effects due to exposure of second-generation antipsychotics during pregnancy are limited in Sri Lankan context. Hence understanding the risks of antipsychotic medication used in pregnancy and their effects become an important clinical concern. The main propose of this study was to determine the maternal outcomes and neonatal outcomes of mothers who were on antipsychotic treatments during pregnancy.

A retrospective cohort study design was used to collect data from the hospital record rooms in North Colombo Teaching Hospital and Teaching Hospital Kuliyapitiya by using a stratified sampling method. Every 10$^{th}$ Bed Head Ticket (BHT) from obstetric wards during 2021 were included in the study. Pregnant mothers who were less than 16 years old and who were on medications other than antipsychotics were excluded from the study. Four hundred thirty-one BHTs which were included in the data analysis was categorized in to two groups: mothers who were on antipsychotic medication during the gestational period (AP group), and mothers without antipsychotic medications (WAP group). Demographic data of the mothers, data on medical comorbidities, history of drugs used during pregnancy, medical comorbidities during pregnancy, Pregnancy outcome and neonatal outcome were collected.

Neonatal outcomes were compared among two groups using t test for two sample means. Data were analysed using Statistical Package for Social Sciences (SPSS) software version 25.

Out of 431 pregnant mothers 2.55% (11) were belonged to AP group and 97.45% (420) were belonged to WAP group. Mean age of study participants was 30.28 (SD ± 5.3) years. Mothers who were on antipsychotics were diagnosed to have anxiety (27.3%), depression (45.4%), schizophrenia with depression (18.2%), and schizophrenia with bipolar affective disorder (9.1%). Neonatal and outcomes of the two groups are shown in table 1.

**Table 1:** Neonatal outcomes of AP and WAP groups

| **Parameter** | **WAP group (mean + SD)** | **AP group (mean + SD)** | **P value (t test)** |
|---|---|---|---|
| Birth weight (g) | 2862.54 ± 497.23 | 2624 ± 449.17 | 0.116 |
| Length (cm) | 48.05 ± 2.76 | 47.77 ± 2.74 | 0.737 |
| Head circumference (cm) | 32.80 ± 1.68 | 33.05 ± 2.16 | 0.629 |
| Gestational age at delivery (days) | 265.66 ± 9.44 | 266.39 ± 17.57 | 0.806 |

In WAP group maternal outcome was recorded as normal vaginal delivery 54.05%, assisted vaginal delivery 1.66%, elective Lower Segment Caesarean Section (LSCS) 22.86% and emergency LSCS 21.43%. 63.64% mothers had normal vaginal delivery while 36.36% of mothers were subjected to elective LSCS in AP group. There was no statistically significant difference in maternal and neonatal outcomes between WAP and AP groups.

Although there is no statistical difference in maternal and neonatal outcomes among pregnant mothers who were on antipsychotics during gestational period and who were not on any medication, further research is encouraged since pregnant mothers are vulnerable for complications. Since the present study included only limited number of mothers, authors suggest conducting a similar study island wide for a better outcome.

**Keywords:** Antipsychotics; Maternal Outcomes; Neonatal Outcomes

# *Session F:*
# *Technology*

# Materials and Tools Related Factors Influencing Efficiency of Labour in Sri Lankan Building Construction Projects

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## Abstract

The construction industry is one of the prominent sectors that plays a key role in the economic growth and recovery of a country. The productivity of work outputs is the essential component, which enables the successful completion of construction projects. Past studies highlight a wide range of factors that affect the productivity of labour operations in the construction sector of many developing countries. In the construction sector, materials and tools related factors are one of the significant contributors to the low productivity levels of labour operations. Accordingly, the perspectives of different job categories play a very significant component in upgrading organisational policies and management practices. This study aims to examine the materials and tools related factors that affect labour productivity in construction, based on the different perspectives between two job categories.

Many studies highlight the importance of the quality of the work materials and tools to maintain the labour performance at a satisfactory level, whereas material shortages and material delivery delays were the major problems against the progress of construction. On the other hand, material storage problems were identified as the major barriers to the progress of a large number of construction projects. Importantly, recent studies reveal that equipment shortages, equipment breakdown and tool delays have been significantly affecting the productivity of labour operations in the Sri Lankan construction sector. In the present study, industry expert interviews were also carried out with a focus on understanding the current/recent practices of the Sri

Lankan construction industry. The majority of the interviewees highlighted similar factors identified from the literature review (as mentioned above), where a few of them revealed that the quality of working tools and poor maintenance, equipment safety and material cost have also been influencing the labour productivity in Sri Lankan construction practices. The qualitative approaches were used to filter the factors identified from the literature review and interviews. The quantitative study methodology was then adopted through a questionnaire survey among 154 building construction contractors in Sri Lanka, where construction managers and engineers represented 90 contractors. The remaining 64 contractors were represented by construction supervisors and technical officers working there. The impacts of the materials and tools related factors on labour productivity in construction were measured using the Relative Importance Index (RII) method based on a 5-point scale.

The impact levels of the materials and tools-related factors on labour productivity are illustrated in Figure 1. Overall, the perspectives of construction managers and engineers highlight that most of the factors had a high-level impact on labour productivity. Meanwhile, construction supervisors and technical officers perceived that those factors had a moderate impact. The overall results indicate small gaps between the perspective levels of different working categories on most of the factors. Findings of this study will contribute to upgrade the current practices of the construction firms in Sri Lanka, towards achieving higher levels of labour productivity.

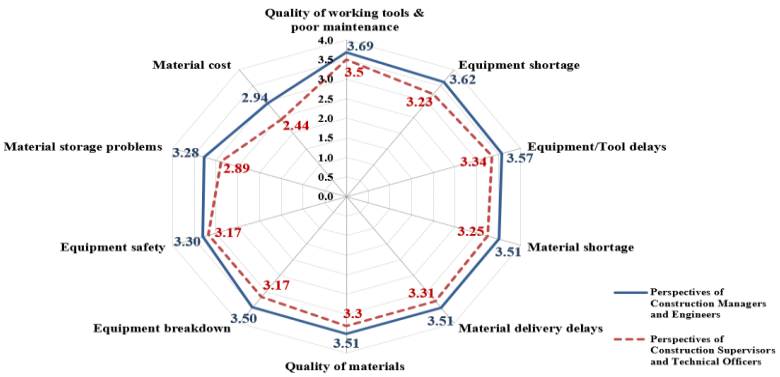


**Figure 1**: Impact Levels of Materials and Tools Related Factors on Labour Efficiency in Sri Lankan Building Construction Projects

**Keywords:** Building Projects; Construction Industry; Equipment; Material-Related Factors; Labour Productivity; Sri Lanka

# Effect of Graphite Oxide Loading on Physical Properties and Electrical Conductivity of Natural Rubber Composites

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**Abstract**

The interesting physical and electrical properties of graphite oxide (GO) have led to much excitement among scientists in recent years. Further, GO is the product obtained when bulk graphite is exposed to strong oxidizers such as sulfuric acid, phosphoric acid, potassium permanganate, etc. In this study, natural rubber (NR) composites were prepared by varying the GO loading from 2 phr (parts per hundred rubber) to 10 phr at 2 phr intervals. GO showed significant enhancement in physical properties and electrical conductivity of the NR composites as evident from the results obtained when compared with the control. The composite prepared with 6 phr loading of GO indicated the moderate physical properties in terms of hardness, tear strength and resilience. However, the composite prepared with 10 phr loading of GO exhibited remarkable improvement in electrical conductivity. Further, the former composite showed greater improvement in hardness and tear strength. Therefore, the NR composite prepared with 10 phr loading of GO could be suitable for high electrical conductive polymeric applications.

Variation of hardness of NR composites with GO loading is shown in Figure 1. Hardness of all six composites is observed in the range 40– 45 IRHD. Hardness of all the composites prepared with GO is higher than that of the control. The composite prepared with 10 phr loading of GO shows the highest hardness and it can be attributed to the highest toughness. Further, tear strength of most of the NR composites prepared with GO is higher than that of the control and may be due to existence of a strong interface between the NR matrix and GO due to improved adhesion between the two materials. The resilience of a polymeric material emphasizes the flexibility and elastic behavior of a material. The

control composite has indicated the highest resilience due to the absence of GO as the filler material. Moreover, generally, resilience decreases with the increase in hardness and hence the resilience results are in agreement with the hardness results. Furthermore, the composite prepared with 6 phr loading of GO shows moderate physical properties in term of tear strength (40 N/mm), resilience (70%) and hardness (43 IRHD). Electrical conductivity of GO-filled NR composites varies from 0.26 to 31.9 µs/m as shown in Figure 1. The composites prepared with GO have shown higher electrical conductivity than the control. The composite prepared with 10 phr loading of GO exhibits remarkable improvement compared to other GO-filled NR composites. Further, electrical conductivity of polymeric materials depends on several factors such as particle shape of filler, polymer–filler interaction, and influence of preparation conditions on the volume distribution of conductive particles. In addition, electrical resistivity of GO-filled NR composites varies from 3.9 x $10^6$ to 3.1x $10^4$ Ωm. Generally, NR is a fully insulated polymer material due to poor electrical conductivity and high electrical resistivity. Moreover, the electrical conductivity of the GO-filled NR composites has been developed by two orders of magnitude, owing to the uniform dispersion of GO in the NR matrix.

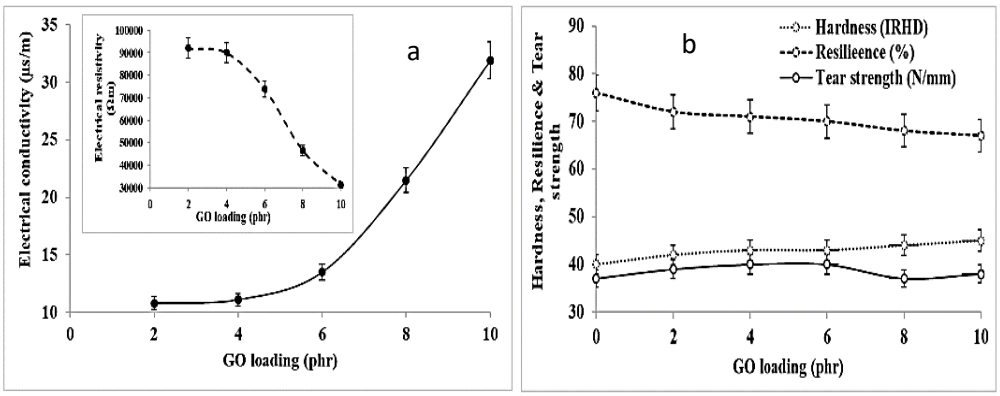


**Figure 1:** Properties of NR/GO Composites, (a) Electrical conductivity and (b) Physical properties

The 10 phr GO filled NR composite showed an increment in electrical conductivity and hardness by 12169% and 12.5%, respectively in comparison to the NR composite prepared without GO.

**Keywords**: Electrical Conductivity, Graphite Oxide, Hardness, Natural Rubber, Resilience

# A Miniaturized Uniform Meander Line UHF Antenna for a Passive RFID Tag

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## Abstract

In the field of automatic object identification, passive radio frequency identification (RFID) systems that operate at Ultra High Frequency (UHF) band are quite popular. There is no internal battery in passive tags; they only have an antenna and an RFID chip where the chip is powered by the energy harvested from the antenna. The use of RFID is often limited by the size of the tag, which is determined by the antenna size. Miniaturization of the tag antenna is therefore a major design concern in RFID systems. This study uses a meandering method on a printed dipole antenna, which serves as the reference antenna. A printed dipole antenna was used to obtain the planer configuration in the RFID tag. When the antenna's impedance matches that of the chip, power transfer from the antenna to the chip is maximized. The chosen chip for the present study, Rocky100, has a high capacitive input impedance of 64 - j 469 Ω at 868 MHz. Thus, implementing an internal impedance matching strategy is a challenging research. As the novelty, this is the first time an internal impedance matching structure has been proposed while using size reduction approaches for a fully passive UHF RFID tag produced with the Rocky100 chip.

The structure and the dimensions of the reference antenna are shown in Figure 1(a). To match the impedance of the antenna with the chip's impedance, a modified T-match structure was utilized. The antenna was modelled using Ansys HFSS (High-Frequency Structure Simulator) and was optimized for impedance matching using parametric optimization. The reference antenna

was constructed on an FR4 substrate and has an overall dimension of L=130 mm and W= 25 mm which is quite large and needed to be miniaturized. During the initial stage of minimizing the antenna size, the dipole arms were folded as shown in Figure 1(b). With the folded structure, the length of the tag was reduced to 110 mm. Next, a meander line structure was explored as a size reduction strategy. Initially, a single meandering section was added to the folded antenna design. The miniaturized antenna's structure and dimensions are shown in Figure 1(c). By adding a single meandering segment, the antenna's length was reduced to 100 mm, resulting in a 23% reduction in overall size. Table 1 summarises the performance of the three antenna designs.

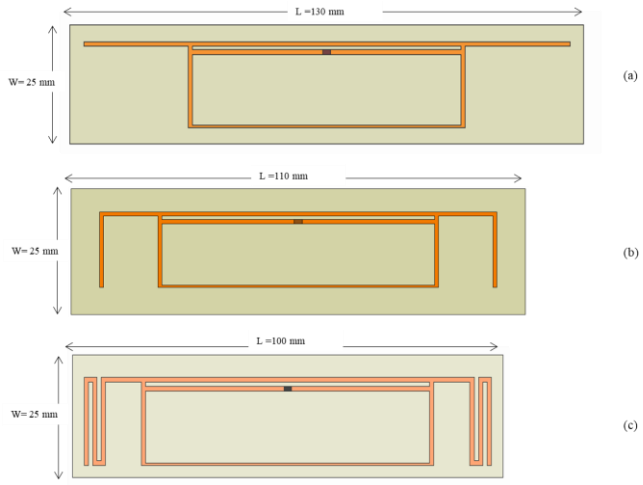


**Figure 1:** Antenna Sructures and Dimensions in Each Stage; (a) Reference Antenna, (b) Folded Antenna, (c) Meander Line Antenna.

**Table 1:** Performance Comparison of the Antennas

| **Parameter** | **Reference Antenna** | **Folded Antenna** | **Uniform Meander Line Antenna** |
|---|---|---|---|
| Input impedance (Ω) | 68.5 + j 461.7 | 62.53 + j 471.6 | 72 + j 473 |
| Resonance frequency (MHz) | 870 | 870 | 865 |
| Size ($mm^3$) | 130 × 25 × 1.6 | 110 × 25 × 1.6 | 100 × 25 × 1.6 |

The number of meandering sections per wavelength and the distance between two meander lines generally determine how significantly an antenna's size can be reduced. Hence, in future work, the effect of these parameters will be examined to check the possibility of further reducing the antenna’s size.

**Keywords:** Passive UHF RFID; Planer Dipole; Meandering; Miniaturization

# Analysis of the Effect of Solar Irradiance on the Total Harmonic Generation of the Grid-Connected Rooftop Solar PV Systems

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## Abstract

Rooftop solar-based distributed generations are emerging as an alternative to conventional power plants due to several reasons such as the reduction of fossil fuel-based energy resources and fluctuation of electricity rates. With the advancement in power electronics technology, the rooftop area can be effectively utilized to mount solar panels, and extracting the maximum possible solar power becomes very simple. However, fast-switching power electronics devices can generate harmonics, and it has become a major power quality issue that is required to be taken care of while installing and operating grid-connected solar PV systems. Harmonics can distort the sinusoidal waveform and cause damage to the connected applications while reducing the quality of the power.

With a high penetration of rooftop solar systems, the renewable power share of the total power generation increases. Therefore, the harmonics generated by solar PV systems become significant in the quality of the bulk power. Therefore, each rooftop solar system should be operated within acceptable limits of total harmonic distortion (THD). Also, the amount of solar irradiance can determine the maximum power delivered by a solar PV system. Thus, a more comprehensive study on the power quality of a grid-connected solar system is required based on the level of solar irradiance. Therefore, this paper presents a study on analyzing the harmonics generation of a rooftop solar system with different solar irradiance levels.

A 300-kW rooftop solar system is modeled in PSCAD/EMTDC software. The model has four main sub-systems; (1) solar panels, (2) maximum power point

tracker, (3) boost converter, and (4) voltage source converter (VSC). The maximum power point tracker tracks the solar panel output voltage at the maximum power point and the duty cycle of the boost converter is changed to regulate the input voltage corresponding to the maximum power point. The voltage source converter delivers the generated power to the grid while regulating the DC link voltage and the reactive power. The converter is connected to the grid via an LC filter. To analyze the effect of the solar irradiance level on the harmonics distortion at the point of common coupling (PCC), solar irradiance applied to the solar panel is changed.

The output RMS current and total harmonics distortion (THD) (up to 256 harmonics) at the point of common coupling (PCC) with the variation of the solar irradiance are analysed. The output current varies linearly with the irradiance. Also, the THD levels are nearly constant around 2.5 % for higher irradiance levels. However, when the irradiance level reduces, the THD level increases dramatically, and it is around 20 % at 50 $W/m^2$. Therefore, under low irradiance levels, low-quality power is injected into the grid. However, since the associated current is lower at low irradiance levels, the effect of the harmonic on the large power system is negligible. However, according to the simulation results, if a high number of rooftop solar systems are connected to the distribution grid, the total harmonic current injected into the power system increases even under low irradiance levels.

In summary, it can be concluded that a low level of irradiance adds a significant amount of harmonics to the distribution network reducing the power quality. A recommendation would be that rooftop solar systems can be configured to get disconnected from the system when the THD level exceeds 5% threshold value as per IEC 61000-3-2 standard.

**Keywords:** Harmonics; Irradiance; Power Quality; Voltage Source Converter

# Investigation of the Optical and Physical Properties of Green Synthesized Silver Nanoparticles using Ceylon Olive Extract (*Elaeocarpus serratus*)

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## Abstract

Nanotechnology contributes to rapid development in the field of science due to the tremendous applications of nano-metallic particles; gold, platinum, silver, titanium, zinc, cerium and iron in several industries. Many chemical and physical methods involved in the synthesis of metallic nanoparticles, utilize hazardous chemicals and are extremely costly. Researchers are focusing on the green synthesis of metallic nanoparticles to address these issues. This study was conducted to investigate optimal process conditions for producing silver nanoparticles (AgNPs) by using green synthesis with Ceylon olive (*Elaeocarpus serratus*) (Fig.1) extract and to characterize the synthesized AgNPs. Antimicrobial potential was evaluated against two gram-negative bacteria, *Pseudomonas aeruginosa and Escherichia coli.* Optimization of the volume of extract, temperature, and pH was carried out for obtaining a high yield and to improve properties of AgNPs. To optimize the synthesis of AgNPs, 40 ml of 1.0 mM $AgNO_3$ was reacted with varying volumes of fruit extract (110, 130, 150, and 170 µl) by adding dropwise. A UV-visible spectroscopy analysis was performed in the range of 300 – 800 nm to optimize the volume. To optimize the temperature and pH, various temperatures (40, 50, 60, and 70 °C) and different pH values (5, 6, 7, and 8) were used. The synthesized AgNPs obtained at the optimum conditions were used to characterize properties by using UV-visible spectrophotometer, particle size analyzer, X-ray diffraction (XRD), Fourier transforms infrared spectroscopy (FTIR), and scanning electron microscope (SEM) coupled with X-ray energy dispersive spectroscopy (EDX). One of the unique optical properties of AgNPs such as the surface plasmon effect has clearly been observed in the UV-Vis

absorption studies. The agar well diffusion method was used to determine the antimicrobial activity in cooperation with 50 µg/ml of AgNPs and compared with that of $AgNO_3$.

The visual observation of colour change from colourless to yellowish brown indicated the formation of AgNPs. Optimum parameters for the synthesis of AgNPs were found to be the extract volume of 150 µl, the temperature of 60 $^0$C and the pH of 7. A single and sharp surface plasmon resonance band at around 434 nm confirmed the formation of AgNPs. Particle size analysis for AgNPs shows that most of the particles are in the nano range with an average size of 90 nm. XRD peaks were observed at 38.26$^o$, 46.23$^o$, 64.47$^o$, 77.54$^o$, and 81.71$^o$, indicating that the particles are crystalline in nature with face-centered cubic (FCC) structure and the crystallite size was around 19 nm from the Williamson-Hall uniform deformation model. FTIR indicates the presence of phytochemicals containing carboxyl (-C=O), hydroxyl and amine (N-H) groups in Ceylon olive extract. They act as reducing and capping agents for Ag ions and AgNPs respectively. SEM analysis depicts the different sizes of spherical nanoparticles (70 – 120 nm). The formation of AgNPs is further confirmed by EDX due to an energy peak at around 3 keV. AgNPs synthesized by Ceylon olive extract indicated higher antimicrobial potential against *Pseudomonas aeruginosa compared with* that of *Escherichia coli*. A higher antibacterial effect of AgNPs was also observed compared to conventional $AgNO_3$.

This study presents a straightforward, inexpensive, environmentally friendly method for producing silver nanoparticles using Ceylon olive extract alternative to physical and chemical methods. The results showed that a low concentration of Ceylon olive fruit extract and silver nitrate solution was sufficient for producing silver nanoparticles and optimal process conditions can be used as a protocol for large-scale synthesis. This study indicates Green synthesized AgNPs can be used to have protection from bacterial infections.

**Keywords**: Antimicrobial Activity; Ceylon Olive; Green Synthesis; Silver Nanoparticles

# Development of a SDFT-based, Grid Connected, Voltage Source Inverter for Current Harmonic Compensation

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## Abstract

Harmonic current is introduced into the system in the form of currents whose frequencies are the integral multiples of the fundamental power system frequency by non-linear loads connected to an electrical power system. The cumulative effect of many non-linear loads can result in problems, even though a single non-linear load may not have much of an influence on the Total Harmonic Distortion (THD) level of grid current. The traditional methods for lowering the THD level of the current in distribution grids include isolation transformers, specific passive filters, and others. A more efficient approach than the currently used traditional approaches is to provide a current harmonic compensation function as an ancillary service to the grid-connected inverters. Due to the rapid growth in the use of grid-connected solar systems, even if the percentage that one photovoltaic (PV) inverter can reduce the THD level of grid current is low, the cumulative effect of the grid-connected PV inverters is high. This study suggests a three-phase inverter control strategy to make use of the distributed generator connected to the grid. This inverter may improve the total harmonic distortion (THD) level of the grid current by supplying a compensation current from the inverter in addition to active power transferring to the grid. The suggested system is shown in Figure 1. According to that, the inverter is connected to the distribution line in parallel at the point of common coupling (PCC) through an interface LC filter. The primary objective is to send active power to the PCC. Additionally, harmonic compensation is an ancillary service. This inverter is controlled with pulse width modulation (PWM) by comparing its feedback current to a reference current. The compensatory current is then delivered to the PCC by the inverter. By repeating this cycle, the grid's current harmonics are mitigated. An improved Sliding Discrete Fourier Transform (SDFT) is applied to determine

the system harmonics. The inverter's controller is composed of two control blocks as shown in Figure 1.

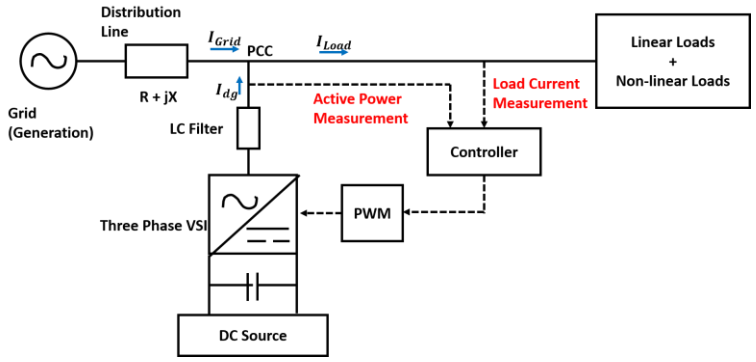


**Figure 1:** Block Diagram of Overall System

A non-linear load ($I_{load}$) draws both the fundamental current component and the harmonic current component from the grid. Then, ($I_{grid}$), the grid current also has harmonics. The proposed system provides current ($I_{dg}$), which is made up of harmonic compensation current and the active power reference current. The load current ($I_{load}$) is used to compute the harmonic compensation current. Then the harmonic portion of the load current is supplied by the inverter ($I_{dg}$). Then the THD value grid current ($I_{grid}$) will decrease. MATLAB Simulink is used to design and simulate the model. A simulation model is used to validate the inverter's performance. Initially, a non-linear load of a diode rectifier (800 W) was used to analyse the proposed system. The grid current's THD value, which is 30.12% without the compensator (inverter), is then reduced to 10.85% with the compensator. As the inverter is injecting harmonic compensation current into the grid, the grid current approaches a sinusoidal waveform. THD level reduction of the grid current is 64% due to the harmonic compensation capability of the inverter. Additionally, two different forms of non-linear loads, a semi-converter and a thyristor bridge converter were used to assess the validity of the system. Current harmonic compensation percentages for the semi-converter load and the thyristor bridge converter are 78.38% and 63.6%, respectively. It is evident that a significant improvement in the THD level of the grid current can be achieved as a result of the cumulative effect of the harmonic current compensation capacity of grid-connected inverters.

**Keywords:** Ancillary Service; Current Harmonic; Grid-tied Inverter; Three-Phase; Sliding Discrete Fourier Transform (SDFT)

# Machine Vision-based Defect Detection Scheme with Adjustable Computational Burden for Typical Manufacturing Environments

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## Abstract

Sri Lanka must focus on improving manufacturing in order to sustainably recover from the present crisis. High labour costs associated with manufacturing have been cited as one of the major disadvantages of the country slowing down industrial growth. Quality assurance in manufacturing is vital for achieving competitive advantage. However, labour-intensive manual quality inspection may be not feasible in certain industries. Therefore, relatively inexpensive automated defect detection mechanisms applicable for typical production lines can to improve product quality and to drive down production costs. In order to provide a such solution, we propose a relatively inexpensive vision-based automated defect detection system targeting symmetric objects which move on the conveyer belt. It identifies and notifies defects of any shape of the object placed in anywhere on the camera frame. The proposed method is based on the image comparison of edge-filtered images to identify the foreign edges in the targeted product. Any defect that results in observable foreign or unusual edges on the edge-filtered image can theoretically be detected by such a comparison. Images of the ideal object and to-be-checked objects are captured by the camera and processed further before the eventual comparison. They are; the targeted image and reference image which are the photographs of the targeted product and the non-defective sample with a pre-set square shape image selecting a minimum background area respectively. However, the captured images may not be in the same orientations and therefore be not suitable for machine vision comparison. Hence, an orientation mapping mechanism is embedded into the system and it is achieved in three steps; they are identification of the outermost edge of the

matched image section in the image of the target graphic, estimation of orientation differences between the reference image and identified image section, and transformation of the pixels of the identified image section to match the orientation of the reference image. The identification of matched image section in the target image is done using the Scale Invariant Feature Transformed (SIFT)-based key point mapping technique. According to the shape of the reference image, the identified image section is cropped into a square shape section and the orientations are mapped using geometric transformations. In order to make the system more easily and adaptable for real manufacturing environments, a self-camera triggering mechanism to minimize the distortions of the captured images and an IoT-based remote monitoring mechanism to access the information of the system anywhere in the world by using a mobile-based application have been added. In addition to that, by adjusting the thresholds such as the number of matched key points, the system could be adjusted for different types and different levels of defect identifications by minimizing the computational burden. To test the proposed method, A prototype using a 2 MP manual focus camera, LED light array with the light diffusing palate, a Raspberry Pi 4 single-board computer, and a slow-moving coverer belt which moves on 1 to 1.5 $ms^{-1}$ was constructed as shown in Figure 01(a). The test results have been observed for different image samples of pre-set defective transparent containers and the decisions were made by comparing the pre-defined thresholds. One of the resultant images is shown in Figure 01(b). All test cases were successful and it runs the range of 1 to 2 second processing time. Overall results suggest that the system has a high potential to identify the defects in the symmetric object with low-computational burden, and it can be used in the manufacturing industry as a low-cost solution to identify the defect of any shape of the moving or non-moving symmetric object placed in anywhere of the camera frame effectively.

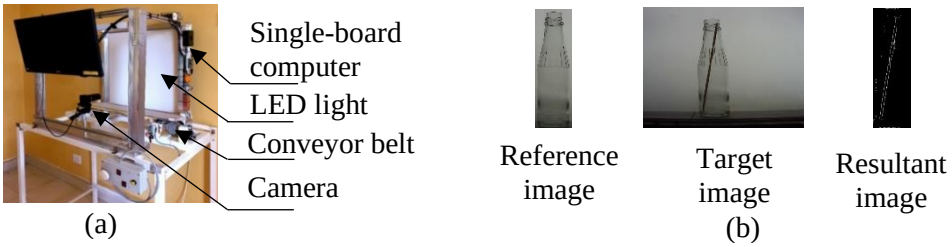


**Figure 1:** (a) Developed Prototype System and (b) Sample Resultant Image

**Keywords:** Defect Detection; Automated Product Quality Monitoring; Defective Edges; IoT-based Monitoring

# A Comparative Assessment of Direct Heating Method and Autoclave Method for Deacetylation of Chitin into Chitosan in Developing a Chitosan Extraction Method

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## Abstract

Shellfish waste is increasingly being utilized globally as a source of chitosan, and it is also an alternative to overcome the waste accumulation problem. Sri Lanka lacks the cost-effective technology to produce chitosan and do further value addition from this waste, therefore a small proportion of the shellfish waste is exported as a raw material while a large quantity is still wasted. Therefore, the overall objective of this research was to develop a cost-effective technology for extracting chitosan, and this particular study focuses on one step of the whole process. Chitosan extraction occurs by first extracting chitin from the shells and then converting chitin into chitosan. Chitin extraction consists of demineralisation using Hydrochloric acid; deproteinisation using Sodium hydroxide; and decolourisation using Potassium permanganate followed by Oxalic acid. Then this resultant chitin is converted to chitosan using Sodium hydroxide and a heat treatment. In this study, the most effective deacetylation treatment was evaluated using a combination of treatments as (a) with 40% NaOH followed by direct heating/ autoclaving (b) 24 hours steeping at 40% NaOH followed by direct heating/ autoclaving (c) with 50% NaOH followed by direct heating/ autoclaving (d) 24 hours steeping at 50% NaOH followed by direct heating/ autoclaving. Direct heating is involved heating chitin at 100°C temperature for 2 hours in a dry oven, and autoclaving involved 121 °C temperature at 15 psi for 15 min in an autoclave. The chitin extracted from Whiteleg shrimp (*Litopenaeus vannamei*) shells using a standard protocol was used for this experiment. FTIR spectra showed characteristic peaks in the spectral regions of 3600-3000 $cm^{-1}$ and 1700-1500

$cm^{-1}$ in all chitosan samples. XRD spectra for chitosan extracted from direct heating method exhibited two characteristic broad diffraction peaks at 2θ values of 10 and 20 which were typical fingerprints of semicrystalline chitosan. When autoclaving treatments are considered, the XRD spectra showed several calcite peaks for all the treatments except 24 hours steeping in 50% NaOH, indicating the improper conversion of chitin to chitosan. The degree of deacetylation (DDA) was higher in direct heating method compared to the autoclave method, and it further increased with 50% NaOH and 24 hour steeping. Chitosan extracted by autoclave assisted method showed better whiteness values compared to that of direct heating method in all treatments as the autoclave method avoids long heating times during deacetylation. Viscosity values were significantly decreased with increased concentration and with steeping in direct heating method ($p<0.05$) which may be due to the formation of low molecular weight chitosan oligomers by chemical depolymerisation in the extraction process. DPPH free radical scavenging activity was significantly increased in direct heating method compared to that of autoclave method and also it has been increased with the increased concentration of NaOH and steeping which may resulted due to increased DDA. In conclusion, autoclaving method is not suitable for deacetylation of chitin to chitosan. Direct heating method of deacetylation with 40% NaOH is recommended for chitosan production and it is cost effective based on the shorted chemicals at industrial level production as well.

**Table 1:** Physico-Chemical Properties of Extracted Chitosan

| **Method of deacetylation** | | **Yield %** | **DDA %** | **Whiteness (%)** | **Viscosity** | **DPPH activity** |
|---|---|---|---|---|---|---|
| **Method** | **Deacetylation** | | | | | |
| Direct Heating | 40% NaOH | 33.52 | 81.04 | 71.17 ± 0.35 | 149.20 ± 1.66 | 66.03 ± 0.88 |
| | 40% NaOH+ Steeping | 32.33 | 82.42 | 72.15 ±3.46 | 140.00 ± 1.55 | 73.71 ± 2.05 |
| | 50% NaOH | 31.91 | 85.25 | 72.90 ± 0.29 | 131.87 ± 0.32 | 76.42 ± 0.73 |
| | 50% NaOH+ Steeping | 30.07 | 87.54 | 71.75 ± 1.43 | 60.33 ± 3.94 | 84.10 ± 0.48 |
| Autoclaving | 40% NaOH | 33.71 | 74.89 | 73.80 ± 2.10 | Not in the measurable range. | 21.36 ± 0.70 |
| | 40%NaOH + Steeping | 33.40 | 75.46 | 73.85 ± 3.59 | | 22.94 ±1.27 |
| | 50% NaOH | 33.50 | 77.61 | 74.28 ± 1.12 | | 38.87 ± 0.61 |
| | 50% NaOH+ Steeping | 33.23 | 80.17 | 73.28 ± 0.67 | 100.27 ± 0.55 | 62.13 ± 1.87 |

**Keywords**: Autoclave; Chitin; Chitosan; Deacetylation; Direct Heating

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# n-$Cu_2O$/ p-$Cu_2O$ p-n Junction Electrode on Cu substrate for Photovoltaic Applications

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## Abstract

Due to the rising demand for energy, in-depth studies on the advancement of photovoltaic technology have gained importance and interest. The world's primary energy sources are non-renewable and are quickly running out. Solar energy is a dependable renewable energy source that can be used to solve this enormous problem. For this, solar cells can be used to convert solar energy through the photovoltaic (PV) effect into electrical energy. The photogeneration of charge carriers and the separation of charge carriers are the two tasks that a solar cell carries out.

However, the materials used to make commercially available solar cells, such as Indium (In), Germanium (Ge), Gallium (Ga), and Silicon (Si), are hazardous and expensive. Therefore, materials that are environmentally friendly, affordable and low toxic are highly desired for photoelectric conversion. So cuprous oxide ($Cu_2O$) based photovoltaic devices have a great demand to overcome this problem. As $Cu_2O$ has attractive semiconductor properties like narrow band gap (2 eV), abundance, easy production process, and high absorption capacity for wavelength from 200 – 600 nm, it can be used for electronic and optoelectronic applications. To date, many methods have been employed in the synthesis of $Cu_2O$ such as chemical vapor deposition, electrochemical deposition, and hydrothermal fabrication.

In this research to fabricate $Cu_2O$ based photovoltaic device to achieve both p-type and n-type $Cu_2O$ thin film on Cu substrate, the outer layer of (99% purity) copper plate (1 cm × 2 cm) was removed using sandpapers. It was polished until a mirror-like surface was obtained. They were then washed with distilled water to prepare a well-cleaned copper sheet. The well-cleaned copper sheet was immersed in 0.005 M Copper Sulphate solution ($CuSO_4$) and boiled to

100 °C until the formation of $Cu_2O$ crystals. The immersing time controls the thickness of the film n-$Cu_2O$ on the Cu substrate.

After synthesis, the Cu/n-$Cu_2O$ photoelectrode was kept in the muffle furnace for oxidation purpose by annealing at different temperatures until the formation of p/$Cu_2O$ crystals. Initially, a heating rate of 10 °C/minute was provided inside the furnace starting from room temperature, after reaching 200 °C, 300 °C,400 °C, and 500 °C, Cu/n-$Cu_2O$ photoelectrode was kept constant for 15 minutes and cool down to room temperature.

The scanning electron microscopy SEM image was observed to evaluate the surface morphology of the synthesised Cu/n-$Cu_2O$/p-$Cu_2O$ electrode, as shown in Fig.1. It is clearly shown that the p-$Cu_2O$ nanocrystals layer was formed on the n-$Cu_2O$ microcrystals, and the p-$Cu_2O$ crystals can be observed in the ~100 nm range. The X-ray diffractogram shows n-$Cu_2O$ and p-$Cu_2O$ variations clearly. The diffuse reflectance spectra of solid samples were recorded using Shimadzu 1800 UV spectrophotometer. For Mott-Schottky analysis, a NOVA Autolab was used with a three-electrode configuration having platinum (Pt) as a counter electrode, silver chloride/ silver (AgCl/Ag) as a reference electrode and ferrous sulphate ($FeSO_4$) with 0.025 M solution was used as the electrolyte. Therefore, with the results obtained, the study concluded that a p-n junction is formed on the Cu substrate.

$$Cu^{2+}{}_{(aq)} + Cu_{(s)} + H_2O_{(l)} \rightarrow Cu_2O_{(s)} + 2H^{+}{}_{(aq)}$$

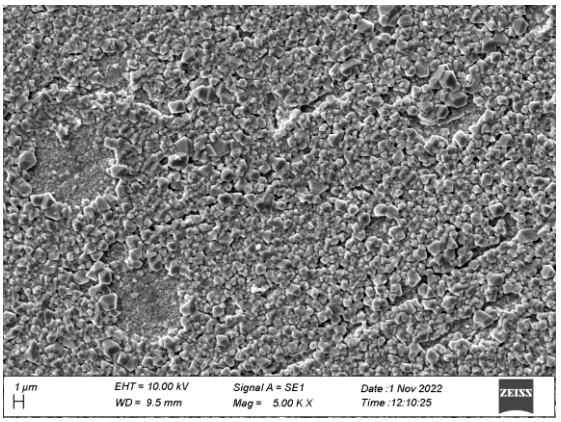


**Figure 1:** SEM Micrographs of Cu/n-$Cu_2O$/p-$Cu_2O$ Electrode

**Keywords:** Cuprous Oxide ($Cu_2O$), P-N Junction, Photoelectrode

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