Navigating the Future: Unveiling Tomorrow's Trends and Insights Through Innovative Research

Wayamba University Research Congress - 2023

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"Navigating the Future: Unveiling Tomorrow's Trends and Insights Through Innovative Research"

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Message from the Vice Chancellor
Wayamba University of Sri Lanka

I am pleased to write this message for the Proceedings of the 8th Wayamba University Research Congress (WURC) – 2023 coming under the theme of "Navigating the Future: Unveiling Tomorrow's Trends and Insights Through Innovative Research".

Beyond my 'formal' duty to promote and safeguard an outstanding culture of research in my university, I, at every time possible and within my capacity over the last couple of decades, tried my level best to develop such a culture by joining with the like-minded academic and administrative crowds within and outside of our university. I firmly believe that with such a collective and team-oriented effort only that we would be able to accomplish those esteemed levels with expanded frontiers of knowledge in new trends of research and innovation, which for sure pave a way for our young researchers and students to follow in their footsteps.

Hence this inclusive event – "Wayamba University Research Congress", will bring the researchers in various disciplines into one destination where they can collaboratively share their outcomes and learning from others; all will definitely aid in finding favorable solutions to the local, regional, and global issues we are facing today.

I really appreciate the untiring efforts of all who contributed to make the WURC into this scale, including the Chairman and Members of the Senate Research & Higher Degrees Committee and those attached to various Sub-Committees to look after the whole process until completion. Also, I take this opportunity to congratulate the scholars who have won the awards as the Most Outstanding Senior and Young Researchers and as the holders of Certificates of Merit.

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

Message from the Chairman
Senate Research & Higher Degrees Committee

Wayamba University Research Congress is the leading annual research event of the Wayamba University of Sri Lanka, designed to highlight and debate the research progress of postgraduate students, which is open to the university staff. Building on the success of the last seven congresses, this year's event once again highlights the postgraduate research conducted by the six faculties under the theme Navigating the Future: Unveiling Tomorrow's Trends and Insights through Innovative. The event will highlight faculty-level research awards, Wayamba University research awards for both junior and senior categories, as well as awards for publications in SCI journals. Recognizing the publications in SCI journals by postgraduate students is a new addition to the congress of 2023. This will further encourage postgraduate students to publish their findings in index journals. The Senate Committee oversees postgraduate research across various fields, including MPhil and PhD degrees. Despite all the challenges we have faced during the current economic crisis in the country, characterized by soaring inflation, our researchers have continued to engage in research as usual. This is evidenced by the high number of abstracts we have received this year.

The success of a conference of this nature depends on the support given by the Vice-Chancellor, the Senate Research and Higher Degrees Committee members and administrative and non-academic staff. I would like to specifically thank the Co-Chairs, Dr. R. Thotagamuge and Dr. (Mrs.) M.S.F. Sirasa, who took on the challenge of guiding the five sub-committees to work smoothly. I acknowledge the work of many academics and reviewers for their significant cooperation during the review process. At this juncture, I deliver a special thank you note to the authors whose technical contributions are presented in these proceedings. It is because of their excellent contributions and hard work that we have been able to prepare these proceedings. I offer my congratulations to those presenting their findings. On behalf of the Senate Research and Higher Degrees Committee, I firmly believe that your participation will add glamour to this historic occasion, and it is my pleasure to welcome you all to WURC 2023.

Prof. Kapila Yakandawala
Chairman, Senate Research & Higher Degrees Committee,
Wayamba University of Sri Lanka

Message from the Dean
Faculty of Agriculture & Plantation Management

I am delighted to be able to write this short message on the eighth occasion of the Wayamba University Research Congress. It is very important that universities carry out high quality research as research is the backbone of any developing society, and I am very happy that the Wayamba university is at the forefront in this aspect. Events such as this creates a path for the academics of the university to showcase their important research outcomes and obtain valuable feedback from peers. This has helped both academics and postgraduate students immensely in the past 7 occasions. 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 8th congress as well. As Dean of a Faculty, I am proud to see the research culture prosper in the university. 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.

Prof. Jagath Edirisinghe
Dean, Faculty of Agriculture & Plantation Management,
Wayamba University of Sri Lanka

Message from the Dean
Faculty of Applied Sciences

It is with great pleasure that I write this message to mark the Wayamba University Research Congress-2023 (WURC-2023), which is held for the eighth successful time this year. Scientific Research is the foundation for new knowledge. Greater emphasis has been placed on generation of new knowledge and innovations through research carried out at universities, dissemination of knowledge and its potential contribution to economic development of the country. Wayamba University has well recognized research as a priority and has been engaged in promoting research activities at the University through provision of financial assistance and other opportunities. 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. 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.

It is noteworthy that the best researchers at University level and at Faculty level are to be recognized at the Research Congress. This trend would lead to a sustainable research culture at Wayamba. WURC-2023 is a result of coordinated effort of the academic community and the university administration. I take this opportunity to thank the Vice-chancellor, the Chairman of Senate Research and Higher Degrees Committee, administrative officers and the co-chairs of WURC for their contribution towards the success of the event. I also appreciate the dedication and the effort of the researchers in producing high quality research output. The reviewers of the publications too deserve our appreciation for their contribution. 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.

Herewith I convey the best wishes of the Faculty to the presenters and to the award winners at WURC-2023.

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

Message from the Dean
Faculty of Business Studies & Finance

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.

Education is always a sign of learning and development. It should be research-oriented and helping society to create something new. Thinking in an innovative and searching new ways are significant to cope with the context of the present socio-economic challenges in Sri Lanka. The enhancing socio-economic challenges 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.

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

Message from the Dean
Faculty of Livestock, Fisheries & Nutrition

It is with great pleasure and anticipation that I convey this message to the Wayamba University Research Congress – 2023. Research Conferences serve as catalysts for innovation, transformation, and the exchange of scientific findings and research ideas that shape the future and future research. In addition, it brings together brilliant minds, visionaries, and thought leaders from diverse fields and backgrounds, each contributing their unique perspective to the collective pursuit of solutions to some of the most pressing challenges of our time. WURC-2023 theme, 'Navigating the Future: Unveiling Tomorrow's Trends and Insights Through Innovative Research', make a stage to discuss solutions for the challenges constantly evolving in a world and explore new horizons, foster interdisciplinary collaboration, and harness the power of our collective intellect to drive positive change.

Today, we will engage in a series of stimulating presentations and discussions, that will undoubtedly expand our knowledge and inspire us to think beyond conventional boundaries. I would like to express my heartfelt gratitude to our dedicated organizing committee, whose tireless efforts and commitment have made this conference possible. Their dedication to ensuring a seamless and enriching experience for all attendees is truly commendable. I would also like to extend my deepest appreciation to our presenters, who have graciously agreed to share their expertise and insights with us. Your contributions are invaluable, and we are honored to have you as part of this event. Scientists' presence here today is a testament to your commitment to lifelong learning and your dedication to making a difference, further, your active engagement in discussions, and networking with peers provides an opportunity to develop you personally and professionally.

I extend my warm wishes for a productive and enriching 8th Wayamba University Research Congress-2023 and may this conference be a source of inspiration, knowledge, and meaningful connections.

Senior Prof. (Mrs) Chamila Jayasinghe
Dean, Faculty of Livestock, Fisheries & Nutrition,
Wayamba University of Sri Lanka

Message from the Dean
Faculty of Medicine

I take this opportunity to express my best compliments to the 8th Wayamba University Research Congress – WURC 2023. I believe that WURC 2023 provides an excellent opportunity for the enthusiastic researchers including undergraduates, postgraduates and academic staff to present their research.

It is evident that research at Wayamba University of Sri Lanka has contributed in the fields of science, health, agriculture, technology, finance and industry to seek answers to the prevailing issues and make further developments. Researchers are benefited by this platform where they can share the knowledge of their original discoveries in front of a community of intellectuals.

I am pleased to state that the Faculty of Medicine, Wayamba University of Sri Lanka offers a top-notch learning environment for medical studies and research. This young medical faculty is dedicated to conducting influential research and upholding the highest standards of excellence around the world. Our faculty's research focuses on identifying and resolving significant health issues in our nation. By outlining novel research directions and encouraging the development of a positive research culture while fostering the next generation of young scientists, we hope to increase the scope of our collaborative and translational research areas. The Faculty of Medicine, Wayamba University of Sri Lanka has significantly increased its contribution to scientific research by submitting numerous research findings at WURC 2023. We take great pride in our expanding list of research initiatives, our publications, and the global influence we have had in each of our fields.

Research is the foundation of progress and innovation. It is through research that we gain new knowledge and insights that can help us solve some of the world's most pressing problems. I extend my best wishes for a successful conference, filled with interactive sessions and exchange of knowledge so that, together, we can look forward to a future of truly groundbreaking discoveries that will change the world for the better.

Dr. Sanjeewa Bowatte
Dean, Faculty of Medicine,
Wayamba University of Sri Lanka

Message from the Dean
Faculty of Technology

I extend my warmest greetings to each of you as we prepare to embark on the exciting journey of Wayamba University Research Congress (WURC) 2023. Under the timely theme, "Navigating the Future: Unveiling Tomorrow's Trends and Insights Through Innovative Research," we have a unique opportunity to reflect on the challenges and opportunities that lie ahead. While our discussions will undoubtedly be rich in innovative research ideas, it is imperative that we also acknowledge and address the pressing issue of Sri Lanka's ongoing financial crisis. As the Dean of the Faculty of Technology, I believe it is our collective responsibility to shed light on the situation and consider the impact it has on our academic community. The financial crisis that Sri Lanka is currently facing has sent ripples of uncertainty through various sectors, including higher education. The instability, inflation, and diminishing opportunities have forced many of our academics to consider leaving our country in search of a more secure future. This exodus of talent, the brain drain, poses a significant challenge to the continuity and growth of research and innovation within our nation. In light of these circumstances, WURC 2023 becomes even more critical. Our research and innovations are not just academic pursuits but the seeds of progress for Sri Lanka. We must use this platform to discuss and propose solutions that can help stabilize our academic environment and create opportunities for the future.

Let us collectively work towards preserving our academic community, ensuring a vibrant research landscape, and securing a brighter future for our students and generations to come. Also, I wish to convey my appreciation to the diligent organizing committee for their efforts in orchestrating this esteemed event, as well as to the presenter and all the awardees. Let us collectively steer through the uncharted challenges ahead with resilience, determination, and the transformative force of innovative research.

I look forward to fruitful deliberations at WURC 2023. Thank you.

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

Message from the Co-Chairs
8th Wayamba University Research Congress - 2023

Welcome to the 8th Wayamba University Research Congress 2023, a celebration of academic excellence and innovation, organised by the Senate Research & Higher Degrees Committee. With the theme, "Navigating the Future: Unveiling Tomorrow's Trends and Insights Through Innovative Research," this congress provides a platform for scholars, researchers, and innovators to showcase exciting work and collectively push the boundaries of knowledge.

Our journey towards this congress has been characterized by dedication, hard work, and a shared commitment to advancing the frontiers of research. As co-chairs, we are deeply honoured to witness the fruition of these efforts in an event that spotlights the finest minds in academia and research.

We extend our heartfelt congratulations to all the awardees, whose remarkable contributions have enriched our academic community. Your commitment to excellence serves as an inspiration and reinforces our dedication to nurturing a culture of research and innovation at Wayamba University of Sri Lanka.

We wish to express our heartfelt appreciation to those whose unwavering support has been pivotal to the resounding success of this congress. The Vice Chancellor's visionary leadership and unwavering commitment to research have been the driving force behind the transformation of our vision into a remarkable reality. The Chairmen of the SRHDC has tirelessly steered our efforts, moulding this congress into a prestigious academic gathering of profound significance. The Keynote Speaker's expertise and insights have left an indelible mark, setting the stage for the intellectual discourse that has defined this congress. We are equally grateful for the invaluable administrative expertise and support provided by the Registrar, Bursar, and Librarian, ensuring the seamless organization of this event. The dedication and behind-the-scenes contributions of all the organizing

subcommittees' lead and all subcommittee members deserve special recognition for their tireless efforts. Our profound thanks also go to the reviewers, the panel chairs, and the panel members who have diligently maintained the scientific integrity and balance of this congress. The dedication of our academic and administrative staff has been the bedrock of this congress, and to our postgraduate students, we extend our heartfelt appreciation for your enthusiasm and contributions as future leaders of research. Lastly, the collective efforts of the Entire University Staff have been indispensable in contributing to the overall success of this event, and we sincerely thank you for your unwavering commitment to the University's mission.

In the spirit of collaboration and the relentless pursuit of knowledge, let us unite to celebrate innovation, share insights, and collectively shape a brighter future. We are eagerly anticipating the stimulating discussions, knowledge sharing, and networking opportunities that this congress promises to deliver.

Once again, we extend our sincere thanks for your invaluable contributions, and we wish everyone a rewarding and enriching experience at the 8th WURC 2023.

Dr. Fathima Sirasa | Dr. Roshan Thotagamuge
Co-Chairs,
8th Wayamba University Research Congress - 2023

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Lifestyle Agriculture

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Empowering KPIs to Monitor and Evaluate the Performances of Research & Development in the Commercial Agriculture Sector

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Abstract

Commercial Agriculture (CA) plays a significant role in the process of economic growth of a nation, especially in the areas of food security, employment, and trade; yet, it has been faced with severe competition across the supply and value chains and is subjected to the threats of adverse and diverse policy set-ups. Inventions and innovations through Research and Development (R&D) are, therefore, inevitable to solve the key problems in productivity as well as other contemporary issues, including environmental degradation, resource scarcity, and changes to the demographics. To date it has been paid a little attention towards deepening the understanding of how an institution utilizes the Key Performance Indicators (KPI) in place, with an association of the relevant Critical Success Factors (CSFs), to improve research performance. There exists a significant gap in the literature, especially in the context of CA in Sri Lanka, as there is no comprehensive empirical research on the association of KPI and CSF carried out. This study sheds light on the use of such interventions in leveraging organizational research capability to produce 'commercializable' research that thrives on 'sensitivity' qualities such as corporate social responsibility and social awareness through heavy collaborations.

The process of collection and analysis of data was phased out into two phases to facilitate taking the full coverage of information and insights of research leaders. An in-depth review of the literature was carried out in Phase I to identify the major performance drivers of R&D on CA and the KPIs of research institutes. In Phase II, the administrators attached to research institutes working on CA (n=32) were contacted with a structured interview guide consisting of 15 probing questions. Analyses were then carried out in 3 stages that employed Thematic Analysis as well as the development of Theoretical Frameworks to reveal the Strengths, Weaknesses,

Opportunities, and Threats (SWOT) faced by the institution and to establish KPIs in Performance Measurement Systems (PMS). The Thematic Analysis performed on those perspectives was dissected into 5 Themes along with 12 Sub-Themes, 32 Categories, and 152 Codes to underscore the importance of context, policy attributes, enablers, and organizational benefits gained from a well-thought PMS consisting of carefully selected smart KPIs. Table 1 summarizes the code maps of collaboration and commercialization.

Table 1: Summary of code similarities through code cooccurences.

No.	Research Commercialization	Research Collaboration	Similarity
1	Research Value Preservation	Transparency of KPIs Availability of KPDs Government Contribution Farmers Contribution	Low
2	Market Identification		Medium
3	Research Value Communication		Low
4	Demand driven Research		Low
5	KPI on commercialization		Low

Based on those outputs derived, the framework in Figure 1 was proposed to depict the performance management of R&D systematically and explain the underlying analytical system based on selected KPI-KPD relationships.

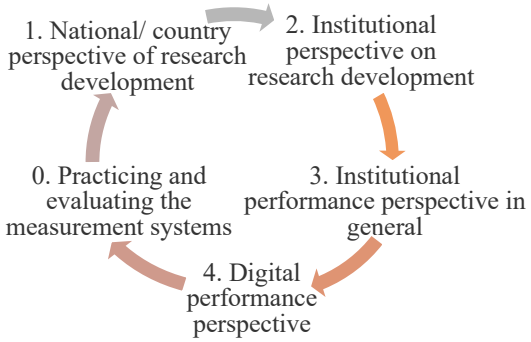

Figure 1: Perspectives of proposed performance measurement framework.

This was further extended to provide the basis for KPIs to work in real-time through the data-driven dynamism provided by digitally enabled PMS and to facilitate a future-proof agenda for research in the CA sector. The results from those analyses will be influential in setting an organization's vision and mission to be good-fit with the sectoral, commercial, and other key areas of importance at the level of national to make those "informed decisions" are well facilitated by concrete KPI-based data and information.

Keywords: Commercial Agriculture; Key Performance Indicators (KPI); Monitoring & Evaluation; Performance Management; Research and Development

Characterization of Arrowroot (*Maranta arundinacea*) Starch as a Promising Starch Source in Sri Lanka

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Abstract

Starch is one of the most commonly used components in the human diet, and its physicochemical properties play a significant role in determining its functionality in food applications. Arrowroot (*Maranta arundinacea*; Family: Marantacea), an underutilized tuber crop in Sri Lanka, shows promise as a starch source for the food industry. This study aims to evaluate the physicochemical, nutritional, and functional properties of arrowroot starch.

The arrowroot starch extraction was done by wet extraction method and the process involved blending cut arrowroot slices with water, followed by filtration and drying. The yield (%), proximate parameters named moisture content (%), total solid content (%), ash (%), crude protein (%), crude fat (%) and crude fiber (%) contents were measured according to Official Methods of Analysis (AOAC). Physicochemical and functional properties were measured such as colour attributes (L*, a*, b*) by colorimeter, granular morphology by light and electronic microscopes, viscosity (cP) by viscometer, flour density (g/ml), least gelation concentration (%), swelling power (g/g), amylose content (%) by spectrophotometer, total starch content (%) by acid hydrolysis method, solubility (%), moisture sorption capacity (%), DSC thermogram by Differential Scanning Calorimeter, X-ray diffraction analysis by X-ray diffractometer, and Fourier-transform infrared by FT-IR spectrophotometer were assessed. Parametric data of proximate analysis, physicochemical and functional properties evaluation were done by Analysis of Variance (ANOVA) using Minitab statistical software.

The arrowroot starch exhibited a lower yield than the values from previous studies, possibly due to the fibrous nature of the rhizomes. Granular morphology

examination revealed that oval, spherical, and irregular globular shaped starch granules were the most prominent. The length and width of the granules were 44.99±1.27 µm and 31.44±0.58 µm, respectively. The nutritional analysis showed that arrowroot starch had acceptable moisture (>15%), ash (1.12±0.13%), crude protein (0.72±0.02%), crude fat (0.26±0.19%), and crude fiber (1.00±0.09%) contents.

Table 1: Flour density, solubility, swelling power, viscosity, amylose content and total starch content of arrowroot starch.

Parameter	Value (Mean±SD)
Least Gelation Concentration (LGC) (%)	8.00±0.83
Bulk density (g/ml)	0.69±0.01
Tapped density (g/ml)	0.88±0.02
Carr's Index (%)	19.16±1.86
Hausner ratio	1.24±0.03
Viscosity (cP)	7660±2910
Swelling power (g/g)	11.22±2.32
Solubility (%)	12.47±1.62
Amylose content (%)	24.95±1.49
Total starch content (%)	66.00±0.48

Differential scanning calorimetry (DSC) analysis revealed the gelatinization temperature of arrowroot starch as 77.95 °C indicating the advantage of using arrowroot starch in the food industry due to low gelatinization temperature. Results of X-ray diffractometry revealed that arrowroot belongs to type A starch since it has two strong peaks around 17° and 18° in X-ray diffraction pattern. Fourier-transform infrared (FT-IR) analysis confirmed the polysaccharide nature of arrowroot starch and the resulting spectrum was identical to starch. The findings of this study provide valuable insights into the potential applications of arrowroot starch in the food industry. Its unique properties make it a viable alternative to wheat flour, with applications in various food products. The research contributes to the characterization of arrowroot starch and highlights its functional behaviour, nutritional value, and physicochemical properties. The findings are important for the development of innovative food applications and contribute to the advancement of the food industry in Sri Lanka.

Keywords: Arrowroot; Gelation Studies; *Maranta arundinacea*; Physicochemical Properties; Proximate Composition

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An analysis of Drought Incidences in the Coconut Plantations in the Intermediate Zone in Sri Lanka

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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 as the fourth, in terms of the contribution to the world coconut production and land extend under coconut. 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 soils with diverse moisture and nutrient regions in different agro-ecological zones. The annual national production of coconut is between 2500-3000 million nuts mainly depending on the climate condition. Among these productions, 70% is being consumed domestically, and the rest is used to produce coconut-based products. 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. Coconut yield depends on climatic and weather variables such as rainfall, temperature and relative humidity. Many studies have confirmed that the optimum weather conditions for the growth of coconut include a well-distributed annual rainfall of about 1500 mm, a mean air temperature of 27 ^{0}C and relative humidity of about 80%-90%.

This study was carried out to investigate the trends in meteorological drought incidence over selected coconut plantations and how these drought incidences affected coconut production in the Puttalam District, Sri Lanka. In this study, 14 coconut estates were considered, and GPS coordinates were taken by visiting those estates. Rainfall data were obtained for the study period, from 1983 to 2018, from the Department of Meteorology in Sri Lanka and predicted for the coconut estate locations by using the Kriging technique. 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. Analysis was done in different time sequences, and time duration from October to September was used as the hydrological year (SPI 12), and October to March and April to September were used as a 6-month time scale (SPI 6) 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 (SPI 3). Calculated SPI values were compared with the SPI classification values for the dryness (1 to -2)/ wetness (1 to +2) 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.

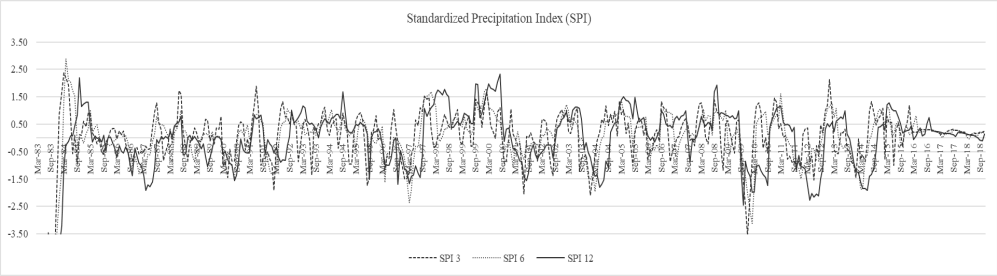

Figure 1: Temporal variation of the Standardized Precipitation Index.

According to the SPI3 and SPI6 values, moderate drought events had occurred in 1986/87, 1990, 1996, and 2001. Severe drought events had occurred in 1992, 1997, 2004 and 2013/2014. Extreme drought events were observed in 2004 and 2009/10. When considering the long-term time scale (SPI12), moderate drought events were observed in 1986, 1990, 1995 and 2001. Severe drought events were observed in 1987, 1997, 2004 and 2014. An extreme drought event occurred in 2009/10 and 2012. With these drought events, coconut production was compared in selected areas. After the drought events, coconut production had been reduced because of the 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].

Identifying Critical Constraints Prevailing in the Mushroom Cultivation and Marketing Process in Sri Lanka

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Abstract

Mushroom sector in Sri Lanka is still growing, with only a few value-added products available on the market. Mushroom exports accounted an average of 0.6 million tons and a value of US$ 1.7 million from 2016 to 2018. At present, mushrooming is a cottage industry with many bottlenecks. The study aims to identify the prevailing constraints in mushroom production and marketing among the primary producers and prioritize those to develop plausible strategies to strengthen the sector. The study adopted mixed methods (both qualitative and quantitative). Primary data was collected from August to December 2022 using a pre-tested structured questionnaire. Key informant interviews, focus group discussions and field observations were also conducted. The farm household that cultivates mushrooms was considered the basic unit for data collection. Accordingly, 100 small and medium scale mushroom growers were selected from Kurunegala (n=35), Kandy (n=25), Kegalle (n=20) and Colombo (n=20) districts using the multi-stage random sampling. Area selection and list of growers were selected with the aid of the expertise knowledge acquired from main institutions directly promoting mushroom industry. Information collected through all instruments was validated through triangulation. A five-point Likert (where, 1 is strongly disagree and 5 is strongly agree) scale was used to assess the constraints. Relative Important Index (RII) was used to prioritize the constraints identified.

Sourcing quality planting materials was the major production related constraint faced by primary producers (Table 1). Primary producers questioned the quality of the spawn that they obtained from the private commercial establishments. Producers were not sufficiently aware of certifications and standards. Limited knowledge on crop house establishment was identified as the second constraint. Improper housing results in high vulnerability to pest and disease attacks. Primary

producers were not aware of the ideal environmental conditions or techniques for establishing a standard crop house. Despite this, they used sparse materials to build the crop house, leading to unfavourable conditions for cultivation. Difficulty finding growing media continuously was identified as the third production related constraint.

Table 1: Ranking of critical constraints in the mushroom industry.

No	Constraint	RII	Rank
	Mushroom Production		
1	Acquiring quality planting materials	0.876	1
2	Sourcing quality growing media continuously	0.821	3
3	Limited knowledge on pest and diseases	0.765	6
4	Limited cultivation monitoring and extension	0.774	5
5	Limited awareness on new mushroom varieties	0.784	4
6	Limited knowledge on crop house establishment	0.845	2
	Mushroom Cultivation		
1	Poor knowledge on value-addition process	0.754	4
2	Poor knowledge on post-harvest handling	0.812	3
3	Less awareness about marketing channels	0.899	1
4	Poor linkage with the large-scale suppliers	0.852	2
5	Sudden demand and price variations	0.741	5

Less awareness about marketing channels was reported as the major marketing constraint (Table 1). Producers had a narrow understanding of the market and its environment, which limited their accessibility to the market channels. This also limits the value-added opportunities in the sector. The second major constraint was poor linkage with the large scale suppliers. Packets were sold directly to consumers as independent ventures, reducing the growth prospects of those initiatives. The large number of such homogenous products on the market resulted in less bargaining power for suppliers. The third constraint was poor knowledge of post-harvest handling of mushrooms. Producers usually practiced selling the harvest as quickly as possible since it cannot be stored or transported for more than 24 hours at ambient conditions. Producers were not aware of appropriate postharvest practices for storage and processing. Study focuses to construct an Entrepreneurial Behaviour Index (EBI) during the next tenure.

Keywords: Agribusiness; Constraints; Marketing; Mushroom; Relative Important Index

Impact of Environmental Awareness on the Probability of Adoption of Eco-friendly Agricultural Practices: A Case Study from the Vegetable Farmers in Kalpitiya

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Abstract

Overuse of fertilizers and agrochemicals in agricultural production has become a major concern in many parts of the world. Modern crop varieties are highly fertilizer-reliant, and despite the awareness of the destructive nature of modern agriculture, farmers tend to utilize an increasing amount of fertilizer. In terms of total fertilizer usage, Asia represents around 56% of the total global fertilizer usage. Out of the three major nutrients, Nitrogen is the most commonly used nutrient in agricultural production. Infiltration of Nitrogen into groundwater has become a major concern around the world. As a result, several researchers have focused on groundwater contamination caused by nitrogen leaching.

At present researchers are attempting to develop a variety of eco-friendly practices to limit Nitrogen usage. However, the majority of small farmers, particularly those in Asia, do not find these ecologically sound methods commercially viable. Therefore, regulation of farmer behaviour is of significance to address this issue. Environmental stewardship is a type of behaviour that is concerned with the appropriate use and protection of the natural environment. As a result, this study aimed to examine the effect of environmental awareness commonly on environmental stewardship, particularly in the Kalpitiya peninsula.

To acquire primary data in the Kalpitiya area, 800 vegetable growers were interviewed using a structured questionnaire. The vegetable farmers for this study

were selected using a two-stage sampling process. Environmental awareness was assessed using an index created from responses to a series of Likert-type statements, and it was linked to stewardship behaviour as measured by willingness to adopt eco-friendly agriculture practices (Table 1). Furthermore, human capital and the extent of cultivation were meant to characterize the intention of utilizing environmentally friendly practices. The environmental stewardship behaviour (Dependant variable) was accounted for using the question "If an eco-friendly practice is introduced, would you follow it?".

Table 1: Distribution of values of the Awareness Index.

Awareness Index Value	Frequency	Percent (%)	Cumulative Percent (%)
0.00< Awareness Index<=0.25	24	2.92	2.92
0.25< Awareness Index<=0.50	11	1.34	4.26
0.50< Awareness Index<=0.75	17	2.07	6.33
0.75< Awareness Index<=1.00	770	93.67	100.00

Using the variables, a probit model was estimated. The findings elicited that environmental awareness is closely associated with the adoption of environmentally friendly practices. The higher the value of the awareness index, the greater the likelihood of adopting environmental stewardship behaviour.

Apart from the awareness index, the human capital index, which is both positive and significant, plays a vital role in increasing environmental stewardship behaviour. The cultivation extent yielded a negative sign, showing that the adoption of environmentally friendly practices is low in the case of bigger cultivation extents. This could be related to farmers' perceptions of the cost involved in applying such practices over bigger regions of land. The findings significantly support the claim that the awareness of environmental damage is linked to the adaptability of environmentally friendly agricultural practices.

Further, the findings of this study provide insight into all areas where environmental stewardship behaviour is required and encouraged. Future research is recommended in this area, focusing on the moderating and mediating factors between awareness and behaviour.

Keywords: Environmental Awareness; Environmental Stewardship; Kalpitiya; Probit Model; Vegetable Farmers

Acknowledgement: This work was supported by the AHEAD DOR grant awarded to the Faculty of Agriculture and Plantation Management.

Morphological Diversity of *Nymphoides hydrophylla* (Lour.) Kuntze in Sri Lanka

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Abstract

Nymphoides hydrophylla ("Kumudu") is an underutilised native aquatic ornamental plant species in the local landscaping industry. However, the plant has the potential to promote sustainable landscapes. Therefore, this study was designed to evaluate the morphological diversity of *N. hydrophylla* in Sri Lanka, aiming to popularise this underutilised ornamental species in sustainable landscaping activities.

Four, five, and six different *N. hydrophylla* populations in natural aquatic habitats were explored from the wet (Hirugal Devalaya, Pansilgoda, Diyawannawa Athuru Ela, and Maakilangamuwa), dry (Maaminiyawa, Galkulama, Mahakalaththewa, Thariyankulama, and Ibbankatuwa), and intermediate (Imbulgodayagama, Rathmale, Atawarala, Karagaswewa, Moonamalegama, and Digana Mahawewa) zones of the country. Four individual plants from each population were investigated, and altogether, 60 plants were evaluated. The morphological diversity was assessed through measurements of leaf morphology (leaf length, leaf width, leaf area, leaf thickness, petiole length, petiole width, leaf fresh and dry weights, leaf abaxial and adaxial colour), stem morphology (number of stems, stem length, stem width, and stem colour), flower morphology (number of flower buds per node, flower diameter, stalk length, corolla lobe length, corolla lobe width, corolla tube length, and bract length), and fruit and seed morphology (fresh fruit weight, fruit length, fruit width, seed number per fruit, and seed diameter). The data were standardised to mean zero and a unit variance before the analysis. Complete linkage hierarchical cluster

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analysis and Principal Component Analysis (PCA) with correlation matrix were used to express the diversity of plant population.

There were no three distinct clusters observed to represent the three climate zones of the country. However, the dendrogram showed two distinct clusters at a linkage distance of 1.55. Plants from 12 populations were included in group 1. The second group consisted of three habitats (Pansilgoda, Maakilangamuwa, and Diyawannawa Athuru Ela) from the wet zone, confirming that *N. hydrophylla* from those three habitats were morphologically different from those in group 1. The PCA revealed that the eigenvalues greater than one (i.e., from the first seven principal components (PC)) accounted for 91% of the total morphological variation of the *N. hydrophylla* populations. Cumulatively, the first and second principal components explain approximately 50% of the total variation. The highest-loaded morphological traits to exhibit variation in PC1 were leaf length and leaf width. The fresh fruit weight was the major contributor to PC2. Moreover, the major morphological traits to express the variations in PC3, PC4, PC5, PC6, and PC7 were fruit length, number of seeds per fruit, leaf abaxial colour, stalk length, and the number of flower buds per node, respectively. Thus, the most important traits to explain the morphological diversity of the *N. hydrophylla* populations in Sri Lanka are leaf length, leaf width, leaf abaxial colour, stalk length, number of flower buds per node, fresh fruit weight, fruit length, and number of seeds per fruit. Moreover, many of these traits belong to reproductive morphological characters. Further, the majority of the evaluated *N. hydrophylla* populations were included under the group 1, irrespective of the climate zone. The present study demonstrates that the *N. hydrophylla* plants obtained from the habitats in group 1 could be used in sustainable landscaping activities in diverse climate zones of the country.

Keywords: Aquatic Ornamental Species; Ecological Diversity; Morphological Traits; Sustainable Landscapes

Meta-genomic Analysis of Bacteria in Imported Seed Potato to Sri Lanka

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Abstract

The plant microbiome play important roles in the health and productivity of crops by forming complex co-associations with plants. The metagenome studies have enlightened the understanding regarding the roles of individual taxa in modulating plant physiology, colonization and health. Seed potato (Solanum tuberosum) was identified as one of the most commonly intercepted agriculture commodities at the entry ports of Sri Lanka due to pest infestations. The analysis of potato microbiome was identified as important to understand it's association with the tuber health and to identify the biosecurity threats.

This study was conducted to identify the endophytic bacterial community in imported seed potato to Sri Lanka using a metagenomic approach. Metagenomic DNA extracted from the imported seed potato tubers was used for this analysis. The PCR amplified V3-V4 regions of 16S rDNA was sequenced using Illumina next generation sequencing platform. The resulting FASTQ files were submitted to the DADA2 online analysis pipeline for the detection of Amplicon Sequence Variants (ASVs).

The results revealed the diverse but taxonomically structured communities of bacteria associated with seed potato tubers. Identified bacteria were from the phyla Actinobacteria, Bacteroidetes, Firmicutes, Proteobacteria and Streptophyta (Figure 1). The microbial populations within the healthy tubers contained more than 90% of bacteria belonging to the Firmicutes phylum. The most abundant

classes were Actinobacteria, Bacilli and Negativicutes. Bacilli was frequently among the dominant taxa. It was detected that the microbial diversities within the healthy tissues were different from those in the unhealthy tubers. The most dominant bacterial population in visually unhealthy tubers was Proteobacteria. Bacteria belonging to Enterobacteriales, Pseudomonadales, Xanthomonadales, Acidiferrobacterales, Cellvibrionales orders under Gamma Proteobacteria were the highest in abundance. These results demonstrate the structure of seed potato microbiome and the microbiome differences associated with the physiological conditions.

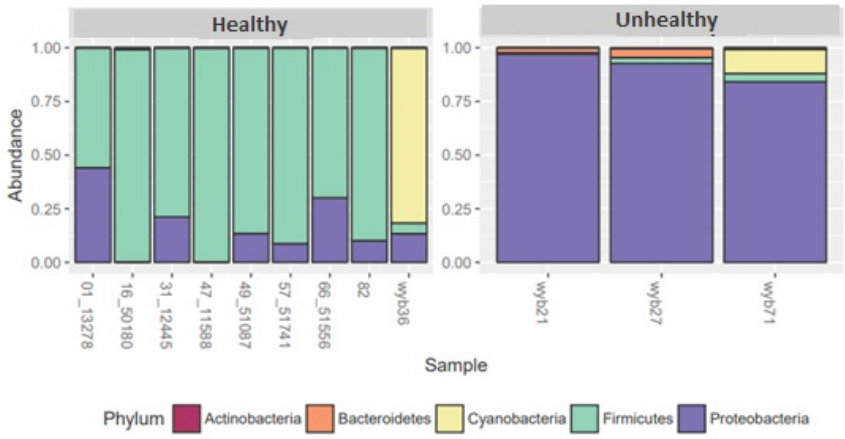

Figure 1: Overall relative abundance of microbial populations by phylum (mean abundance > 0.001).

Keywords: Metagenomics; Microbiome; Next Generation Sequencing; Seed Potato

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Biodiversity in Urban Residential Gardens: Exploring the Motivational Strategies to Enhance Gardening towards Biodiversity Conservation

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Abstract

A high proportion of urban green spaces comprise residential gardens, which harbour flora and fauna. Increasing attention must be paid to this component for the role it plays in conserving biodiversity in urban areas. Therefore, the present study attempted to assess the floral and faunal diversity of the residential gardens in Colombo and Gampaha districts, along with the perceptions on motivational drivers of urban residents on strategies to enhance gardening towards biodiversity enhancement. A total of 300 households were selected based on stratified random sampling from the two districts (n=150/district). A questionnaire survey was conducted, along with a garden survey for floral diversity, butterfly and avifaunal surveillance studies. The Chi-square test of association was used to identify the significant socio-economic drivers and the role played by perceptions. Species richness (SR) and Shannon-Weiner Index were calculated based on the floral and faunal counts observed in the studied residential gardens.

Regarding floral diversity, the Gampaha district denoted a higher species richness than Colombo. Within Gampaha district, Gampaha divisional secretariat reported the highest richness (SR=234), while Thimbirigasyaya divisional secretariat reported the highest richness (SR=196) in Colombo. In both districts, 88 plant families were recorded. In the Gampaha district, Shannon-wiener index was 3.16, while it was 2.88 for the Colombo district. According to the butterfly surveillance study, Gampaha district denoted the highest species richness (SR=26) compared to Colombo (SR=15). With regards to butterfly diversity, in Gampaha district the Shannon-wiener index was 2.85, while it was 2.04 in the Colombo district. Concerning the bird diversity, yet again, Gampaha district denoted the highest species richness (SR=33) compared to Colombo (SR=23). Meanwhile, the

Gampaha district reported a Shannon -wiener index value of 2.81, while a 2.69 was reported from the Colombo district.

Even though, residential gardens provide space for flora and facilitate the conservation of small wildlife, a lack of knowledge among the residents was noted as the main barrier. Since residential gardens integrate conservation into people's everyday lives, recognizing conservation as a social and people centred approach would be highly effective. Different methods could be adopted to motivate people towards gardening for biodiversity enhancement in urban settings. The majority of respondents in both districts strongly agreed with the fact that government rules/policies can influence gardening towards biodiversity conservation in urban landscapes (Mean Score [MS] =4.89 in Gampaha district, and MS =4.25 in Colombo district). Taxes are types of policy instruments aimed at raising domestic investments that can be used to promote the development of a sustainable city. However, the majority of respondents in both districts strongly opposed the imposing of a taxation process related to enhancing conservation practices (Colombo district 60%, Gampaha district 55%). Implementation of a rewarding system was ranked as the second-best motivational mode (MS= 3.95) in place of gardening for biodiversity enhancement in Gampaha district, while the provision of incentives (MS=3.75) was ranked second in the Colombo district. Respondents in both districts did not have a strong agreement about the success of implementing community projects.

According to the Chi-square test of association, age, education level, employment and income were significantly associated ($p<0.05$) with the attitudes on biodiversity enhancement in the Gampaha district. Subsequently, in the Colombo district, attitudes were significantly correlated ($p<0.05$) with age, education level and number of years at the residence. The outcomes provide the antecedents of the motivational factors of urban residents towards the enhancement of biodiversity. This behavioural information with the related quantitative assessment of biodiversity could increase awareness and facilitate the community to make sensible and socially-inclusive choices in implementing urban biodiversity conservation strategies in residential landscapes.

Keywords: Biodiversity Conservation; Residential Gardens; Socio-Demographic Factors; Urban Gardens; Sri Lanka

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Morphometric Investigation Reveals New Species in the Genus *Lagenandra* in Sri Lanka

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Abstract

The genus *Lagenandra* is an aquatic plant genus known for its ornamental value in the aquarium industry around the world. During the present taxonomic revision in Sri Lanka (2018 onwards) of the genus, upto-date, four new species with two varieties have been recognized. Insights on novel species in Sri Lanka plays a crucial role in biodiversity conservation. These insights can help stake holders understand the unique ecological roles and potential threats these new species might pose, allowing for more effective conservation strategies to be developed and implemented.

Continuing field explorations have encountered populations with new characters which required further studies. Hence, the aim of this current study was to assess the distinction between these populations using morphometric analysis. Field work was carried out during the period 2020-2023, focusing the wet zone of the country, in the locations where the new populations were encountered. The plant specimens were studied in detail, and morphological characters, both vegetative and reproductive, were coded into a data set, together with the other *Lagenandra* species. At least three mature individuals were coded from a population. The data set was subjected to a multivariate analysis using Past software (version 2.15). Hierarchical Cluster Analysis was carried-out with the data collected from 194 populations employing 89 qualitative and quantitative characters (leaves, cataphylls, spathes etc). The consequently recovered major clusters were identified.

The Hierarchical Cluster Analysis resulted in 17 phenetic groups, of which 12 phenetic groups corresponded to already described species; *L. bogneri* de Wit, *L. erosa* de Wit, *L. jacobsenii* de Wit, *L. koenigii* (Schott) Thw., *L. lancifolia* (Schott) Thw., *L. ovata* (L.) Thwaites, *L. praetermissa* de Wit and *L. thwaitesii* Engler while four corresponded to new species with two varieties; *L. wayambae* Madola, K.

Yakandawala, D. Yakandawala & Karunaratne, *L. kalugalensis* Madola, D. Yakandawala & K. Yakandawala, *L. srilankalensis* Madola, D. Yakandawala & K. Yakandawala *Lagenandra peradeniyae* var. *peradeniyae* K. Yakandawala Madola, D. Yakandawala & K. Yakandawala and *Lagenandra peradeniyae* var. *speciosa* Madola, D. Yakandawala & K. Yakandawala. The other five phenetic groups corresponded to the populations with morphological characters that have not been described as species before. One phenetic group possessing a slightly opened limb, a unique character, was recognized as a new species and named as *Lagenandra limbusleviterapertae* Madola, D. Yakandawala & K. Yakandawala. Of the other four phenetic groups, two groups required further field observations to describe them as new taxa. The other two phenetic groups were a combination of morphological characters with *L. koenigii*, once again calling for further studies, using molecular data.

The most contributing characters for the grouping based on the SIMPER analysis were the length of the petiole followed by leaf length and cataphylls length. The currently available taxonomic keys for field identification of *Lagenandra* are based on the spathe characters. However, as all the species exhibit seasonal flowering, it stands as a barrier in the field and in exit points of the country during the non-flowering times. Therefore, these identified vegetative characters would be important to modify the present keys facilitating the identification of non-flowering specimens. The study has added a new endemic member to the genus *Lagenandra*, uplifting the number of species from 13 to 14 in Sri Lanka and to 21 in the world, enhancing the biodiversity richness.

Keywords: Aquatic Ornamental; Biodiversity; Conservation; Multivariate Analysis

Acknowledgment: This work was supported by the Peradeniya University [Grant Number: URG/2022/57/S]; National Herbarium, Peradeniya and other online herbaria; Forest Department of Sri Lanka; Department of Wild Life Conservation and Wildlife Conservation Society-Galle.

Perceptions of Coconut Growers on the Impacts of Climate Change on the Performance of Coconut Industry

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Abstract

Climate change is recognized as one of the key challenges facing the coconut industry in Sri Lanka that possesses the potential of generating critical impacts on the production and productivity, and in turn, on the livelihoods of the people connected with this industry. Coconut (*Cocos nucifera* L.) is considered as the most widely grown commercially important perennial plantation crop in Sri Lanka. It spreads over 400,000 ha of land area in all administrative districts of the country except those at the elevations beyond 750 m above Mean Sea Level. Coconut performs well under a Mean Annual Temperature between 27 and 29 ^{0}C and Mean Annual Rainfall of 1250 – 2500 mm/year. Therefore, changes in monsoon rainfall patterns and increase in maximum air temperature are two key factors that influence the variability of coconut production in major coconut growing areas. Several studies have identified rainfall, evapotranspiration, temperature, solar radiation, sunshine hours, relative humidity and wind velocity as the major variables that influence the coconut yield.

The key stakeholders governing this industry are seemingly knowledgeable on the trends pertaining with the parameters of climate change. Yet, the behaviour of, and inventive strategies on, adaptation by the more vulnerable target group of coconut growers' perceptions on climate change impacts were not well explored. Minimizing the impacts of climate change, requires perception and adaptation. With that, growers' ability to perceive climate change is a key precondition for their choice of adaptation.

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To fill this gap in literature, this study was conducted to investigate such phenomena with a sample of 400 coconut growing households, selected using the stratified random sampling technique, covering three major districts belonging to the coconut triangle, *i.e.* Kurunegala [N=160], Puttalam [N=140] and Gampaha [N=100]. Head of the household and the spouse were subjected to an in-person interview with the aid of a structured questionnaire, which comprised of statements formulated in the form of "attitudinal statements" to explore those phenomena on a *10-point Likert-scale*. The data derived were then subjected to descriptive statistical methods, including estimation of percentages, ratios and means, using the Statistical Package for Social Sciences [SPSS (*Version 23*)].

The results derived from analysis suggested that the coconut growers perceptions on the individual criteria in concern varied in terms of the geography (district) and socio-economic characteristics of the household, especially during the last 5 to 10 year period and more specifically in the dry periods in their estates relevant to Kurunegala, Gampaha and Puttalam districts, respectively, with percentages: "Decline in coconut yield" (75,81,74); "Yellowing and drooping of more number of coconut fronds" (78,84,74); "Wilting and drying of more number of coconut fronds" (76,83,71); "Inflorescence abortion" (55,74,38); "Falling of more number of button nuts" (79,84,73); "Death of more number of palms" (48,66,26); "Lowering of the ground water level" (73,81,72); "Changing fertilizer type into an organic" (61,72,63), and "Increase of pest and disease infestations" (72,82,69).

The outcome of analysis revealed that the majority of coconut growers from all three districts had more than 70 percent perception level on the factors in concern. This signals the fact that those facilitative and regulatory authorities in action on this industry must now come into a single platform supported by a policy framework with a common agenda to minimize those "already visible" and "with potential" effects of climate change and to sort of the most fitting mechanisms of adaptation and mitigation to guarantee the best short to long-term solutions.

Keywords: Adaptation; Climate Change; Coconut Industry; Coconut Growers; Perceptions

Influence of Health Claims on Consumer Preferences Towards a New Herbal Tea Product

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Abstract

Nutrition and health concerns are becoming increasingly important when consumers make food purchasing decisions. In response to these concerns, with the recent developments in the food industry, many new food products enter the market claiming health benefits and reduced risk of diseases. Among beverages, tea is considered the second-most widely consumed beverage worldwide after water. At present, a large number of differentiated tea products can be seen in the market.

The aim of this research study is to evaluate the consumer preferences and purchase intent for a new herbal tea made from gotukola (Centella asiatica), curry leaves (Murraya koeinigil) blue butterfly pea flowers (Clitoria ternatea), cinnamon (Cinnamomum verum), and ginger (Zingiber officinale) mainly focusing on antioxidant and antidiabetic properties. The study examines various attributes and factors that can influence the purchase of the new herbal tea. Survey captured the influence of health consciousness, price, overall appearance, taste, nutritional value and antioxidant activity of the product on purchase intent.

A Discrete Choice Experiment was employed to analyse the consumer preference for the herbal tea. Data were collected from n=350 supermarket consumers covering North Western, Southern and Western provinces. A pilot study was carried out with a sample of twenty respondents to validate the questionnaire and choice cards. The questionnaire was designed covering sociodemographic aspects, purchase intent, behaviour and consumer preferences. A Conditional Logit model was employed to estimate the preferences. The participants made a discrete choice from a set of presented alternatives which contained a number of attributes with different levels, combined within choice sets. In this application, participants were asked to

select between four options in each choice task: price, health benefits (antioxidant and antidiabetic properties, slogan and flavour and colour. A Health-Related Index (HRI) and a Taste-Related Index (TRI) were calculated to capture the health and nutrition related aspects. A Confirmatory Factor Analysis (CFA) was performed to quantify the latent factors by testing validity of statements related to health and taste of the product.

Results indicate that 60.8% of respondents would probably buy the new herbal tea product. Age, nutritional content, overall appearance, antioxidant activity and Health Relative Index showed a significant positive impact on the purchase intent while Taste Relative Index, price and income did not influence the purchase intent of herbal tea ($p<5\%$). Nutrition and health claims regarding health benefits from antioxidant and antidiabetic properties showed a strong positive influence on purchase intent. Consumers' higher willingness to pay for the herbal tea could be attributed to the food-health relationship leading to disease risk reduction. Moreover, nutrition claims on the label and use of natural ingredients showed were key consumer concerns while advertising had a significantly lower influence on purchasing behaviour.

Introducing new healthier food options to the market is crucial to cater to the consumer demand. Before launching a new product to the market, producers must consider the consumer preferences and demographic factors. Consumer preferences and purchase intentions widely vary among consumer groups. Therefore, results can be used to determine the target market for herbal and similar products. It is evident that respondents have a stronger preference for health statements and implied benefits that result from consuming a functional beverage. The findings therefore are important in informing both pricing strategies promoting functional beverages.

Keywords: Butterfly Pea Flower; Discrete Choice Experiment; Health Claims, Herbal Tea

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Food Innovations, Nutrition & Health

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The Current State of Food Literacy Education in Sri Lankan Secondary Schools: An In-depth Analysis

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Abstract

School food literacy education is a key strategy that establishes capabilities in students to manage modern complex food system. School food environment is also important to promote healthy food behaviours. Food literacy education in Sri Lankan secondary schools is delivered through integrated subjects: Home Economics, Health and Physical Education, Agriculture, Food Technology, and Science. However, no systematic evaluation has been conducted to assess the effectiveness of the delivery of food literacy education (from grades 6 to 11). This research aims to investigate the current state of secondary school food literacy education in terms of curricula, teaching-learning process, and school food environment.

The first part of this research was an expert study in which food and nutrition experts (n=17) were interviewed to identify the important components of food literacy education. Likert scales with food literacy sub-components extracted from the literature were used in data collection. The Fuzzy Delphi method was used to determine consensus among experts' opinions. Next, learning outcomes extracted from teachers' guides related to subjects that contain food literacy lessons were mapped against the sub-component list to examine the scope of the current curriculum. Then a qualitative study was conducted to examine the opinions of various stakeholders (students, teachers, parents, principals, education administrators, food and nutrition experts and canteen holders) regarding food

literacy education and school food environment. Focus group discussions and key informant interviews were carried out in six provinces (Northern, Southern, Western, Eastern, North-Western, and Central) in Sri Lanka. A maximum variation sampling technique was used to recruit participants. All discussions and interviews were recorded, transcribed and translated into English. Data analysis was done using Nvivo 14 software employing the thematic analysis method.

The results identified Thirty-four sub-components covering three components; (1) food system from farm to plate (n=12), (2) food, nutrition and health (n=9), and (3) broad context of the food system including social, economic, cultural, and environmental and political aspects of food (n=13) as important components for food literacy education by the experts. The curriculum mapping revealed that most of the sub-components (n=30) except emotional influence in food consumption, the world food problem, deforestation, and greenhouse gas emissions were already included in the school curricula. All stakeholders agreed on the importance of food literacy education in schools. However, they pointed out insufficient practical components in the school, lack of application of knowledge in daily life and insufficient activity-based learning to improve food skills as limitations. Teachers were identified as role models for healthy food behaviour, and the principal's contribution was appreciated. Uneven distribution and limited resources among schools, undervaluing of food literacy-related subjects, and inadequate professional development for teachers to update knowledge were identified as main obstacles to food literacy education. Despite the fact that professional development opportunities and teaching-learning materials were limited, the teachers were confident in teaching.

In conclusion, current school food literacy curricula include most of the important components but are deficient in skill development. Lack of food literacy training for the teachers and unsupportive school food environment, where less activity-based learning is conducted are the obstacles to having effective food literacy education in secondary schools in Sri Lanka.

Keywords: Curriculum; Food Literacy Education; Secondary Schools; Stakeholders; Qualitative Studies

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Dietary Fat Intake Significantly Alters Body Fat Composition and Insulin Sensitivity in Healthy Adults: Findings from Coco_Heart Sri Lankan Cross Sectional Study

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Abstract

The associations of visceral adiposity and insulin resistance with cardio vascular disease (CVD) risk markers have long been recognised. However, the impact of different dietary constituents, more importantly the dietary fatty acids on visceral adiposity and insulin resistance are still unclear. The present study aimed to determine the impact of dietary fat on visceral adiposity and insulin resistance and changes with different fat intake levels. In the Coco_Heart-Sri Lankan cross sectional study, 401 healthy adults (243 males and 158 females; mean±SD age 43±8 years) had measurements of body weight (BW), body mass index (BMI) and body fat composition including visceral adiposity, total body fat mass and % body fat mass (%TBF) using a multi-frequency segmental body composition analyser. The height and waist circumferences (WC) were also measured using standard techniques. A fasting blood sample was collected to determine blood glucose levels and insulin resistance markers (serum insulin levels and homeostatistic model for insulin resistance (HOMA–IR). The fasting glucose levels were analysed using a fully automated biochemistry analyser. The serum insulin concentration was analysed using ELISA kits (DRG Instruments GmbH, Germany) and HOMA-IR was calculated by using a standard equation. Dietary intake was assessed using a 3-day diet diary (including two-week days and one weekend day) and dietary fatty acids intake was assessed via FoodBase 2000 software modified for Sri Lankan dishes. A general linear model (ANCOVA) was performed to assess the impact of higher total fat intake on insulin resistance and body fat composition by stratifying the study cohort according to the level of total fat intake after adjusting for age and gender. Spearman linear regression model was used to identify the degree of variability of body composition markers

and insulin resistance associated with different type of dietary fatty acids. Mean±SD of BW, BMI, WC, body fat mass, %TBF and visceral adiposity were 64.1±12.1 kg, 24.2±4.3kgm^{-2}, 86.0±10.0 cm, 18.2± 6.9kg, 28.2±8.0%, 8.9±3.8, respectively. Serum glucose, insulin and HOMA–IR index were 4.83 (4.4-5.3) mmol/L, 8.87 (6.76-12.77) µIu/mL, 1.9 (1.4-2.7). Total fat (TF), saturated, poly unsaturated, and monounsaturated fatty acid intakes as percentage of total energy (±SD or interquartile range) were 24.9% (±5.4%), 16.3% (±3.9%), 1.3% (1.0-1.6%) 2.8% (2.2-3.5 %) and trans fatty acid intake was 0.04 (0.0-0.15) g/day, respectively. Study participants with higher level of total fat intake (Q4) depicted significantly higher BW (P<0.001), BMI (P=0.028), WC (P=0.009), %TBF (P=0.001), visceral fat level (P=0.002), fat mass (P=0.000) and serum insulin level (P=0.003) compared to low fat intake groups (Q1, Q2 and Q3) while HOMA IR (P=0.004) was also greater in Q4 group compared to group with lowest fat intake (Q1). Percentage total fat intake and saturated fatty acid (SFA) intake had weak positive correlation with BW (r=0.24-0.25), %TBF (r=0.20-0.22) and fat mass (r=0.25) in males and females. Serum insulin (r=0.17-0.23) and HOMA IR (r=0.17-0.24) index of females and BMI (r=0.14-0.17) and WC(r=0.16-0.17) of males also depicted weak positive correlation with both %TF and %SFA. In conclusion, higher total fat intake is attributable to greater visceral adiposity and insulin resistance. Thus, reduction of total fat intake particularly the SFA intake may have favourable outcomes in terms of visceral adiposity and insulin resistance.

Keywords: Visceral Adiposity; Insulin Resistance; Gender; Total Fat; Saturated Fatty Acid

A favourable ethical opinion for the conduct of this study was given by the Ethics Review Committee of Sri Lanka Medical Association (ERC 20-011).

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

Comparison of Lipid Yields Extracted from Four Microalgae Species

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Abstract

Recently, microalgae have gained considerable attention worldwide due to their extensive application potential in the nutraceutical, aquaculture, biofuel and biopharmaceutical industries. They are considered as a vital source of lipids, long-chain polyunsaturated fatty acids, chlorophyll, phycobiliproteins, enzymes, starch, cellulose, antioxidants, and other active metabolites. Moreover, microalgae possess more advantages over traditional long-chain polyunsaturated fatty acids sources. Although globally microalgae have been extensively studied as an alternative source of lipids and essential fatty acids for humans and aquaculture, limited studies are available on microalgal species in Sri Lankan waters. Thus, present study aimed to evaluate the lipid content of four microalgal species used in the Sri Lankan aquaculture industry, as a baseline for the investigation of the potential of Sri Lankan microalgae as a source of omega-3 fatty acid nutraceuticals.

Pure cultures of *Thalassiosira pseudonana* and *Chaetoceros calcitrans* microalgae were obtained from a shrimp hatchery and *Nanochloropsis oculata* and *Chlorella vulgaris* were obtained from the National Aquaculture Development Authority, Baththuluoya. For biomass collection, microalgae were centrifuged at 4000 rpm for 20 minutes and the harvested microalgae were dried in a hot air oven at 60 ^{0}C for 24 h until constant weight was achieved. Dried microalgae samples were subjected to cell lysis using a microwave with an operational frequency of 2450 MHz at 100 ^{0}C for 2 minutes. Then the lipid extraction of harvested microalgae samples was performed following the Bligh and Dyer (1959) method and the lipid contents of the analysed samples were calculated.

The lipid content of *Thalassiosira pseudonana*, *Chaetoceros calcitrans*, *Nanochloropsis oculata*, and *Chlorella vulgaris* was recorded as 12.2±0.8%, 12.5±0.5 %, 18.6±0.2%, and 16.5±0.4% respectively, indicating the highest lipid content in *Nanochloropsis oculata* followed by *Chlorella vulgaris*. Lipid extraction from microalgal biomass can be accomplished using various mechanical or chemical approaches. However, economic viability and eco-friendliness are also vital in selecting an extraction method. Therefore, present study will be extended further to optimize the most efficient and cost-effective method for extraction of lipid from the selected algal species and to evaluate the fatty acid profiles to determine the potential of these species as a source of omega-3 fatty acid nutraceuticals.

Keywords: Lipid; Fatty Acids; Microalgae; Nutraceutical; Extraction

Development of a Nano-Emulsified Chitosan Edible Food Film from the Whiteleg Shrimp *(Litopenaeus vannamei)* Shell Waste

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Abstract

Currently, the majority of packaging materials used in the food industry are produced from petrochemical polymers. However, those materials are practically non-biodegradable, which causes a negative effect on the environment. Therefore, the present study introduces a nutritionally enriched environmental friendly edible material to be used in packaging made out of from the whiteleg shrimp *(Litopenaeus vannamei)* waste which meanwhile provides an ideal solution for the waste accumulation issue in shellfish industry.

Initially the required raw whiteleg shrimp shells were collected from a shellfish processing plant in Dankotuwa area. Then chitosan with 80.22 % of degree of deacetylation, 57.89 ± 2.89 % of solubility and apparent viscosity of 554.83 ± 1.04 was successfully extracted from whiteleg shrimp waste according to the modified simple method described in Liyanage et al., 2023. Extracted chitosan was solubilised in 10% vinegar as it is well-known for its health benefits related to digestion, blood sugar control, and fighting infection. Later the film forming solution was enriched with 3% vitamin E nano- emulsion (Particle size- 99.497 nm ± 0.983) in order to improve the health benefits and antioxidant abilities of the edible film. Film forming solution was then casted on a silicon plate and dried at 40°C, 24 hours to prepare the nano- emulsified edible film. Prepared novel edible film was then characterised to measure its thickness, solubility, transparency, UV light barrier properties, mechanical properties (tensile strength & elongation at break), thermal properties and antioxidant properties.

Prepared nano edible films made with chitosan had a thickness value lower than 0.1 mm (0.052 ± 0.0017 mm). As the films were contained a negligible moisture content (0.08% ± 0.05) those prepared films were able to successfully store approx. 03 months without deterioration by keeping inside a desiccator. According to the characterisation of mechanical properties of the film, it was identified that the tensile strength of the film was 11.60 ± 0.2646 MPa and Elongation% of 4.6133 ± 1.1648 which is fairly acceptable for an edible film. Further the prepared film did not swell (Swelling %- 0.03 ± 0.03) in the presence of water. Thermal stability of the prepared film was around 209.23°C as per the results taken from thermal Thermogravimetric analysis. The film shows excellent UV screening ability without sacrificing its transparency which is desirable to prevent UV light driven lipid oxidation, discoloration of the packed food and leading to loss of nutrients. Further, it was reported 60.59% ± 0.88 of antioxidant activity value from the DPPH free radical scavenging assay which will prolong the shelf life of wrapped foods by retarding the rate of oxidation reactions experienced by food components. Considering all these properties, this edible nano film can be suggested to use as an active biodegradable film for wrapping fatty foods (Meat/ Nuggets/ Burgers) which is often susceptible for oxidation or making sachet packets in instant noodles that contains oily flavouring ingredients as it will be convenient and nutritionally beneficial for the consumers when consuming these products.

Keywords: Chitosan; Edible Film; Nano Emulsion; Shell Waste; Vitamin E

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Formulation of Millet and Rhizome Flour Incorporated Noodle and Evaluation of their Functional Properties Using *In-Vitro* Assays and Human Clinical Trial

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Abstract

Poor dietary habits directly contribute to the development of metabolic syndrome (MetS) that defined as a cluster of risk factors that can cause several non-communicable diseases such as type II diabetes mellitus and cardiovascular diseases. Functional foods have shown to prevent and control MetS. The aim of this study was to evaluate the functionality of a formulated noodle containing three millets (*Panicum milaceum, Paspalum scrobiculatum, Setaria italica*) and two rhizomes (*Lasia spinosa, Nelumbo nucifera*) flours on reducing the risk of MetS.

Selected underutilized cereals, yams and rhizomes were screened based on their physicochemical and functional properties. *Panicum milaceum, Paspalum scrobiculatum, Setaria italica, Lasia spinosa* and *Nelumbo nucifera* were selected for functional food development and further analysis. Noodle was prepared as one of the functional food products incorporating 40% of millet and rhizome flour mixture with 60% of wheat flour. Formulated product was analyzed for nutritional, functional and sensorial properties and cell culture assay was conducted to determine the cytotoxicity of the formulated product. Human clinical trial was conducted to assess the functionality of the product in reducing the risk of MetS clinically. The inclusion criteria for clinical trial study were over-weight and obese, men and women between the ages of 20 to 60 years-old. Intervention period was 12 weeks and the number of subjects was 09 per each group. Blood sample collection and anthropometric data collection were performed at baseline (1st day) and on the 1st days of weeks 6 and 12. Blood pressure, height, body weight, waist and hip circumferences and body composition data were collected as anthropometric data and blood glucose, HbA1C, plasma insulin, liver function tests and lipid profile were

analyzed as biochemical parameters. All data were statistically analyzed and the level of significance was set at $p \leq 0.05$.

This formulated noodle contained a higher level of dietary fiber and resistant starch content with a lower level of starch content that could lead to its proven anti-diabetic activity and there was no cytotoxicity in the product. According to the results obtained from clinical study, participants who consumed millet and rhizome flour incorporated noodle experienced a significant ($p<0.05$) reduction in weight, waist circumference and BMI over the 12 weeks intervention period. The average weight loss was 1.6 kg, the average waist circumference loss was 7.4 cm and the average BMI reduction was 0.7 kg/m^2. These findings are promising, as they suggest that the intervention had a positive impact on body weight and body composition. Reductions in weight, waist circumference and BMI are generally associated with improved insulin sensitivity. Insulin resistance is a key factor in the development of type II diabetes, and interventions that lead to weight loss and improved body composition can help alleviate insulin resistance and reduce the risk of diabetes. According to the studied biochemical parameters, the study found that the control group had a significant elevation in serum glutamic-pyruvic transaminase (SGPT) enzyme levels, with an average increase of 10.60 IU/L over the 12 weeks. In contrast, the intervention group, who consumed millet and rhizome flour incorporated noodle, had a much smaller elevation in SGPT levels, with an average increase of only 0.17 IU/L. This result suggests that the intervention may have a protective effect on the liver, as evidenced by the minimal increase in SGPT levels in the intervention group compared to the control group.

Overall, the findings of this study showed incorporation of millet and rhizome flours to formulate noodle could increase the dietary fiber and resistant starch content while decreasing starch content. Thus, it showed anti-diabetic properties by inhibiting starch hydrolyzing enzymes. Findings of human clinical trial are relevant to insulin resistance as they indicate positive changes in weight, BMI, and waist circumference, which are associated with improved insulin sensitivity. Additionally, the potential protective effect on the liver could further contribute to better metabolic health. However, it is important to note that this is a short-term intervention study, and the long-term effects and sustainability of these changes need further investigation.

Keywords: Clinical Trial; Diabetes Mellitus; Functional Food; Insulin Resistance

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Evaluating the Efficacy of Legume-based Instant Soup Mix for Obesity-Related Disorders Using *In-Vitro* Bio Assays and Human Clinical Trials

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Abstract

The effect of functional food especially legume-based products designed for obesity on humans has not been assessed and popularized in Sri Lanka. This research study could be the key to raise awareness in Sri Lankan community about functional diet treating obesity and related disorders. The current study focuses on the efficacy of novel legume-based instant soup mix incorporated with under-utilized legumes available in Sri Lanka: *Mucuna pruriens* and *Canavalia gladiata*, in terms of anti-diabetic, anti-obesity and anti-hypertensive properties using in-vitro bio assays and evaluating obese human subjects on their blood biomarkers and anthropometric measurements over a period of 12 weeks. Anthropometric measurements and blood samples were obtained from 20 subjects during three clinical visits (week 0-baseline, week 6-mid and 12-post intervention) including the initial screening. The 20 subjects who met the study criteria were randomly divided into two groups (n=10 each) and given either legume soup (30 g/ day) or a placebo (30 g/ day).

Both *in-vitro* alpha glucosidase and alpha amylase inhibitory activities of the legume-based instant soup mix were 0.52 and 0.08 mg Acarbose equivalent per g dry weight, respectively. *In-vitro* pancreatic lipase inhibitory activity was 14.39 mg Orlistat equivalent and Angiotensin Converting enzyme inhibitory activity was 2.15 mg Captopril equivalent, per g dry weight of the legume-based instant soup mix. There was no significant reduction in weights (average of 0.61 kg & 0.99 kg) of both group of participants, control and those who consumed legume-based soup for 12 weeks, respectively. A significant reduction in BMI (average of 0.2 kg/m^2 & 0.4 kg/m^2) was not seen in both groups. However, there was a significant reduction in

waist circumference (average of 5.6 cm) (p=0.03) of the participants in the treatment group, whereas, the control group of participants did not exhibit a significant reduction in waist circumference (average = 1.11 cm). Waist circumference of participants is an indicator of abdominal obesity which is associated with insulin resistance and increased risk of developing type-2 diabetes. Reduction in waist circumference of participants in the treatment group showed that the intervention had a beneficial effect on reducing abdominal fat and potentially improving insulin sensitivity in the intervention group. A significant reduction was observed in HbA1C % (average of 0.23 % (p=0.02)) of the participants in the treatment group. The participants in the control group were not observed with a significant reduction in HbA1C %. This suggests that the intervention had a positive impact on blood sugar levels, leading to better glycaemic control in the intervention group. There was a significant reduction in total cholesterol level (average decrease of 11.89 (p=0.02)) of the participants in the treatment group. There was no significant reduction in total cholesterol levels of the participants in the control group and total cholesterol levels were increased in control group during the period of 12 weeks (average increase of 33.67 (P=0.051)). A significant increase was observed in HDL level (average increase of 2.60 (p=0.03)) of the participants in the treatment group, whereas the average increase in HDL level of control group participants was not significant. Nevertheless, there was a significant decrease in LDL level (average decrease of 16.51 (p=0.02)) of the participants in the treatment group.

Incorporating legumes into the diet exerts multiple health benefits towards regulation of blood glucose levels and abdominal fat reduction which are major concerns of obesity-related disorders. However, further studies addressing the limitations of small sample size, specific participant characteristics and other potential contradictory factors are in need to confirm the evidence.

Keywords: Cholesterol; Diabetes; Human Clinical Trial; Legumes; Obesity

Acknowledgement: Financial support from AHEAD/RA3/DOR/WUSL/FST.

Effect of Nutrition Education on Lifestyle Management and Glycaemic Control of Type 2 Diabetic Patients

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Abstract

Lifestyle modification plays a pivotal role in achieving the glycaemic control of type 2 diabetic patients (T2D). Nutrition education empowers diabetic patients to attain and sustain the proper glycaemic control. Providing the necessary knowledge and skills on meal preparation, food selection, food purchasing and dining for the T2D is a timely requirement of the country. Therefore, this study aimed at developing the educational curriculum and set of educational materials for providing the necessary knowledge and skills for T2D and to assess the effect of nutrition education programme on lifestyle management and glycaemic control of them.

One hundred and twenty (n=120) T2D patients were recruited as subjects from the Sandalankawa District Hospital and communities living near vicinity of the university. T2D those who were in the age range of 18-65 years, taking oral hypoglycaemic agents for glycaemic control, who can read and write in their native language were recruited to the study. T2D those who were on insulin for their glycaemic control, following specific dietary modifications prescribed by a dietitian, experienced severe complications of diabetes, hospitalized for more than two weeks before the study, unable to read and write properly were excluded from the study. The allocation sequence for the intervention (Nutrition Education Programme) and control (General Education Programme with general lifestyle modification guidelines) was generated using a computer generated randomized list. Out of the 120 T2D recruited, only 100 subjects completed the study. Hundred (n=100) T2D were randomized to receive either the Nutrition Education Programme (NEP) (n=50) or control (General Education Programme (GEP)) (n=50) for 15 weeks. GEP consisted of 03 educational sessions of dietary management using the plate model, foot care, importance of physical activity, stress management and one group counselling session. NEP had 03 counselling sessions, cooking sessions and interactive discussion sessions spreaded over 15 weeks in addition to the GEP. T2D

who followed NEP were provided with the educational materials as dietary booklet with interactive worksheets, cooking recipe booklet and clinical chart to plot the progress of glycaemic control and other biochemical and physical parameters for one year. Both groups were followed up to 15 weeks on the respective programme. Information on general lifestyle pattern, anthropometry, blood pressure, fasting plasma glucose (FPG), glycated haemoglobin concentration (HbA1c), fasting insulin level (FI), fasting plasma lipids, dietary intake and physical activity level were assessed at the baseline (t=0) and the end (t=15 weeks) of each study phase. Knowledge on lifestyle management was measured at the baseline and the end of each study phase using a pre-validated questionnaire with scores.

T2D followed the NEP for 15 weeks showed significant ($p<0.05$) reduction in their body weight (59.8 kg ± 9.2 vs 59.0 kg ± 9.0), waist circumference (89.7cm ± 10.8 vs 88.2 cm ± 9.7) and lifestyle management score (6.4 ± 0.3 vs 8.7± 0.3) related to the glucose management, healthcare use, dietary and physical activity management compared to the baseline and T2D of the GEP. Glycaemic control of the intervention group has significantly ($p<0.05$) improved compared to the baseline and control group as indicated by reduced HbA1c (9%±1.5 vs 7.8% ±1.9 & 8.1% ± 1.3). There were slight improvements in FPG, FI and fasting plasma lipids observed among T2D followed the NEP compared to the T2D of GEP; however, those improvements were not statistically significant. Reduction of total calorie intake, energy intake from carbohydrates, fats and added sugar, increase in protein intake and fruits and vegetable intake was observed among T2D of the NEP phase compared to the GEP phase at the end. Improvements in the diet and physical activity levels of T2D of the NEP phase may have contributed to the improvements in glycaemic control and reducing the body weight.

Therefore, it can be concluded that the nutrition education programme conducted for 15 weeks was effective in improving the glycaemic control and body weight of the T2D through improvements in the dietary modifications and physical activity promotion.

Keywords: Diet; Glycaemic Control; Nutrition Education; Type 2 Diabetes

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Development of a Sun Exposure Questionnaire for Young Adults to Estimate Vitamin D Status

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Abstract

Vitamin D deficiency is a common public health problem in many countries around the world, including Sri Lanka. It is essential to identify vitamin D status and its determinants when planning intervention programmes to improve the vitamin D status in the community. Since the method to determine serum 25(OH) D is expensive, there is a need to develop low-cost method to assess vitamin D status at the community level. Therefore, this study aimed to: i) identify the vitamin D status and factors associated with vitamin D status among young adults and ii) develop a sun exposure questionnaire to estimate the vitamin D status of young adults.

A total of 75 young adults ranging in age from 18 to 44 years were recruited from a rural setting in Sri Lanka by stratified random sampling. Two Gramaniladari divisions were selected from the Pannala divisional secretariat to recruit young adults. Socio-demographic information, Physical Activity Level (PAL), anthropometric data were gathered. A three-day diet diary was used to determine vitamin D intake. Sun exposure behaviors were identified using a questionnaire. Serum 25(OH)D concentration was measured using an Enzyme-Linked Immunosorbent Assay (ELISA).

The mean serum 25(OH)D concentration of the participants was 49.67 + 18.16 nmol/L. The percentage of vitamin D sufficiency, insufficiency, and deficiency was 34.5% (n=29), 47.6% (n = 40) and 7.1% (n = 6), respectively. Vitamin D status was associated with gender (p = 0.006), where the mean serum 25(OH)D concentration for males (55.46 ± 21.06 nmol/L) was significantly higher than for females (44.03 ± 12.73 nmol/L). Younger people had significantly higher (p = 0.01) serum 25(OH)D compared to older people. The nature of the occupation (p=0.021), duration of sun exposure (p=0.003) and skin exposure area during weekdays (p=0.019) and weekend days (p=0.043) were significantly associated with serum 25

(OH)D concentration (Table 1). A sun exposure questionnaire was developed by considering the sun exposure behaviours that were significantly associated with serum 25(OH)D concentration.

Table 1: Determinants of serum 25(OH)D concentration in young adults (n= 75)

Variables	Serum 25(OH)D (nmol/L)	P value
Gender		
Males	55.46 ± 21.06	0.006
Females	44.03 ± 12.73	
Age		
< 36 years	44.11 ± 11.47	0.010
> 36 years	54.80 ± 21.56	
Vitamin D intake (µg/day)		
< Median (4.36 µg/day)	46.35 ± 12.70	0.061
> Median	54.46 ± 21.36	
Nature of occupation		
Indoor	44.75 ± 10.75	0.021
Outdoor	55.25 ± 14.77	
Both	56.12 ± 10.07	
Duration of sun exposure		
< 30 min/day	42.52 ± 20.02	0.003
> 30 min/day	56.15 ± 21.05	
Skin exposure to body area during weekdays		
< 20 %	45.25 ± 9.75	0.019
20 – 40 %	52.50 ± 12.75	
Skin exposure body area during weekends		
< 20 %	45.75 ± 14.27	0.043
20 – 40 %	52.25 ± 15.30	

More than half of the young adults were vitamin D insufficient and deficient. The vitamin D status of young adults was determined by age, gender, nature of occupation, duration of sun exposure and skin exposure area. The sun exposure questionnaire, which gathers information on the nature of the occupations, sun exposure duration, and skin exposure body area can be used as a tool to estimate the vitamin D status of young adults.

Keywords: Serum 25(OH)D; Young Adults; Vitamin D Status; Sun Exposure; Questionnaire

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Ecosystems of Food Production

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Diversity and Assemblage of Mangroves in Kalaoya Estuary Sri Lanka; Special Reference to Fresh and Marine Water Influx

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Abstract

Mangroves, coastal tropical forests thriving within the dynamic intertidal zones of coastal ecosystems, exhibit remarkable adaptations to the ever-changing biotic and abiotic components of tropical and subtropical shorelines. These adaptations drive their exclusive presence within specific ecological niches, creating distinctive communities. This study explores the species composition diversity and patterns of diversity along Sri Lanka's KalaOya estuary. A comprehensive survey of 267 randomly selected transects within the mangrove ecosystem was undertaken, each transect measuring 1 meter in width and 10 meters in length. Species abundances, encompassing both true mangroves and associated plants, were recorded in each plot. The impact of tidal forces, waterlogging, and soil conditions on each transect was documented. A range of diversity indices including individuals, dominance, Simpson's diversity index (Simpson_1-D), Shannon's diversity index (Shannon_H), evenness, Brillouin, Menhinick, Margalef, equitability, Fisher alpha, Berger-Parker, and Chao-1 were calculated for each transect. Alpha diversity values enabled the clustering of the 267 transects into three distinct categories: fringing mangroves, middle waterlogged area, and other specific vegetation, based on water influx and waterlogging conditions. Among the fifteen true mangrove species identified, including *Avicennia marina, Excoecaria agallocha, Rhizophora mucronata, and Lumnitzera racemosa,* dominance varied. Notably, *Xylocarpus rumphii and Scyphiphora hydrophyllacea* exhibited minimal prevalence, confined to limited spatial extents. Dominant mangrove-associated species such as *Clerodendrum*

inerme and Acrostichum aureum significantly influenced community composition. The diversity index revealed spatial disparities, with the highest diversity (H'=1.609) along the water and landward margins of the mangrove vegetation, and the lowest diversity (H'=.0) within middle regions and certain monostands dominated by *Avicennia marina*. Hierarchical cluster analysis reinforced three zones :Fringing mangroves, Middle waterlogged area, and other specific vegetation, which merged with terrestrial plants along the landward margin.

These clusters revealed unique assemblages linked to freshwater influx, tidal influences, and inundation conditions. The distinctiveness of Simpson_1-D, Shannon and Brillouin, diversity indices across clusters highlighted their ecological significance. Results underscored the substantial influence of freshwater input and tidal effects on mangrove species distribution and community structure. This investigation provides information on intricate spatial distribution patterns among mangroves within the vegetation which should further be evaluated using beta diversity.

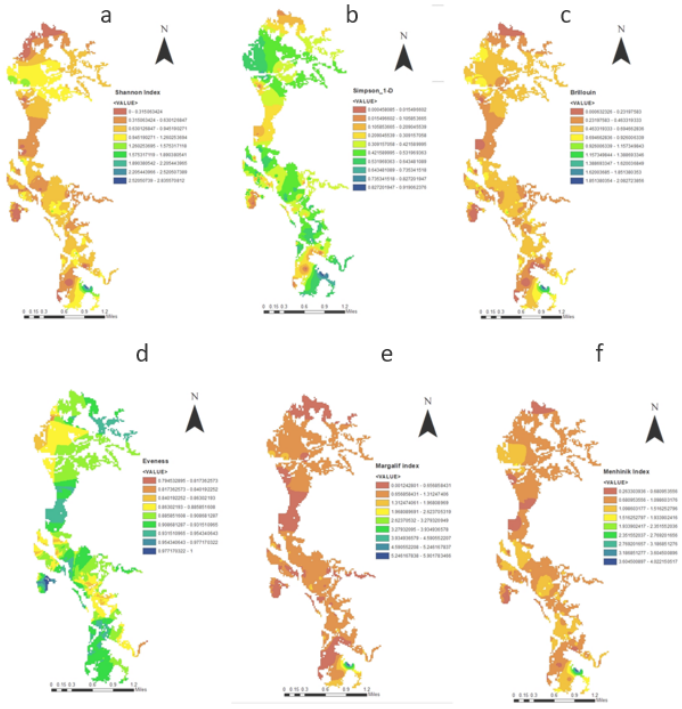

Figure 1: Spatial variation of the Diversity index; a) Shannon's diversity index (Shannon_H), b) Simpson's diversity index (Simpson_1-D), c) Brillouin, d) evenness, e) Margalef and f) Menhinick index.

Keywords: Alpha Diversity; Kalaoya; Mangrove; Species Composition

The Distribution Pattern and Habitat Use of Wild Elephants in and Around Maduruoya National Park, Sri Lanka

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Abstract

The last census in 2011 of the Department of Wildlife Conservation revealed the total number of wild elephants in Sri Lanka to be around 6000. The eastern wildlife region where the study site resides is estimated to harbour a population of about 1600 wild elephants. A substantial number of wild elephants live in and around Maduruoya National Park which is in the eastern wildlife region of Sri Lanka. In both in and around Maduruoya National Park wild elephants move through their natural pathways and corridors in search of food, water, and mates. Moreover, throughout the year there is a variation in the total elephant population within the Maduruoya National Park and its surrounding areas. The objective of this study is to identify the movement pattern and use of different habitats by wild elephants and how it affects the Human-Elephant Conflict (HEC) in the surrounding communities of Maduruoya National Park.

Data collection involved monthly observations integrating both direct and indirect observation methods including dung pile counts. All observed elephants were recorded with the GPS locations along with the habitat found. Compiled data were analysed using ArcGIS (10.8) and seasonal and monthly distribution and habitat usage maps were prepared.

During the months of June to January, most elephants were recorded inside the National park. The majority of the elephants were found to move out of the park from the months of February to May where elephants were found outside the park

feeding on the remains of harvested crop fields. During the rainy season from September to December, most elephants were found utilizing the dense and medium-density forests. During the months of June, July, August, and January most elephants were observed in the grasslands and shrub lands close to the reservoirs while from February to June majority inhabited teak plantations, harvested paddy fields, and croplands adjoining the national park. High rates of human deaths due to elephants, property damages, and elephant deaths were recorded within the past five years, contributing to a high incidence of HEC. Within the last five years, much of the HEC incidence recorded around Maduruoya National Park was between the months of April and May. Almost all property damages were recorded between May to July.

In conclusion, the best practice thereof, to maintain a healthy population of wild elephants within the park and to reduce the intensity of HEC is to open natural elephant corridors from Maduruoya National Park to Wasgomuwa, Somawathi, and Flood Plains National parks that link the ancient migratory routes through the other protected areas allowing free range movement. The habitat improvement practices in the national parks and community engagement and awareness programmes are some proposed measures for mitigating HEC around Maduruoya National Park.

Keywords: Maduruoya National Park; Elephant Habitats; Human Elephant Conflict; Natural Elephant Corridors

Comparative Analysis of Genomic DNA Extraction Methods for Elasmobranch Tissues

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Abstract

Elasmobranchs (sharks and rays) play an important role in marine ecosystems but are facing global population decline, primarily due to overfishing. In 2022, the number of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) listed for endangered sharks and rays species has increased from 47 to 151. Sri Lanka is among the world's largest fishing nations for sharks due to national and international demand for their meat, fins, gills, and oil. Due to similarity in appearance or lack of distinctive features in many derivative products, they can be accidentally mislabelled or deliberately labelled as a different species. To support monitoring and legal enforcement, reliable genetic methodologies such as DNA barcoding, mini barcoding, and real time q-PCR can be used. The extraction of high quality DNA is the first step for any genetic test especially when establishing new protocols for shark and ray identification.

Here we compare the quantity, purity, efficiency, cost effectiveness, and ability to conduct PCR amplification of cytochrome oxidase subunit 1 gene of elasmobranch using four different DNA extraction methods; Qiagen DNeasy Blood & Tissue Kit, HotSHOT DNA Extraction Kit by Bento Bioworks, MACHEREY-NAGEL NucleoSpin kit, and Bio-Rad Chelex method. The results indicated that the efficiency of DNA extraction was influenced by both the method used for DNA extraction and the type of sample. Higher concentrations of DNA were obtained from tissues stored in ethanol (Qiagen kit:141.7±112.3; Hotshot kit;17.87±20.; Bio-Rad Chelex:155.71±77.30; and Nucleospin kit:138.2±72 ng/µl) while the lowest concentration was obtained from dried tissues (Qiagen kit: 27.4±24; Hotshot

kit;8.27±10.47.; Chelex:63.44±9.04; and Nucleospin kit:27.2±26 ng/µl). Qiagen DNeasy Blood & Tissue Kit showed high quality DNA (value of A260/A280 for tissues in ethanol: 1.82 ± 0.14; dried tissues: 1.76 ± 0.23; and frozen tissues: 2.05 ± 0.06) and the chelex method showed higher quantities compared to other methods (value of DNA concentration for tissues in ethanol: 155.71± 77.3; for dried: 63.44±9.04; for frozen: 244.17±82.46 ng/µl).

However, the most cost-effective and time-effective methods were the HotShot kit and Chelex. But to obtain higher quality DNA, modifications such as using magnetic beads to clean DNA extracted by the Hotshot kit or adding 10 mg/ml of proteinase K for the Chelex method are recommended prior to PCR amplification. To conclude, if yield is the priority, the Chelex method is recommended whereas if the quality of extracted DNA is most important, the Qiagen DNeasy Blood & Tissue Kit can be recommended. Considering both quantity and quality values, DNA extracted from tissues stored in ethanol using Qiagen DNeasy Blood & Tissue Kit was selected for metabarcoding in elasmobranch species to build up a DNA reference library for Sri Lankan elasmobranch species using nanopore sequencing. This library will then be used to identify products in trade and fisheries that cannot be visually identified.

Keywords: CITES; Genetic Identification; PCR; Sharks and Rays

Population Dynamic Parameter Estimations of a Slipper Lobster in Pethalai, Sri Lanka

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Abstract

In many parts of the world, slipper lobsters support commercially valuable fisheries yet some species have been overexploited without proper management measures. A slipper lobster, *Thenus orientalis* fishery has been well established in Pethalai region on the east coast catering to the demand in tourist hotels, yet scientific information for sustainable management of these slipper lobsters is limited. Therefore, current study attempted to find out important population dynamic parameters that may pave the way to proper fishery management practices for Slipper lobster. Samples (n = 543) were randomly collected from commercial gillnet bycatch in the Pethalai landing site (7°55'45.6"N 81°32'37.1"E) from June 2021 to June 2023. The species was identified as *T. orientalis* using keys given in Marine Lobsters of the World by Holthius in 1991. Their carapace length (CL) was measured to the nearest 0.01 mm where the distance from the fine notch in front of the carapace to the posterior end of it behind. Carapace length is a more consistent measure for Decapods, so carapace length was used for dynamic parameter analysis in this study. Female specimens' month-wise carapace length data were grouped into 5 mm carapace length classes and frequency data (LFQ) were recorded. The LFQ data were loaded to the FiSAT II (version 1.2.2) software package. Estimations of von Bertalanffy growth parameters were analysed using the ELEFAN I module; an initial estimate of asymptotic carapace length (L∞) was obtained using the Powell-Wetherall method. Growth constant (K) for the optimum growth curve and L∞ had been computed. Total mortality rate per year (Z) was calculated using the original LFQ data by the length-converted catch curve method. Natural mortality rate per year

(M) was estimated using an empirical equation derived by Pauly, (1980). Probability of capture against the carapace length plot was created. Carapace length which 50% of the catch retained was estimated. An assessment of the relative yield-per-recruit (Y'/R) was conducted, in relation to the exploitation ratio (E) based on the present carapace length at first capture (L 50%) using the growth parameters (L ∞ and K) as well as mortality parameters (Z, M, and F). Exploitation ratio (E) and carapace length at first capture (L 50%) values were estimated and recorded in a tabular format. Determination of the smallest carapace length at which 50% of females with ovigerous setae reached maturity was considered as the length at 50% maturity. Obtained parameters were as follows: L ∞ (107.63 mm), K (0.59 yr^{-1}), Z (1.42 yr^{-1}), M (0.79 yr^{-1}), F (0.62 yr^{-1}), and L 50% (67.79 mm). Furthermore, estimated the exploitation ratio (Eest) was 0.44. It's important to note that the carapace length at 50% maturity for females was 64.00 mm, which is lower than L 50%. Key exploitation reference points: E10, which signifies a 10% increase in (Y'/R) and was at a value of 0.65, and E50, representing the point at which the stock is reduced to half its virgin biomass, with a value of 0.39. These values provide insights into potential impacts of different exploitation rates on *T. orientalis* stocks. Notably, that E10 suggests that any further increase in E could potentially harm the *T. orientalis* stocks, as it approaches the critical threshold of Emax (0.74), even though the current exploitation level (Eest) indicates that the stocks are currently underexploited. *T. orientalis* is primarily landed as bycatch. Minimum legal mesh size regulations and gear restrictions & closed seasons during spawning periods have proven ineffective in conserving the species. This study advocates for the implementation of conservation measures targeting lobster bycatch fishing community. Raising awareness through targeted awareness programs, in conjunction with establishment of user rights, is recommended as an effective approach to safeguarding *T. orientalis* populations.

Keywords: *Thenus orientalis*; By-Catch; Dynamics; Conservation

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Checking the Suitability of Processing Waste of Three Different Fishes as a Source of Type-I Collagen

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Abstract

Out of the global aquaculture and fisheries production of 177.8 million tonnes in 2020, only 157.4 million tonnes had been used for human consumption (FAO, 2022). Generally, fish processing recovers only 20 – 50% as edible portions and the remaining parts are discarded as non-edible by-products, with a global annual average of 20 million tonnes (FAO, 2022). A part of these by-products is already being used for low-value applications such as fish meal or crude oil production, but more valuable and profitable uses are possible from fish waste due to the presence of valuable nutrients and bioactive compounds such as collagen, gelatin, peptides, vitamins, minerals and enzymes. Due to its vast applications in food, cosmetic, nutraceutical, pharmaceutical and biomedical industries, the extraction of type-I collagen from fish discards has gained significant research attention to develop industrially relevant protocols.

The growth of the aquaculture and fisheries sector in Sri Lanka has established more than 75 medium and large-scale export-oriented fish processing plants over the past decade. Every year these fish processing plants generate a huge amount of waste after the filleting process that includes collagen-containing materials, mainly skins, bones, left-over muscles and fins. Therefore, the present study was conducted to evaluate the suitability of skin, bones, left-over muscles and fins of three main commercial fish species, Yellowfin tuna, Seer fish, and Asian sea bass for commercial-scale collagen extraction.

Raw materials were obtained from a fish processing plant located in Ja-Ela, Western Province, Sri Lanka. Acid-soluble collagen from skin, bones, left-over muscles and

fins were then extracted from three individuals of each fish species by slightly modifying the protocols described by Muralidharan et al., (2013) and Nagai and Suzuki, (2000). The obtained yields on a wet-weight basis are given in Figure 1. There was no significant difference in collagen yield among the three selected fish species (two-way ANOVA), however, collagen yields were significantly different (two-way ANOVA, $p<0.05$) among four different body parts with the highest yield from skin in three selected fish species.

Then the freeze-dried skin collagens were characterised by Fourier Transform Infra-Red (FTIR) spectra, X-ray diffraction (XRD) spectra, Ultra Violet (UV) spectra, and Scanning Electron Microscopy (SEM) for the type, availability of triple-helical structure, purity, and morphology. The presence of amide A, amide B, amide I, amide II and amide III bands in FTIR spectra confirmed that the skin collagens were type-I. The absorption ratios calculated from the FTIR spectral results for the skin collagens were 0.98, 1.01 and 0.98 for the Yellowfin tuna, Seer fish, and Asian sea bass, respectively. XRD spectral results further proved the preservation of the triple-helical structure of skin collagen from all three species. The UV spectral results confirmed the purity of collagen with respect to the absence of non-collagenous proteins. SEM images confirmed the porous and film-like nature of extracted collagen. In conclusion, this study confirms the suitability of the skin of all three commercial fish species selected in this study as a source of type-I collagen for commercial-level extractions.

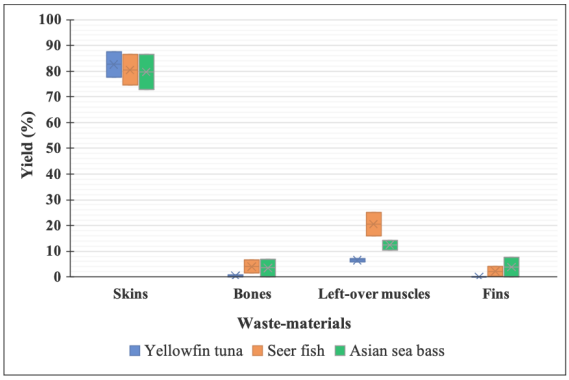

Figure 1: The yield of collagen of the skins, bones, left-over muscles and fins of yellowfin tuna, Seer fish and Asian sea bass.

Keywords: Acid-Soluble Collagen; Commercial Fish Species; Fish Waste; Type-I Collagen

Acknowledgement: This work was supported by the AHEAD grant scheme [Grant number AHEAD/DOR-80/AQF/WUSL].

Evaluation of the Ability of Fungi Species Isolated from Sri Lankan Soils to Solubilize Eppawala Rock Phosphate

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Abstract

Phosphorus (P) is an essential macronutrient in the biosphere. P is available in soils in both organic and inorganic forms. Nevertheless, the bioavailability of P is significantly low. Therefore, the deficiency of available P in soil limits crop productivity. Synthetic P-fertilizers cause adverse environmental and health issues if applied at excessive levels. As an alternative, for sustainable utilization, phosphate-solubilizing microorganisms (PSM) could play an important role in making P available for plants by dissolving insoluble phosphates. PSM solubilize phosphate by secretion of secondary metabolites such as organic and inorganic acids, exopolysaccharides, siderophores and enzymes. In this study, the qualitative and quantitative potential of fungal species isolated from Sri Lankan soils to solubilize phosphate was evaluated. Four phosphate-solubilizing fungi (PSF) were isolated from soil by using the National Botanical Research Institute's Phosphate (NBRIP) medium which comprises $(Ca_3PO_4)_2$ as the sole phosphate source. Morphological identification of isolated species was done. The phosphate solubilizing potential of isolated fungal species was evaluated qualitatively using phosphate solubilizing index (PSI) and halo-zone diameter/ colony diameter (HD/CD) value. Based on the PSI and HD/CD, the fungal species with the highest phosphate solubilizing ability was selected for the quantitative analysis. The phosphate solubilizing potential of the selected fungus was identified qualitatively by replacing the phosphate source with High-graded Eppawala Rock Phosphate (HERP) in the modified NBRIP media, which contains bromophenol blue. The

quantitative analysis of HERP solubilization by the selected fungus was done using a UV spectrophotometer according to the molybdenum blue method. 1×10^7 spores per mL spore solution was inoculated to NBRIP broth (1:9) containing HERP as the sole phosphate source. The fluctuation of the pH in the media was also measured. The experiments were performed for six days and the absorbance and pH readings were obtained after each 24 hours from the inoculation. Data analysis was done by using two-way ANOVA using the R statistical software. Halo zone-forming fungi were isolated as PSF. According to the colony morphology, and light microscopic observations, the isolated fungi belonged to the genera of *Aspergillus* and *Penicillium*. One *Aspergillus* sp. was selected as the most efficient phosphate-solubilising fungi among isolated species based on the qualitative analysis. PSI of selected *Aspergillus* sp. was 2.501 and HD/CD value was 1.501, which indicated a strong ability (HD/CD of strong P solubilization ≥1.5) to solubilize phosphate. The formation of a yellow colour zone around the colony confirms the acid production and HERP solubilization of *Aspergillus* sp. in modified NBRIP media. The results of quantitative analysis for HERP solubilization showed a significant difference between control samples (without inoculation) and *Aspergillus* sp. inoculated samples ($p<0.05$). Maximum phosphate solubilization was recorded on the second day after the inoculation and HERP solubilization has become a constant level from day one after the inoculation (Figure 1). The pH of the medium was decreased parallelly and became constant level with HERP solubilization due to the acid production by fungus for phosphate solubilization. According to the results, it can be concluded that *Aspergillus* and *Penicillium* species have the potential to solubilize phosphate in the HERP. The selected *Aspergillus* sp. has a significant ability to solubilize HERP for sustainable utilization of the Eppawala rock phosphate deposit. There is a potential to use this *Aspergillus* sp. to produce phosphate biofertilizer.

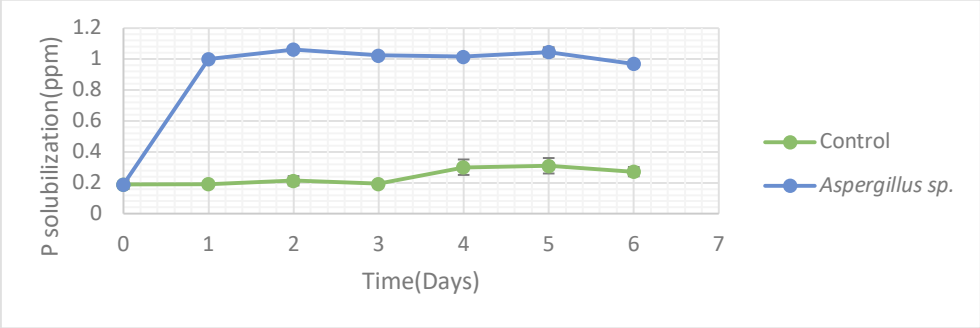

Figure 1: The graph of Phosphate solubilization (ppm) vs. time (Days)

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

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Synthesis of Dicalcium Phosphate from Eppawala Rock Phosphate and Eggshells

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Abstract

Dicalcium Phosphate (DCP) is the common source of phosphate in poultry feed. Sri Lanka entirely depends on the import for feed grade DCP. Commercially DCP has been synthesized using a precipitation reaction between phosphoric acid (source of phosphorus) and $CaCO_3$. There was a potential to synthesize DCP with Eppawala Rock Phosphate (ERP) as a source of phosphorus and eggshell as a source of calcium carbonate. Therefore, the proposed research focuses on rock phosphate's chemical and physical processing to synthesize feed-grade P from ERP, which is safer for animal feed. Initially, ERP was cleaned by scrubbing and washing. Then it was ground and sieved to obtain 10 µm particles. Prepared samples were used to synthesize the DCP. The eggshell was collected from bakery waste and cleaned and the shell membrane was removed. After that, it was sterilized using an autoclave to remove pathogens. Prepared ERP was dissolved with concentrated nitric acid and added with eggshell powder until the reaction mixture reached pH 2.5 and precipitation was removed at this stage and filtrate was collected. Filtrate again added with eggshell powder with continuous stirring until the reaction mixture reaches pH 4.5. Reaction carried out at different reaction times (15, 30 and 60 minutes). Finally, the precipitate was collected, washed with deionized water, and

oven dried at 80 ℃ for 3 hours. Precipitate was analysed by XRD and SEM-EDAX analysis to find out the chemical composition. According to the findings, DCP can be synthesized from ERP and eggshell powder. The process involved two steps including acid dissolution with concentrated nitric acid and precipitation of DCP by adding eggshell as a source of $CaCO_3$. The reaction is creditably dependent on the pH, reaction temperature and time. DCP was synthesized at pH 4.5, 50 ℃ and 15 minutes of reaction time. EDAX results showed that samples comprised 16-17% P and 35- 41% Ca. It indicates there is some amount of unreacted $CaCO_3$ remaining with precipitation. While increasing the reaction time it increases the impurities of other calcium phosphate other than the DCP. It can be concluded that DCP can be synthesised using ERP as a phosphate and eggshell as a calcium source. The optimum conditions for DCP synthesis using eggshell powder are pH 4.5, 50 ℃ temperature, and 15 minutes of reaction time.

Keywords: Animal Feed; Eggshell; Phosphate; Rock Phosphate; Supplement

Acknowledgement: This research was founded by World Bank [Grant number: AHEAD/RA3/DOR/WUSL/LAS/No: 57].

Global Importance of Jellyfish Species: A Review

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Abstract

The worldwide data published during the last two centuries have shown that jellyfish are one of the most important groups of aquatic fauna. At first, we performed a literature search on important species of jellyfish in Google Scholar using relevant search keywords such as 'jellyfish', 'medusa', and 'siphonophore'. As a large number of publications are available, we attempted to manually select only the publications, which indicate the importance of cnidarian jellyfish with their taxonomic identity at least up to the genera level. Likewise, 750 papers published during the last two centuries (1810 to 2022) were selected. Based on the selected publications, we intended to discuss a variety of different usages, the importance of cnidarian jellyfish species and the pros and cons of socioeconomic and ecological aspects (Table 1).

The jellyfish species recorded with their importance in literature could be categorized under two classes, i.e. Hydrozoa and Scyphozoa. Hydrozoan species were reported in 5, 9, 4, 3, and 2 of families under 5 orders, namely Leptothecata, Limnomedusae, Narcomedusae, Trachymedusae, and Siphonophorae respectively. Moreover, in Scyphozoa, 6, 7, and 14 families were reported under 3 orders, namely Coronamedusae, Cubomedusae, and Discomedusae, respectively. Among the five hydrozoan orders, the majority of importance (64%) was represented by the siphonophore *Physalia physalis*, which is known as one of the most hazardous species all over the world. Among all three scyphozoan orders, discomedusa Aurelia aurita was the highly recorded species (23%). *Aurelia aurita* is known as the typical species in jellyfish studies.

In this review, we have included scientific names, common English names, trade names, geographical distribution, potential markets for each species and commercially and useable body parts of jellyfish from the literature. Based on the literature, China, Korea, Taiwan, Singapore, Malaysia, Japan, Vietnam and

Thailand were identified as the main markets for edible jellyfish in the world. In addition, the Indo-Pacific region is considered to potentially be the most important geographical region for jellyfish fisheries. The genera, *Acromitus*, *Catostylus*, *Crambione*, *Crambionella*, *Lobonema*, *Lobonemoides*, and *Rhopilema*, were identified to own commercially important edible jellyfish species in the Indo-Pacific region.

Table 1: The percentage number of species summarized under different importance/utility. Note: The number shown in the parenthesis indicates the respective number of literature included under each aspect for socioeconomic and ecological importance.

Importance	Category	Aspects	Percentage of species categorized under each aspect
Socioeconomic	Advantages	Ornamental organisms (25)	2%
		Human foodstuff (37)	9%
		Medicinal (67)	7%
		Live-baits (12)	1%
		Aquatic animal feed (14)	1%
		Fertilizer/growth promoter (12)	1%
		Weedicide (11)	1%
	Disadvantages	Stingers (311)	23%
		Anti-aquaculture agents (32)	4%
		Anti-fisheries agents (52)	11%
		Power plant clogging agents (42)	5%
Ecological	Advantages	Natural nutrient source (32)	5%
		Food source of other fauna (41)	1%
		Symbionts (57)	11%
		Bio-indicators (34)	4%
	Disadvantages	Invasive organisms (114)	13%

The breakdown of the compiled literature according to the chronological periods during the last two centuries shows that more than 50% of publications (n = 380) have been published within the last five decades.

Keywords: Cnidaria; Ecological Importance; Literature Survey; Socioeconomics

Acknowledgements: This work was supported by the National Science Foundation of Sri Lanka [Grant number: RG/2016/OMR/01].

An Empirical Study on the Public-Private Intervention in the Culture-Based Fishery of Giant Freshwater Prawn in Sri Lanka

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Abstract

Giant freshwater prawn (*Macrobrachium rosenbergii* (De Man, 1879)) (GFWP) is a high economic value species, found in tropical freshwater riverine and brackish water environments across the Indo-Pacific region. In Sri Lankan reservoirs, the production of GFWP is totally a culture-based fishery (CBF) limited to extensive stocking. Initially, the National Aquaculture Development Authority (NAQDA), the government establishment mandated the development of inland aquaculture and fisheries, initiated GFWP stocking in a subsidy base. But due to constraints of government funding, some of the strategy called public-private intervention (PPI) was introduced to northern reservoirs. Therefore, our objective is to characterize PPI via gathered qualitative and quantitative data from respective fisher organisation (FO) and stakeholders of the selected 6 reservoirs: Pavatkulam (1,214 ha) (N 8.692001, E 80.429001), Muthayankaddu (1255 ha) (N 9.202813, E 80.611777), Vavunikulam (1275 ha) (N 9.087353, E 80.346139), Iranaimadu (2327 ha) (N 9.3151129, E 80.453000), Akkarayankulam (809 ha) (N 9.297919, E 80.325121) and Puthumurripu (151 ha) (N 9.35898, E 80.353972). Catch and stocking information from January to December 2020 was collected from FO records. Randomly selected 10 fishermen at the landing site from each FOs were interviewed using structured and open-ended questions. Market and price details were gathered from both fishermen and collectors. Production analysis was conducted using the Cobb-Douglas production function given in equation (1) and log model in equation (2).

$$y = f(x)e^{u} \quad \text{.....} \quad (1)$$

$$\ln y = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + u \quad \text{.....} \quad (2)$$

According to the information gathered, in the PPI, where a private entity (PE) is resourcing GFWP PLs to the reservoir via a mutual agreement with FO ensuring the by-back. Several key issues were identified to be addressed immediately. First, though the by-back agreement is to ensure the recovery of investment with an interest, on the other hand, it fails to guarantee a fair price to the fishers as it hinders the entry of new competitive buyers. Secondly, the agreement has not specified a timeline for the recovery of capital and interest. The private entity claims that it has the right to harvest each prawn that was stocked, FO's stand is on financial recovery. Market details implicit that GFWP were purchased from fishermen for 900 LKR/Kg which is lower than the open competitive market, 1200 LKR/Kg. In PPI, the per capita income of LKR 108,655 ± 24,186 per annum was solely realised from GFWP by the fishers. A collector in a reservoir is getting a more financial advantage over fishers, where the per capita income is 1,052,448 ± 159,803 LKR per annum. The private entity which is involved in the CBF extension, figures a mean of 12,793,301 ± 2,047,692 in LKR per annum as a profit from a single reservoir, by ensuring a mean capital recovery of 0.4904 ± 0.0215 in percentage. The results of production analysis implicate that, both fishing effort (no of fishermen) (-0.2580631) and stocking density (PLs ha^{-1}) (0.9794597) have a significant influence on the production (Kg ha^{-1}) (p-value: 0.01166). According to the results, increase in effort is not significant enough to contribute to the growth of production, instead, an increase in stocking density is highly potent.

It is evident that the vague nature agreement is an act-of-exploitation, which is contradictory to the objectives and code of conduct of small-scale fishery. Present study recommends a major systematic revision of the PPI strategy; else the prime consequence will be the establishment of a strong monopoly in the GFWP CBF.

Keywords: Culture-Based Fishery; *Macrobrachium rosenbergii*; Public-Private Intervention.

Medicine

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Study of Possible Mechanisms of Oral Hypoglycaemic Activity of *Mormodica charantia* (Bitter gourd) Using [U-^{14}C] Labelled Glucose in the Rat

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Abstract

The use of several plant based preparations of oral hypoglycaemic agents have been subjected to scientific evaluation. Oral hypoglycaemic activity of fruit juice of *Mormodica charantia* Linn has been observed in healthy laboratory animals; in animals with experimental diabetes and in maturity onset diabetics. Mechanisms of oral hypoglycaemic activity of *M. charantia* are theorized by researchers suggest that *M. charantia* involves in an increase in insulin secretion and tissue glucose uptake, decrease in hepatic gluconeogenesis and inhibition of intestinal glucose absorption.

The present study was undertaken to investigate the effect of *M. charantia* on uptake and incorporation of [U-^{14}C] glucose using normal healthy male Sprague-Dawley rats (body weight 200 ± 25 g). The fruits of *M. charantia* after removing seeds and placentae were macerated in a mechanical grinder and squeezed through four layers of muslin cloth to obtain the fruit juice. The animals (n=24) were fasted overnight (14-16 hours). After collecting blood samples (50 µl) from the tail tip for the estimation of fasting blood glucose concentrations, the animals were randomly divided into four groups of six each namely group 1, 2, 3 and 4. Groups 1 and 2 were control groups, administered distilled water and groups 3 and 4 were treatment groups administered *M. charantia* fruit juice. Thirty minutes after administration of distilled water/*M. charantia* fruit juice, the animals received oral dose of [U-^{14}C] glucose 10 ml/kg body weight. Blood samples (50 µl) were collected from the animal groups of 1 and 3 at 1 hour after the glucose load for the estimation of glucose. Following this, the animals were sacrificed and abdominal and thoracic cavities were opened. The gastrointestinal tract was cut opened and the contents were washed with normal saline and the volume made up to 200 ml with distilled water. The glucose estimation in an aliquot (50 µl) of this was done and the total amount of glucose in the gastrointestinal tract was calculated. An aliquot (1 ml) was also

counted for radioactivity. At the same time the liver, adipose tissue, muscle and kidney were dissected and immediately frozen in liquid nitrogen and stored in -70°C until used. Blood samples (2 ml) were collected. The same procedures were followed in the case of groups 2 and 4 at 2 hours after oral glucose challenge. The incorporation of radioactivity into blood, liver, adipose tissue, muscle and kidney were studied by measuring different fractions of these tissues using Beckman LS-1701 liquid-scintillation counter.

The percentage (mean±SEM) [U-^{14}C] glucose in the blood at 1 and 2 hour respectively after an oral glucose load in *M. charantia* group has significantly ($p<0.001 - 0.0001$) lower than the control groups. The percentage [U-^{14}C] glucose absorption from the gastrointestinal tract at 1 and 2 hour respectively after an oral glucose load has also significantly ($p<0.0001$) lower in the *M. charantia* group than the control group. The percentage incorporation of [U-^{14}C] glucose in the liver (per gram dry weight) ($p<0.0001$), adipose tissue ($p<0.001$), muscle ($p<0.001$) and in the kidney ($p<0.05$) significantly higher in *Mormodica charantia* treated groups than in control groups. The percentage incorporation of glucose into glycogen fraction ($p<0.001$), lipid fraction ($p<0.001$), protein fraction ($p<0.001$) in the liver significantly higher in *Mormodica charantia* groups than in control groups.

The results provide strong evidence that the inhibition of intestinal absorption of glucose is most likely to be one of the contributory factors of overall oral hypoglycaemic activity of *M. charantia*. The present study also showed that administration of *Mormodica charantia* significantly increased incorporation of radioactivity from [U-^{14}C] glucose into liver glycogen, lipids and protein. Similarly, significantly higher incorporation of [U-^{14}C] glucose into adipocytes, lipids was also observed. These data are indicative that *M. charantia* act on intestinal as well as extra intestinal sites to bring about its' oral hypoglycaemic activity.

Keywords: *Mormodica charantia*, Oral Hypoglycaemic Activity, [U-^{14}C]

Oral Hypoglycaemic Activity Related Fractionation of *Mormodica Charantia* (Bitter Gourd)

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Abstract

The oral hypoglycaemic activity of *Mormodica charantia* is now well documented. The present study is an attempt to characterize the nature of active principle(s) of oral hypoglycaemic activity related fractionation of *Mormodica charantia*. Solvent extraction and fractionation of *Mormodica charantia* fruits were resulted in different fractions namely ether, ethyl acetate, aqueous extracts, methanol-benzene insoluble fraction and methanol-benzene soluble fractions (MB1 – MB6). Methanol-benzene fractions are derived from ethyl acetate insoluble fraction. Out of the four fractions (ether, aqueous, ethyl acetate extracts and methanol insoluble fraction) of *Mormodica charantia* only ether extract showed potent effect to improving the ability of the experimental animals (Sprague-Dawley rats) to tolerate an external glucose load. The methanol-benzene soluble fraction significantly improved glucose tolerance when administered 30 minutes before oral glucose load. MB3 and MB4 showing a more profound effect than MB2. The ability of MB3 and MB4 to improve the utilization of glucose following an external glucose load was equal to each other and similar to that of *Mormodica charantia* fruit juice.

In view of promising oral hypoglycaemic effect showed by the methanol- benzene soluble fraction (MB4), the MB4 fraction was subjected to further fractionation by column chromatography using methanol-chloroform solvent system. Among the eluted fractions, the methanol-chloroform soluble fraction (MC1) which had the same RF value as authentic charantin (β sitosterol glucoside and 5,25-stigmastadiene-3-ol glucoside), a non-nitrogenous steroidal glycoside, was evaluated for oral hypoglycaemic activity. Previous studies demonstrated hypoglycaemic activity of charantin administered orally as well as intravenously.

MC1 fraction significantly reduced fasting blood glucose concentrations and improved glucose tolerance in Sprague-Dawley rats when administered 30 minutes prior to an oral glucose load. In view of its profound effect on the ability of the experimental animals to tolerate an external glucose load, a dose response study of MC1 fraction was also undertaken. Out of the four different dosages (0.5, 1, 2 and 4 mg/ml) of MC1 fraction investigated all except 0.5 mg/ml fraction showed a potent effect to improve the ability of the experimental animals to tolerate an external glucose load in a dose dependent manner.

In the present study, the profound effect of MC1 fraction on the ability of the experimental animals to tolerate an external glucose load in a dose dependent manner strongly suggests that *Mormodica charantia* possess an oral hypoglycaemic principle which is possibly a non-nitrogenous steroidal glycoside in nature. Preliminary GC/MS studies (data not given) of MC1 fraction indicated the presence of a mixture of two steroidal glycosides in approximate 60% and 30%. Thus, further purification and structure elucidation of MC1 fraction are imperative to identify and characterize the nature of the active principle.

Keywords: Hypoglycemic Activity, *Mormodica charantia*, Active Principles

Prevalence and Risk Factors of Enterobiasis among School Children in the Anuradhapura District, Sri Lanka

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Abstract

Enterobiasis is an infection caused by the intestinal nematode *Enterobius vermicularis*, commonly known as pinworm. It is mainly acquired through accidental ingestion of eggs from contaminated fingernails, food, clothes and surfaces. Despite being relatively benign, pinworm infections can cause significant annoyance, social embarrassment and sleep disturbances due to the perianal itching. Some severe complications have also been reported, including appendicitis, ileocolitis, and pelvic peritonitis. It may negatively impact school performance due to insomnia, irritability, and nocturnal enuresis. Diagnosing enterobiasis mainly involves detecting characteristic eggs in the perianal region using adhesive tapes. However, the faecal examination is of limited relevance because infected people's faeces generally do not contain eggs. This infection is particularly prevalent among pre-schoolers and school children, especially in tropical and subtropical regions. Even though mostly overlooked, it is a significant public health concern in Sri Lanka, where studies have consistently shown a high prevalence. Enterobiasis is associated with crowded living conditions and inadequate personal hygiene and is difficult to eradicate due to its contagious nature and auto-infectivity. Through annual school medical inspections, extensive deworming initiatives targeting

students in Sri Lanka have effectively led to a notable decrease in the prevalence of soil-transmitted helminth infections (STH), reaching as low as 1% by the year 2017. However, the occurrence of enterobiasis persists at levels exceeding 20% among school children. Anuradhapura district is categorized as a low-risk district for STH infections (prevalence 0.21% - 2017). Few cross-sectional studies done on enterobiasis, in different regions of Sri Lanka, show varying prevalence values - Colombo (42.5%) Ragama (38%) Hambantota (6.2%) and Kandy (31.9%).

However, the prevalence of *E. vermicularis* infection among school children in the Anuradhapura district is still unknown. This school-based cross-sectional study attempted to evaluate the prevalence and risk factors of enterobiasis among school children aged 5–10 years attending state schools in the Anuradhapura district. The study was conducted from January to July 2023. After parents'/guardians' consent, a total of 357 children participated in this study from nine schools in five educational zones. Single early morning perianal Scotch tape samples were collected from the participants. For each child, demographic and risk factor data were collected from the parents using an interviewer-administered questionnaire. The mean age, of the study population was 7.79 ($\pm$ 1.47) years. There were 82 samples positive for *E. vermicularis* eggs. The pinworm infection exhibited an overall prevalence of 22.9%. Boys (31%) had a higher prevalence than girls (25%). Factors that displayed significant association ($p<0.05$) were lack of parental knowledge about enterobiasis, nail-biting, hand washing with only water before meals and after defecation and most recent de-worming more than three months prior to sample collection. None of the assessed current clinical manifestations (abdominal pain, loss of appetite, recent onset significant weight loss, perianal itching, nocturnal enuresis and insomnia) did not show a significant association ($p>0.05$). The results of this study suggest a high prevalence of *E. vermicularis* infection among school children. The recorded prevalence value might underestimate the actual prevalence, given that only a single Scotch tape sample was examined from each participant. This approach may not account for the day-to-day fluctuations in egg release by the worms. Given the observed association between pinworm infection and inadequate hygiene practices coupled with limited awareness, it becomes evident that the promotion of proper hygiene and the dissemination of health-related knowledge are pivotal components in the prevention and management of enterobiasis.

Keywords: *E. vermicularis*; Infection; Prevalence; School children; Sri Lanka

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Prevalence of Being 'High-Risk' for Hospitalisation Due to Exacerbation among Asthma Patients Aged ≥20 Years in the District of Gampaha

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Abstract

Hospitalisations due to exacerbated asthma remains high in Sri Lanka leaving a huge burden on health care system. Various interventions have been shown to reduce hospital admissions of patients with asthma. However, these interventions would be best aimed at patients who are at greater risk of hospitalisations.

Thus, risk stratification and identification of the burden of 'high risk asthma patients for hospitalisation' is essential in adopting these interventions cost-effectively. The objective of this study was to estimate the prevalence of 'high-risk asthma patients' and selected risk predictors for hospitalisation among asthma patients aged ≥20 years in the district of Gampaha.

A community-based descriptive cross-sectional study was conducted among patients with asthma aged 20 years and above in the district of Gampaha. Multi-staged cluster sampling technique was used to select the total study sample of 1200 patients. Sample size was determined based on the minimum sample required to detect the expected prevalence of 'high risk for hospitalization' among adult asthma patients, with a predetermined level of precision of 3% and 95% confidence interval. The effect of clustering was overcome by making a correction for design effect. An additional 14% was added to the minimum sample required, to account for non-response among participants. The risk for hospitalisation was assessed using a newly developed and validated risk prediction model, containing ten risk predictors with an individual risk score assigned to each predictor. The summary risk score of the model ranged from 1-11. An interviewer administered questionnaire was used to obtain information on risk predictors of the risk prediction model. High-risk asthma patients were defined according to the cutoff value of the summary risk score of the

model. Patients who scored more than the cut-off value of 4.5 were considered as 'high-risk patients' for hospitalisation. Data collection was done by two pre-intern medical officers and two student nursing officers. Data were analyzed using SPSS version 20.

Table 1: Predictor variables in the newly developed risk prediction model and the weighted scores assigned to them.

Predictor variable	β coefficient	Assigned score
Age ≥ 60 years	0.910	1
Educated ≤ G.C.E. O/Level	0.719	1
Having Diabetes Mellitus	0.609	1
Family history of asthma	0.625	1
Ever smoked	1.022	1
Ever intubated/ given ICU care	1.194	1
Previous hospitalisations due to exacerbations	1.619	2
Uncontrolled asthma	1.232	1
Having symptomatic GORD	1.029	1
BMI ≥ 25 kg/m^2	0.889	1
Total score		11

The study gave a response rate of 93.8% (1125/1200). The age of the asthma patients ranged from 20-86 years with median age of 61 years (IQR 12). The prevalence of 'high-risk asthma patients' for hospitalization due to exacerbation was 16.4% (95% CI:14.2-18.6). The prevalence of selected risk predictors were: age ≥ 60 years 24.2% (95% CI:21.9-26.7), poor educational attainment 67.3% (95% CI:64.5-70.0), having diabetes mellitus 18.8% (95% CI:16.5-21.0), family history of asthma 41.3% (95% CI:38.5-44.2), ever smoked 12.2% (95% CI:10.2-14.1), ever intubated, or given ICU care 2.8% (95% CI:1.8-3.7), previous hospitalisations due to exacerbations 6.6% (95% CI:5.1-8.0), having uncontrolled asthma 63.6% (95% CI:60.8-66.7), having symptomatic gastroesophageal reflux disease(GORD) 18% (95% CI:15.7-20.2), and having BMI ≥ 25 kg/m^2 36.3% (95% CI:33.5-39.0). A significant proportion of patients with asthma are at risk of hospitalisation due to exacerbation of symptoms. This indicates the need to adopt cost-effective asthma management strategies to achieve better control of the disease. Prompt primary healthcare interventions are required to address modifiable risk predictors for hospitalisation among asthma patients.

Keywords: Asthma; Exacerbation; Hospitalisation; Prevalence; Risk predictors

A Study on Symptom Distress Among Transfusion-Dependent β-Thalassemia Patients in North-Western Province, Sri Lanka

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Abstract

β-thalassemia is a common inherited blood disorder with a higher prevalence in Sri Lanka, particularly in the Northwestern province. It is categorized into transfusion-dependent (TDBT) and non-transfusion-dependent (NTDBT) types based on blood transfusion needs. TDBT patients require regular transfusions for survival. Most TDBT patients in Sri Lanka live with the disease throughout their lives and often experience illness-related symptoms affecting their quality of life. Despite the recent improvements in management, the attention given to assess their quality of life is inadequate. Therefore, assessing the illness-related symptoms with a reliable tool is vital to improve the quality of life of these patients.

The Symptom Distress Scale (SDS) is one of the most valid and reliable tools for assessing symptom distress in chronic illness. Since TDBT patients also suffer from most of the symptoms in SDS, the use of such an informative, validated scale enables the capture of the symptom distress of these patients. Therefore, this study aims to assess the extent of symptom distress among TDBT patients and the associated factors among TDBT patients in Northwestern Province, Sri Lanka, using the SDS.

A descriptive cross-sectional study was conducted among adult TDBT patients registered in thalassemia centres (TH-Kurunegala and DGH-Chilaw) in the North Western Province. A TDBT patient was defined as a patient receiving more than eight blood transfusions during the previous year following the diagnosis of β-thalassaemia by haemoglobin high-performance liquid chromatography (HPLC). A

self-administered questionnaire with 13 Likert-type (5-scale) questions consisting of self-rated symptom distress scales (nausea, loss of appetite, insomnia, pain, fatigue, bowel symptoms, lack of concentration, appearance, breathing difficulty, outlook, and cough) was administered to 228 TDBT patients selected based on the stratified random sampling method.

The majority of the participants were males (n = 130, 57%). The median age of participants was 22 (interquartile range (IQR) = 18–26, range = 18–65). The majority of the participants were educated up to the ordinary level (168, 73.7%). The median age of the first blood transfusion among participants was 6 months. The median number of blood transfusions during the previous year was 104 (IQR = 22.5–156, Range = 12–208). All patients were either on one or two iron chelators, with most patients on two iron chelators (128, 56%).Fatigue (200, 87.7%), body pains (154, 67.6%), change in appearance (98, 42.9%), insomnia (66, 29%), loss of appetite (56, 24.6%), and breathing difficulties were the main symptoms that TDBT patients experienced. No one had experienced a change in bowel habits or a cough. The participants rated the disruptions of these symptoms to their day-to-day lives on a scale of 1 to 5. Among the symptoms, fatigue (mean = 2.815, SD = 0.7234), body pain (mean=2.043, SD=0.906), change in appearance (mean=1.859, SD=0.994), insomnia (mean=1.518, SD=0.934), and loss of appetite (mean=1.377, SD=0.709) were reported as the most distressing. Collective symptom distress was rated on a scale of 0 to 52 (mean=6.395, SD=3.848). There was no significant difference in collective symptom distress with gender (T=-1.82, DF=223, p=0.07), usage of parental iron chelators (T=-0.17, DF=216, p=0.919), or number of oral iron chelators (T=0.51, DF=217, p=0.613). However, higher symptom distress was observed among patients with gross craniofacial manifestations (T=-3.58, DF=207, $p<0.05$). There was no significant correlation of symptom distress with age at initial blood transfusion (r=0.033, CI=-0.097, 0.163), pre-transfusion haemoglobin level (r=0.053, CI=-0.078, 0.182), number of blood transfusions during the previous year (r=0.088, CI=-0.042, 0.216), or serum ferritin level (r=0.143, CI=0.013, 0.268).

This research concludes that TDBT patients suffer symptoms that disturb their quality of life, particularly fatigue, body pains, facial appearance changes, insomnia, and loss of appetite. Patients with craniofacial manifestations have significantly higher symptoms of distress. Therefore, this study suggests that attempts should be made to minimize disease morbidity caused by these symptoms to improve the quality of life and well-being of TDBT patients.

Keywords: Sri Lanka; Symptom distress scale; Thalassemia major

Unveiling the Impact of Glucotoxicity Caused by Insulin Protein Misfolding and Safeguarding Insulin Protein Folding by Plant Antioxidants

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Abstract

The perspective on diabetes mellitus has traditionally focused on elevated blood glucose levels and insufficient insulin secretion by pancreatic β-cells. When considering the pathophysiological causes of type I diabetes mellitus a limited attention has been given to investigate the defects in insulin protein processing that leads to insulin protein misfolding. Misfolded insulin protein in the β-cell endoplasmic reticulum (ER) triggers the unfolded protein response (UPR), leading to cell apoptosis. Alterations in UPR of pancreatic β-cells have been observed in type I diabetes mellites, suggesting that defects in insulin protein processing as a pathophysiological cause. Various genetic factors, including insulin gene mutations have been proposed as triggers for insulin protein misfolding. Due to insulin misfolding and apoptosis of pancreatic β-cells leads to chronic exposure of elevated glucose level developing glucotoxicity. Glucotoxicity can affect cellular metabolism of β-cell leading to dysfunction of β-cell, progressing to type I diabetes mellites.

Conventional understanding suggests that cellular oxidants, such as reactive oxygen species (ROS), play a major role in stimulating protein misfolding. The unregulated production of cellular oxidants in β-cell can contribute to insulin misfolding. To counteract this, cellular antioxidants are crucial to maintaining the redox homeostasis and safeguarding the protein folding process. Interestingly, antioxidants are abundantly present in natural substances such as leaves and fruits of many plants. Thus, in the Sri Lankan community, the use of plant materials as a treatment for type I diabetes mellites has been a part of the traditional medicine practice for generations.

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Herein, we assessed the potential of antioxidants found in various plant leaves to mitigate insulin protein misfolding and aggregation. Additionally, we explored potential metabolic aberrations in pancreatic β-cells induced by glucotoxicity. The selected plants were ranawara, walkoththamalli, thebu, and heen bovitiya, all of which have been used for centuries in traditional Sri Lankan medicine to treat diabetes mellitus. The antioxidant activity of the aqueous extracts of the leaves of these plants was compared based on DPPH radical scavenging activity. Subsequently, an in vitro spectroscopic assay was developed to determine how oxidants stimulate the insulin protein aggregation. Then, the ability of the antioxidants in selected plant leaves to reduce formation of insulin protein aggregates was determined. Moreover, the effects of glucotoxicity in pancreatic β-cell metabolism was observed by exploring the protein expression levels with Western blot analysis.

The antioxidant activity of the leaves of the selected plants varies in the order of thebu (IC50:4.63 µg/mL), heen bovitiya (IC50:55.5 µg/mL), ranawara (IC50:278.5 µg/mL), walkoththamalli (IC50:488.5 µg/mL). Spectroscopic measurements at 275 nm wavelength revealed that insulin protein underwent aggregation when exposed to increasing concentrations of H_2O_2, with the most pronounced aggregation at 0.1% and higher concentrations of H_2O_2. The aggregation of insulin protein was significantly reduced when treated with plant extracts. 57% reduction was observed with Thebu (dry weight of 0.2 g), while 26% reduction was showed with Heen Bovitiya (dry weight 0.2 g). Moreover, a noticeable downregulation of insulin and proinsulin synthesis, as well as upregulation of caspase 3 and proteins involved in fatty acid synthesis were observed with Western blot analysis under elevated glucose exposure in INS-1 cells.

This study identifies insulin protein misfolding and aggregation as potential mechanism that contribute to pancreatic β-cell dysfunction and development of glucotoxicity in type I diabetes mellitus. Based on these preliminary findings, we highlight the potential therapeutic role of antioxidants present in local plant materials for managing type I diabetes mellitus and its associated complications.

Keywords: Antioxidants; Diabetes Mellitus, Glucotoxicity; Insulin, Misfolding

A Review on Composition and Functional Properties of Copra-Derived Coconut Oil (CDCO) and Virgin Coconut Oil (VCO)

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Abstract

Coconut oil is one of the most widely used cooking oils in Asia for centuries. It has evolved beyond culinary uses to find applications in diverse areas. Despite the concerns about its health impact, recent research has uncovered its potential as a functional food, offering health benefits beyond basic nutrition. Coconut oil has grown its popularity due to its biological properties, which include anti-diabetic, antioxidant, anti-inflammatory and antimicrobial properties. However, the consumption of coconut oil is still undervalued due to the lack of supporting scientific evidence. Studies show that the composition of coconut oil can be changed and thus its biological properties, depending on the types of coconut oil extracted using different methods. This abstract discusses composition and functional properties of different types of coconut oils, with a specific focus on copra-derived coconut oil (CDCO) and virgin coconut oil (VCO).

Online databases were used to identify papers published in 2002-2022, from which we selected 92 publications using key words and phrases; coconut oil, copra oil, virgin coconut oil, coconut oil composition and biological properties of coconut oil. According to published literature, major phenolic acids identified from coconut oil are protocatechuic acid, p-coumaric acid, vanillic acid, gallic acid and ferulic acid, while the major flavonoids identified are catechin, apigenin, and kaempferol. Total of 28 phenolic compounds have been identified from coconut testa, including 16 phenolic acids and 12 flavonoids. Coconut testa contains the highest content of

phytochemicals quantitatively and qualitatively compared to the white coconut meat. The presence of these phenolics and flavonoids are highly varied based on the extraction procedure, coconut variety and coconut maturity. Therefore, there is a higher possibility of having more phytochemicals in CDCO than VCO because the testa is removed during the production of VCO. Phenolic content of coconut oil from Wet Whole Coconut (WCW), Wet coconut white kernel (WCWK), Wet coconut testa (WCT), Copra whole (CW), Copra white kernel (CWK), Copra testa (CT) have been studied and Total Phenolic Content (TPC) was found to be more in the CW and CT than in the oil extracted from WCWK. It has been demonstrated that drying of the coconut does not have a significant effect on the polyphenolic content of the oil. However, TPC content is highly varied (64 ± 5 µg /g of oil – 12.54 mg/g of oil) among different types of coconut oil extracted from various techniques. It has been reported that VCO consists of different types of tocopherols including alpha, beta, gamma, delta-tocopherols and tocotrienols while showing a wide variation of quantity depending on extraction techniques. Alpha tocopherol content varied from 0.5 ± 0.0 mg/100g of oil to 22.00 ± 1.00 mg/g of oil. Both CDCO and VCO consist of different phytosterols and phytostenols; campesterol, sitosterol, stigmasterol, avenasterol, brassesterol, cycloartenol, sitostenol campestenol. Total phytosterol content in coconut oil ranged from 22.5 mg to 95.1 mg per 100 g of oil samples extracted from various methods. It has been reported that percentage fatty acid composition cannot differentiate among the types of coconut oil, whether VCO or CDCO as they have relatively similar fatty acid composition both quantitatively and qualitatively. Many *in-vitro* and *in-vivo* studies suggest anti-diabetic, anti-inflammatory and antioxidant properties of VCO. Limited research has done to investigate the biological properties of CDCO. However, it is known the main constituents that exert biological properties; phytochemicals are concentrated in coconut testa, which is included in CDCO.

Overall, the evidence suggests that coconut oil is one of the edible oils that contain a range of phytochemicals such as phenolic compounds, tocopherols and phytosterols. These compounds are responsible for biological activities including antioxidant, anti-inflammatory and antidiabetic as proved from *in-vitro* and *in-vivo* studies. Most of the reported studies are focused on VCO even though CDCO contains more bioactive compounds due to the presence of testa. There is currently insufficient evidence to determine which type of coconut oil is superior. However, further studies are imperative to investigate the specific phytochemical profiles and biological effects of both VCO and CDCO.

Keywords: Coconut Oil; Copra Oil; Phytochemicals; Virgin Coconut Oil

Russell's Viper (*Daboia rusellii*) Bite Patterns in Anuradhapura District: Insights from the Anuradhapura Snakebite Cohort

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Abstract

Snakebite is a serious public health concern in Sri Lanka that causes devastating acute and long-term effects. Russell's viper (*Daboia russelii*) (RV) is medically important than any other snake in Sri Lanka, because it causes over one-third of snakebites, frequently causing life-threatening envenoming and is responsible for two-thirds of the snakebite deaths. To effectively prevent RV bites, identifying the RV bite exposure pattern is crucial. This study aims to analyse data from the Anuradhapura Snakebite Cohort (ASC) to identify recent patterns of confirmed RV bites in the Anuradhapura district. Anuradhapura snakebite cohort prospectively records demographic, epidemiological and clinical data of snakebite victims who were admitted to the Teaching Hospital, Anuradhapura from 1st January 2018 to 31st December 2022. We extracted and analysed the demographic information of 413 RV bite patients in the ACS reported during 5-year period from January 2018 to December 2022 to describe the RV bite pattern in Anuradhapura district.

RV bite accounted for 27.3% (413) of all authenticated snakebites (1512) during the study period. Most victims were males (326, 79.3%), and the median age of a victim was 42 years (IQR= 32.5-53). The majority (321, 79.5%) were involved in farming as the primary or secondary occupation. Farmers (245, 61.1%), housewives (35, 8.7%), security forces (31, 7.7%) and manual labourers (21, 5.1%) were the major occupational groups of victims. The majority of RV bites (191, 46.9%) occurred in farmlands, while home garden and roadside bites accounted for 122 (29.9%) and 33 (8.1%) cases, respectively. Among the farmland settings, the highest number of RV bites occurred in paddy fields (153, 80.5%) and chena cultivations (33, 17.4%). The largest proportion of bites (106, 25.7%) took place during a specific 3-hour period

from 6.00 pm to 9.00 pm. However, a distinct daytime bite predominance was observed in the overall bite pattern, as 256 (62%) bites occurred between 6.00 am and 5.59 pm, while only 157 (38%) bites occurred between 6.00 pm and 5.59 am. Monthly snakebite incidence showed two peaks in a calendar year with peaks in March to May and September to November (Figure 1). The highest number of bites was recorded during October. At the paddy fields, peak incidences were seen during November, whereas at chena cultivations it peaked during October. Most bites occurred while walking in the field (247, 59.8%). Engaging in agricultural work (90, 21.8%), and cleaning outdoors (20, 4.8%) were other common circumstances of snakebite. Foot (338, 82.8%) was the predominantly bitten site, followed by the ankle (25, 6.1%) and leg (19, 4.7%). The majority (365, 88.4%) of the bites were unprovoked.

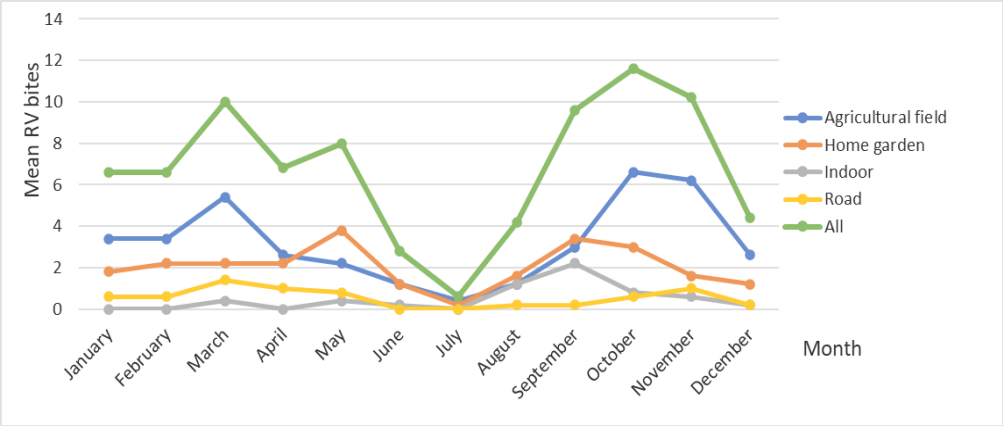

Figure 1: Monthly variation of mean RV bites.

This study reveals that the typical victim is a middle-aged male, who sustains the bite on the foot while actively engaging in agricultural activities. Moreover, the monthly snakebite incidence exhibits a bimodal pattern, peaking in February-April and September-November align with the agricultural (harvesting) seasons of the area, albeit with slight variations across different settings. The highest peak of cases from September to October in both farmlands and home gardens could potentially be due to the larger numbers of RV due to the breeding season occurring in June and July. These findings provide information for enhancing current preventive guidelines and community education programs on Russell's viper bites. However, to fully assess the applicability of these findings to existing preventive strategies, further research is required to gauge the stakeholders' perspectives on snakebite perception and intervention strategies.

Keywords: Russell's Viper Bite; Snakebite Epidemiology; Sri Lanka

Second-Degree Heart Block (Mobitz Type 1) During the Late Febrile Phase of Dengue Fever: A Case Report

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Abstract

Dengue virus infection is endemic in Sri Lanka. While Dengue is typically feared for its potential to induce shock through capillary leakage, clinical manifestations of dengue cover a wide range. Second-degree heart block following dengue fever is a rare complication. Mobitz type I block (Wenckebach block phenomenon) is progressive PR interval prolongation until a P wave fails to conduct. A patient with typical dengue symptoms presented, having fever for three days, headache and thrombocytopenia with Dengue NS 1 antigen positive. Mobitz type 1 second-degree heart block developed on day seven of the illness during the late febrile phase of dengue. She has been previously evaluated for chest pain and the electrocardiogram (ECG) was normal, but the echocardiogram showed myxomatous mitral valve. This 23-year-old girl who is a trained athlete presented to the medical ward of North Colombo Teaching Hospital, with a history of fever for 3 days, headache, retro-orbital pain with no vomiting and bleeding. On examination, her blood pressure was 100/60 mmHg, pulse rate 60 beats per minute.

Peripheral white blood cell count (WBC) on day four was 3.93 x 10^9 /L haemoglobin 12.1 g/dL, and the platelet count was 70 x 10^9 /L. Liver function tests showed mild elevation of liver enzymes; alanine transaminase (ALT) 48 U/L (<40) and aspartate transaminase 51 U/L (<40). Dengue NS1 antigen was positive confirming the diagnosis of dengue fever. Serum sodium level was 142 mmol/L and potassium level was 3.7 mmol/L. Abdominal ultrasound showed no evidence of vascular leakage.

Dengue pre-critical monitoring was initiated. Fluid management was initiated as oral fluid during daytime and IV fluids were administered during the night. Paracetamol 1 g was given for fever. On day seven of the illness, she developed chest

discomfort, and an ECG was done. It revealed a second-degree heart block - Mobitz type 1. She was hemodynamically stable. Blood pressure, Pulse rate, and SPO_2 measurements were done at 2 hour intervals. All the parameters were within the normal range. Troponin I test was done which was negative. A cardiology referral was done and a 2D (two-dimensional) Echocardiogram was performed. 2D eco cardiogram showed the ejection fraction was 60% with mild mitral regurgitation. Myocarditis was excluded by the 2D echocardiogram. Holter monitoring was performed, and it confirmed a Mobitz type 1 second-degree heart block. She was discharged with a cardiology clinic follow-up plan. After six months repeat ECG was taken and the second-degree heart block Mobitz type 1 was still present suggesting a long-term atrioventricular block due to dengue fever.

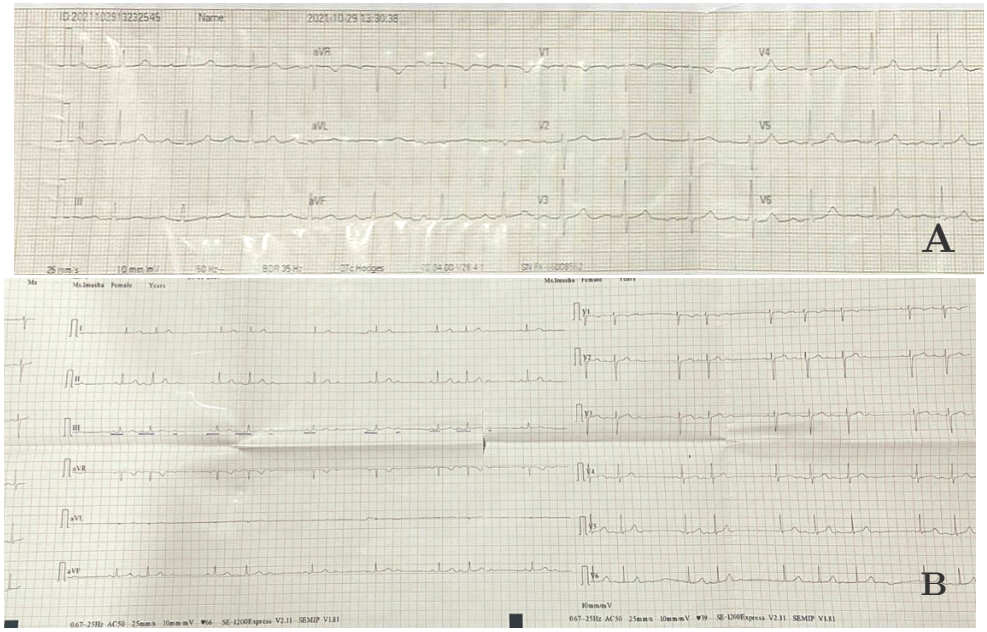

Figure 1: A: ECG of the patient taken prior to dengue fever while investigating for chest pain, B: ECG taken during the late febrile phase of dengue fever.

Recognition of cardiac involvement in dengue is crucial. Rhythm abnormalities are rare but can be a potentially fatal complication of dengue fever. The primary treatment for dengue, which is fluid resuscitation, relies heavily on the stability of the cardiovascular system. Thus, this case highlights the importance of performing timely ECG in dengue patients for identifying cardiac involvement.

Keywords: Dengue Fever; Mobitz type 1; Second-degree Heart Block

Medical Education and Community Medicine

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Factors Affecting the Academic Performance of Medical Students in Anatomy at a State University of Sri Lanka

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Abstract

Medical students will ultimately become medical practitioners working for the progress of the country's health sector, and their academic performance plays a vital role in producing the best quality graduates. Knowledge and experience gained during the first two years at medical faculty will have a significant impact on their future career success. Anatomy is a fundamental preclinical subject, which provides the foundation for future clinical practice.

In Sri Lanka, only a few studies have been conducted on factors affecting academic performance in Anatomy which are based on assessment methods only. Therefore, the objective of this study is to determine the factors affecting the performance of medical students in Anatomy, in the second MBBS comprehensive examination, at the Faculty of Medicine, Wayamba University Sri Lanka. These include personal factors, factors within the medical faculty, factors related to the academic program, factors related to the subject, and factors related to teaching and assessment methods. A descriptive cross-sectional study was conducted among students of the first three batches of the Faculty of Medicine, Wayamba University Sri Lanka. A pre-tested validated questionnaire was distributed among the students as a Google form after getting informed consent. The questionnaire was distributed among 279 students:71 students from the first batch, 66 students from the second batch, and 142 students from the third batch. Data was analysed using SPSS (version 23) software (Frequencies and Chi-square test). A total of 169 students participated in the study and the response rate was 60.5%. Out of them, 113 (66.9%) were females representing the majority and 56 (33.1%) were males. Out of the participants, 156

(92.3%) students passed, and 13 (7.7%) students referred in Anatomy in the second MBBS examination on their first attempt. 10 students had distinctions in Anatomy. According to the perception of the students, personal motivation (81.1%), residence during studies (72.8%), and personal time management in the module (72.2%) were the main factors that had a positive impact on their performance in Anatomy, out of the personal factors. Only 53.3% of the students responded that the financial cost of their studies was favourable, showing a negative trend. All the factors within the medical faculty had a positive impact on their performance, while laboratory facilities (90.5%), internet facilities within the faculty (88.7%), and adequacy of models in Anatomy (88.2%) represented the highest rates. Out of the factors related to the academic program, student support/mentoring programs (73.9%) represented the main factor that had a positive impact.

Only 55.6% responded that the workload of the module was favourable showing a downward trend. Out of the factors related to the subject, number of practical sessions (74.6%) and number of lectures (75.8%) had the highest positive impact while the volume content of the module (59.8%) had the least. Teachers' clear explanation (88.8%), teachers' patience in the classroom (81%), reviewing theory in practical classes (83.5%), and explanation of relevant clinical points (88.8%) were the factors perceived to have the highest positive impact out of the factors related to teaching. When considering assessment methods structured essay questions (87%) and extended matching questions (84.7%) had the highest positive impact on performance as perceived by students. Only 59.1% of students responded that the time duration given for preparation in examinations has a positive impact, showing a negative trend. There was a significant association between students' attendance in lectures and performance in Anatomy ($p<0.05$), but there was no association between attendance in practical sessions and performance ($p>0.05$). There was no significant association between gender and performance in Anatomy ($p>0.05$). Nor was there any association between the A/L attempt at university entrance ($p>0.05$) or A/L Biology result ($p>0.05$) and performance in Anatomy. According to the study results, it is obvious that there are many factors affecting the performance of medical students in Anatomy.

Further improving the factors with positive impact and making necessary amendments to the modifiable factors with negative impact will be important in improving the performance of the students in Anatomy in the future.

Keywords: Academic Performance; Factors; Medical Students; Anatomy

Knowledge and Attitudes Towards Genomic Medicine and Pharmacogenomics among Medical Students of Wayamba University of Sri Lanka

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Abstract

Genomic medicine is an emerging practice of medicine that is being used to provide personalized treatments for patients. Genomic medicine uses an individual's genetic profile to guide the decisions that are being made in regard to the prevention, diagnosis, and treatment of the diseases. Pharmacogenomics (PGX) observes the influence of the entire genome on the drug response. The knowledge and attitudes of medical practitioners on genomic medicine and PGX is very important in the future world as it guides the medical professionals to get an understanding about the patient's genetic profile to provide proper medication or therapy to a specific individual patient.

Herein, this study evaluated a sample of students in the Faculty of Medicine, Wayamba University of Sri Lanka to determine their knowledge and attitudes toward genomic medicine and PGX and how their knowledge and attitudes varied with regards to their academic year.

A validated questionnaire was distributed as a Google form with a participation information sheet among all five batches of the students. The responses were collected and analysed using Microsoft excel and R software. To assess the knowledge on genomic medicine and PGX, scores were generated from 0-12 by adding one point for each correct answer for given questions. Recommended cut-off valves were scored as, >10 (Excellent), 10-8 (Good), 8-5 (Average), <4(Poor).

The study results revealed that the level of knowledge on genomic medicine and PGX among medical students at Wayamba University is average (6.96, n=232), based on the established scoring system. Comparison across different academic years indicated that knowledge about genomic medicine and PGX did not significantly differ based on year of study: first year (8.81, n-36, response rate 55%), second year

(7.75, n=48), third year (8.8, n=50), fourth year (9, n=40), fifth year (8, n=58). Furthermore, differences in attitude towards genomic medicine and PGX were observed based on specific questions. A positive attitude towards genomic medicine and PGX was exhibited by 37% of the students, who also displayed a willingness to participate in genetic research. Regarding the concept of employing genomic medicine for the identification of severe genetic disorders, a majority (71%) of the students expressed agreement. Additionally, a significant portion (41%) of the students were inclined to contribute their biological material to a bio-bank for future investigations. However, 55% of the students believed that sharing personal genetic information could have detrimental effects on their health. Moreover, approximately 57% of the students were disinclined to permit the analysis of their genomes, fearing potential implications for medical insurance. The notion that it is premature to implement genomic medicine and PGX in Sri Lanka was shared by 48% of the students. A neutral attitude (86%) was observed among the students regarding the availability of genetic testing for families with a history of severe hereditary ailments.

In conclusion, our findings highlight an average level of knowledge among students, with no difference across academic years. While a positive attitude towards genomic medicine and PGX was evident in a notable proportion, concerns regarding data privacy, insurance implications, and the timing of implementation also surfaced. These insights highlight the need for comprehensive education and open dialogue to effectively integrate genomic medicine into future medical practice.

Keywords: Genome; Pharmacogenomics; Genomic Aedicine; Knowledge; Attitude

The Resilience Level and Associated Factors Among Medical Undergraduates in a Selected University in Sri Lanka

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Abstract

As defined by psychologists, "Resilience is the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress such as family and relationship problems, serious health problems, or workplace and financial stressors". In addition to "bouncing back" from difficult situations, resilience can lead to immense personal growth. Resilience is considered a complex biological and psychosocial adaptation to internal and external demands.

Youths are a group of people who undergo various challenges and stressors in their lives. Undergraduates are special among youths, who face stressors at a greater extent. Amongst them, the medical undergraduates, obviously face many more live a highly demanding university life. This is a period in which they have to experience novel life events, challenges, and stressors such as meeting totally new peers, being subjected to peer pressure, being involved in romantic relationships, facing competitive examinations and managing financial hardships in present day circumstances. All the changes these undergraduates face as described above, makes them vulnerable to fail at their professional development and psychological balance. If they lack resilience, they are likely to deviate, and be subjected to psychological vulnerability in their adulthood. Therefore, the objective of this study is to assess the resilience level and associated factors among medical undergraduates in a selected university in Sri Lanka.

A descriptive cross sectional study was conducted among medical undergraduates in Faculty of Medicine, Wayamba University of Sri Lanka. There are five batches in the faculty of Medicine, WUSL. All the medical undergraduates (N= 578) currently registered in the faculty of Medicine were enrolled in this study. The two study instruments for collecting data are 14-item resilience scale (Globally accepted

questionnaire which was validated in Sri Lankan context) to assess the resilience level and self-administered questionnaire to gather associated factors of resilience. After obtaining the consent, the study instruments were distributed and the data collected. In 14 Item Resilience Scale, the resilience score ranged from 14 to 98 with higher scores indicating a higher resilience. Based on the resilience score, six levels of resilience were identified namely: High (91-98), Moderately high (82-90), Moderate (74-81), On the lower end (65-73), Low (57-64) and Very low (14-56). The data analysed using Statistical Package for Social Sciences (SPSS) software version 22.0. Magnitude of resilience was described as proportions and expressed as percentages and 95% confidence intervals(CI). Multivariate logistic regression was carried out to identify associated factors of low resilience. Probability <0.05 was selected as the significant level. The results were expressed as odds ratios (OR) and 95% confidence intervals (CI).

The response rate was 85.3% (492/578). Majority were females (n = 341, 69.3%). Eighty-six percent were Sinhalese (n= 421). Overall resilience score ranged from 15 to 98. The median was 73.0 and interquartile range was 67 to 79. Among all undergraduates, levels of resilience are as follows; High 3.9% (n=19; 95%CI = 2.3%-6.0), Moderately high 15%(n = 74; 95% CI =12.0% -18.5%), Moderate 30.1%(n =148; 95% CI = 26.1% -34.3%), On the lower end 30.7% (n= 151; 95%CI = 26.6% -35.0%), Low 9.3% (n=46; 95%CI = 6.9% - 12.3%) and Very low 11.0% (n = 54; 95% CI = 8.4% -14.%). Latter three low levels comprised just above one half (51%) of medical undergraduates. The low level of resilience was highest among the third batch (55.1%), and lowest among second batch (36.7%). Among first batch, 54.4% were low resilient and that of fourth and fifth batches, 52.8% and 49.5% respectively. Male sex (OR=2.4; 95% CI=1.2-4.8; p=0.024), not engage in extracurricular activities (OR=2.2; 95% CI=1.2-4.2; p=0.015) and getting angry frequently (OR=3.0; 95% CI=1.5- 6.0; p=0.003) were significantly associated with low level of resilience.

Observed low level of resilience was higher than that of adolescents in Sri Lankan context. Except the sex, the other two associated factors were modifiable hence corrective remedies are recommended. Resilience enhancing intervention is recommended as half of the medical undergraduates are having low level of resilience.

Keywords: Resilience; Medical Undergraduates; Associated Factors of Resilience

A Study on The Usage of Library Resources by Preclinical Phase Medical Students of an Emerging Medical Faculty in Sri Lanka

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Abstract

Academic libraries play a vital role in higher education. Most importantly, the proper usage of library facilities by undergraduate medical students plays a major role in updating their knowledge, research, and innovations in the field of medical science. Proper utilization of library resources is important in every aspect of the undergraduate medical education. The faculty of Medicine, Wayamba University Sri Lanka is an emerging medical faculty in the country and the resources and infrastructure of the faculty are still under development. The medical library is extensively used by the undergraduate medical students. Therefore, it is important to identify what is expected as against what is available in the current library system and take necessary actions to improve the quality of the library experience of students in this newly established medical faculty. Considering the above facts, the main objective of the current research is to study the usage of library resources by undergraduate medical students of faculty of Medicine Wayamba University of Sri Lanka.

A descriptive cross-sectional study was conducted. The study population (297) was consisted of first year and second year students of the faculty who are currently engaged in the pre-clinical phase academic activities in the Kuliyapitiya premises. A google form containing the self-administered questionnaire was distributed among the students to collect relevant data. The data analysis was performed using IBM SPSS Statistic 20 software. In the selected student population, 265 students responded to the survey and the response rate was 90%. The frequency of library visits was analysed and found out that 50% of students (N=132) visit library very often out of which 11% (N=29) visited the library daily basis. It further shows that 50% (N=133) of students visit the library whenever necessary. Further it was found out that majority of the students preferred to use the library in weekdays (N =176,

66%) whereas 86 (33%) students preferred weekends and only 3 students (1%) preferred to use library on public holidays. Purpose of visits gives essential information about the services that are required for the library users and helps in improving the services and facilities to provide better service to its users. Figure 1 summarizes the purpose of visits to the medical library.

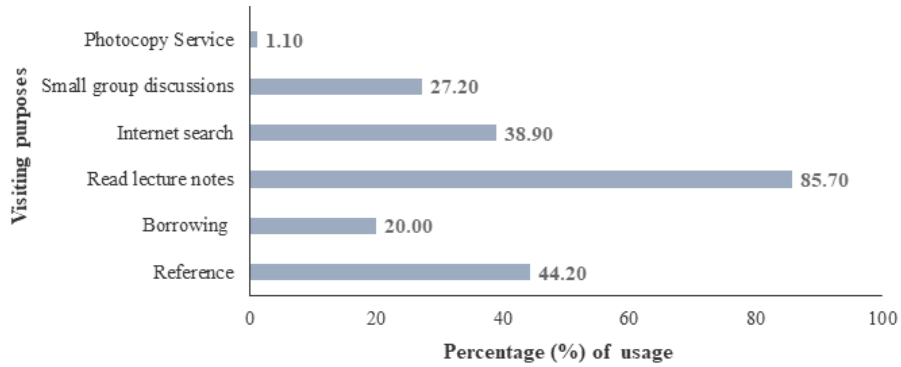

Figure 1: Different purposes of library visits.

According to our data majority of students (86%) come to the library to read lecture notes or to study whereas 44% come to refer textbooks in the reference section. Interestingly, 27% of students visits library to have small group discussions while 39% visit library to utilize internet service. 1% of students use the photocopy service of the library. In user satisfaction data on different library services and facilities majority of the respondents are satisfied about current opening hours, cleanliness, seating capacity, lighting, staff service, security, and availability of catalogues of the medical library. In this study we also wanted to check students' opinion on the library orientation programme. According to our data majority of respondents (75%) mentioned that the orientation programme is very helpful for them. In the survey an open-ended question was given for additional comments and suggestions. In this section many students requested to increase the number of small group discussion areas, improve the internet facility as well as photocopy service of the library, which are also important findings of our data. In conclusion, our study showed that undergraduate medical students of Wayamba University are mostly satisfied with the facilities and services provided by the medical library. However, according to our data, the photocopy service, computer, and internet facilities as well as small group discussion facilities of the library should be improved to provide high quality library experience to our students.

Keywords: Medical Library Services; Medical Education; References; Small Group Discussions

Assessment of Nutritional Status and its Relationship to Diet and Physical Activity among Undergraduate Students of Wayamba University of Sri Lanka

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Abstract

Nutritional status is the sum total of an individual's anthropometric indices as influenced by intake and utilization of nutrients, which is determined from information obtained by physical, biochemical, and dietary studies. University students may face difficulties of getting a good diet, maintaining a proper nutritional status and being physically active since they are in a transition of where they staying away from family home and they tend to develop poor eating habits and lifestyle. This study was conducted to assess the nutritional status and its relationship to diet and physical activity among undergraduate students of Wayamba University of Sri Lanka. The sample size for the study was calculated using OpenEpi, version 3, open source calculator for a 95% confidence level, a standard deviation of 0.5 and a ± 5% confidence interval. A descriptive cross-sectional study was done with the 384 voluntary participation of 3rd year undergraduates of all six faculties of Wayamba University of Sri Lanka proportionately. After obtaining ERC clearance from the ERC committee, Faculty of Medicine and requesting permission from relevant authorities, the data collection was done after receiving written consent from the volunteers. The anthropometric measurements such as weight, height and waist circumferences were taken from the students first. The online questionnaire & 24-hour dietary recall was then circulated among them. For the calculation of BMI, height and weight measurements were obtained using standard guidelines. Body mass index (BMI) was calculated. Then, individuals were categorized based on the BMI cut-off values recommended for Asian populations by WHO expert consultation as underweight < 18.5 kg/m^2, normal 18.5-22.9 kg/m^2, overweight 23-24.9 kg/m^2 and obese ≥ 25 kg/m^2. Men with waist circumference of ≥ 90 cm and women with waist circumference of ≥ 80 cm were identified as having central obesity. Anthropometric data (height, weight, BMI & etc), dietary data (dietary diversity score) and physical activity data were then analyzed using the IBM SPSS version 27. Pearson Correlation test was used to

assess the relationship of nutritional status to diet and physical activity. Out of 384 students who have participated, the prevalence of underweight, normal, overweight and obese BMI categories was 23.7%, 48.2%, 12.2% and 15.9% respectively according to WHO cut off values for Asians. From total of 260 females in this population, the percentages of underweight, normal, overweight and obese students were 25.4%, 50%, 11.5% and 13.1% respectively while from total of 124 males, the percentages of underweight, normal, overweight and obese students were 20.2%, 44.4%, 13.7% and 21.8% respectively (Re. Table 1). According to the waist circumference measured, 20.8% of the population was suffering from central obesity. After entering the university life 64.8% have experienced weight loss while 12.5% have experienced weight gain. The mean Dietary Diversity Score was 6.11 and accordingly 41.9% have consumed 6 different food groups in a day. Consumption of 3,4,5,7,8,9 and 10 food groups were 0.3%, 3.4%, 22.9%, 23.4%, 6.5%, 1.6% and 0% respectively.

The students who have consumed cereals and starchy food, coconut-scraped/ milk, oils, pulses, vegetables and green leaves, fish/lean meat were 100%, 97.7%, 98.2%, 91.4%, 70.1% and 89.8% respectively showing high percentages while students who have consumed fresh milk and its fermented products, eggs, fruits and nuts/oily seeds were 28.1%, 24.2%, 9.6% and 1.6% respectively showing very low percentages as shown in figure 1. The prevalence of high (>3000 Met-min/week), moderate (between 600 and 3000 Met-min/week) and low (<600Met-min/week) physical activity levels was 10.2%, 60% and 29.8% respectively among 235 students responded to International Physical Activity Questionnaire according to the guidelines for analysis of International Physical Activity Questionnaire. The conclusion drawn by this study was that 23.7%, 12.2% and 15.9% of the undergraduates of Wayamba University of Sri Lanka were underweight, overweight and obese respectively and underweight was more prevalent among females while overweight and obesity were more prevalent among males. There was no apparent association between nutritional status and diet or physical activities (P>0.01).

Table 1: Prevalence of underweight, normal, overweight and obese BMI status among 3rd year undergraduates of WUSL.

Gender	Underweight	Normal	Overweight	Obese
Female	25.4%	50%	11.5%	13.1%
Male	20.2%	44.4%	13.7%	21.8%
Total	23.7%	48.2%	12.2%	15.9%

Keywords: Underweight; Overweight; Obesity; Dietary Diversity; Physical Activities

The Influence of Sleep Quality, Knowledge and Practices of Sleep Hygiene on Daytime Somnolence and Burnout of Medical Students in the Faculty of Medicine at Wayamba University in Sri Lanka

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Abstract

The sleep habits of medical students are worth researching; as poor sleep quality has been linked to poor academic performance among medical students. Thus, this study was conducted to describe the influence of Sleep Quality and Knowledge and Practices of Sleep Hygiene on Daytime Somnolence and Burnout among Medical Students in the Faculty of Medicine at Wayamba University in Sri Lanka.

This cross-sectional online survey was conducted after obtaining ethical clearance from the ethics review committee of the faculty of medicine at Wayamba University of Sri Lanka. All the students of the faculty were considered eligible after excluding students who are on treatments for a psychiatric illness, sleep disturbance, or chronic illnesses. The questionnaire was created with literature survey, and face and content validity were assessed with experts' opinion. The 60 questions were organized under subheadings of demographic data, sleep hygiene, sleep quality, perception of burnout, and daytime sleepiness. The questionnaire was pre tested before use. It was distributed as a Google Form, and informed consent was obtained before entering the questionnaire. The data was analyzed using MiniTab 18 software.

The size of the population was 430 which consists of 293 females (68%) and 137 males (32%). The response rate for the study was (N=196) 45%. The average age of the sample was 22.7±1.4 with 73% of the participants being females. Sleep hygiene was a known and understood term for 21.9% of the participants, while another 49.5% had heard the term but didn't know the meaning. 28.6% had not heard the term at all.

The majority (73.5%) of the students sleep around 4-6 hours per day, and none sleep less than 4 hours. 83% perceived their sleep quality as satisfactory, but only 57% were satisfied with their sleep quality during exams. The number of students who perceived reduced quality of sleep increased with the advancing academic year, and the association was statistically significant (p value = 0.004). Participants agreed on taking naps during the day (62.8%), going to bed immediately after eating (67.3%), falling asleep while using a screen device (75.5%), going to bed with an empty stomach (76%), and worrying about spending the day on the bed before falling asleep (79.6%) as practices disruptive to sleep, and also exercising in the late afternoon or early evening (66.3%), going to bed with a book (66.8%), putting away smart devices 30 minutes before going to bed (81.1%), and having a regular sleep schedule (91.3%) as practices that are beneficial to sleep. Only 22% of the participants were familiar with the term "sleep hygiene." 50% of students had heard the word but didn't know the meaning, while 28% had not heard the term at all.

Three-fourths of students (74.5%) experience daytime sleepiness. But it is not associated with their sleep quality (p value = 0.469). According to 59% of students, 1 p.m. to 2 p.m. is the sleepiest period, and the sleepiest academic session was lectures for 79% of students. For this sleepiness, the lecturer (74.5%) played a more significant role than the subject or module (61.7%). 52.6% of the participants said they feel sleepy during the day, even without scheduled academic sessions. Except for 17.9% of the participants, the rest usually take a daytime nap. However, during weekends or vacations, only 51.5% take daytime naps.

57.7% of the participants experienced burnout in their day-to-day lives in the medical faculty. The feeling of burnout in the students is associated with their daytime sleepiness (p value = 0.007) and also with sleep quality (p value = 0.005). Sleep hygiene plays an important role in having quality sleep. Even though the majority of the students were not aware of the term, they knew the good and bad practices for getting quality sleep. As sleep quality affects daytime sleepiness and burnout, taking measures to improve sleep quality will be beneficial for better academic performance.

Even though there is an association between poor-quality sleep and burnout, a significant number of students who are satisfied with their sleep quality experience burnout. Further studies are needed to find other possible reasons for burnout. It is known that burnout per se causes poor sleep, and this vicious cycle needs to be broken to improve the quality of life of medical students.

Keywords: Sleep Quality; Sleep Hygiene; Daytime Somnolence; Burnout

Combination of Multiple Teaching Tools in Learning Biochemistry: Perceptions of Undergraduate Medical Students

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Abstract

Medical schools worldwide use different teaching methodologies mainly in the form of traditional didactic lectures, tutorials, practical and small group discussions. Multiple teaching tools for medical undergraduates in biochemistry play a pivotal role for overall understanding of the subject and its applicability in clinical medicine. The purpose of this study was to implement combination of multiple teaching tools topic wise; to evaluate students' perceptions towards usefulness and acceptability of combination of tutorials, case-based learning sessions (CBL) and flipped classrooms when they were supplemented with coordinated didactic lectures (DLs) at regular intervals and also to evaluate the student's perception toward usefulness of formative assessments. Needs assessment was done in the form of students' feedback to identify the inadequacies of existing teaching methods. The students' felt difficulty to follow the content delivered in didactic lectures, if there is no regular discussion with teachers in the form of tutorial, small group discussion or CBL. Based on the needs assessment, multiple teaching tools and flipped classroom were introduced as alternatives for didactic lectures to improve students' learning.

A quasi-experimental study was conducted over a period of 15 weeks on one hundred and forty-five (145) medical students of preclinical phase of the Faculty of Medicine, Wayamba University of Sri Lanka. Teaching methods were formulated in the Metabolism and Nutrition Module including multiple teaching tools. Formative assessments were conducted simultaneously with feedback to students in a step wise manner to each student individually. The students were exposed to both traditional didactic classrooms and flipped classrooms sessions. After the completion of didactic lectures on a particular topic a tutorial class was conducted for better

understanding and deep learning. This was followed by CBL on the same topic. During CBL sessions, a case with specific learning objectives and structured questions were discussed by a facilitator. At the end of teaching a particular topic using multiple tools, a formative assessment was conducted with multiple choice questions and short answer questions. Students' perception was collected by pretested questionnaire regarding usefulness and acceptability of multiple teaching tools, formative assessments and flipped classroom versus traditional classroom.

Majority (94%) of students felt that basic information given in didactic lectures (DLs) was appropriate with good coordination between didactic lectures and practical (94%) as well as DLs and tutorial sessions (92%). The students also opined that cases discussed gave an insight to the biochemical basis of various conditions (79%) and showed clinical applicability of biochemistry to Medicine (86%). Most of the participating students suggested that tutorials helped them to plan their study (92%), focus on what to be studied (94%), encouraged active participation with better retaining of subject (94%). Regarding coordinated approach with multiple teaching tools, most students felt that it was useful toward: better understanding of the subject (94%), better retaining of the subject (94%), better communication skills (78%), and better preparation for course end exams (94%). Most students agreed Flipped classroom improved their teamwork skills (75%) and self-directed learning ability (70%), motivation and engagement to learning (80%) and allowed them to have access to the lectures at their own space (70 %). Although 77% of them agreed that flipped class was more interesting than traditional class room. Majority of the students (95%) agreed the teacher and peer group feedback was helpful for self-assessments and improvements.

The use of combination of multiple teaching tools separately for each topic would improve the understanding and retaining of the subject as perceived by the students. Majority of the students felt that formative assessment with feedback reinforces their ability to perform better. Flipped classroom model was more effective in improving students' performance than traditional classroom model. Students appreciated the effective use of CBL sessions at the point where it is required during the process of learning. In addition, multiple teaching tools and introduction of flipped classroom enhanced active participation of students in the learning process.

Keywords: Multiple Teaching Tools; Flipped Classroom; Tutorials in Biochemistry; Didactic Lectures; Formative Assessment

Anatomy and Surgery

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Investigating the Role of Serum Vascular Endothelial Growth Factor-A as an Additional Indicator in Prognosis Prediction of Oral Squamous Cell Carcinoma and Oral Potentially Malignant Disorders

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Abstract

Oral squamous cell carcinoma (OSCC) is a cancer with abysmal prognosis affecting specially the South East Asian countries, including Sri Lanka where high disease prevalence is existing. Most commonly, OSCC is preceded by oral potentially malignant disorders (OPMD). Usually, their diagnosis and timely management is delayed as the lesions commonly remain unnoticed or ignored by the patients or the usual histological examination of tissue may not be adequate to predict its prognosis as there is inter and intra-observer variations in interpretations. However, identifying the biomarkers produced by the tumour cells along with usual histological examination may have an added advantage. Vascular endothelial growth factor (VEGF), is one such biomarker, which plays a key role in angiogenesis; the process of forming new blood vessels in both OSCC and OPMDs. Depth of invasion (DOI) described as the distant from the neighbouring healthy epithelium to the deepest point of the invading cells is a reliable indicator of lymph node metastases and overall survival. Dysplasia in OPMDs comprises a loss in the uniformity of individual cell as well as loss in architectural orientation, which is usually graded as mild, moderate, and severe is considered an adverse histological feature in OPMD malignant transformation. However, limited studies have been conducted to assess potential high risk histological features along with expression of VEGF A biomarker in OSCC and OPMDs. The aim of this study was to determine the expression of serum VEGF A (which is considered as the central regulator of angiogenesis and it is minimally present in normal healthy individuals) in OSCC and OPMDs, using

enzyme-linked immunosorbent assay (ELISA) and assess its expression in the presence of potential high risk histological features of OSCC and OPMDs.

A case-control study was undertaken including histologically confirmed OSCC and OPMD and normal healthy individuals matched with sex and age ± 5 years with 25 participants per each group. Individual matching was done to eliminate confounding factors and to gain increased efficiency in the study. There were 5 females and 20 males in each group individually matched for sex and age ± 5 years for the participants of the other two groups.

ELISA was performed with 1:2 dilution in duplicates and standard curve was created in by plotting known concentrations of a reference antigen against the mean readings obtained for each concentration. Unknown values were detected using the created standard curve. The data on histological grade described according to the WHO classification, TNM stage, and depth of invasion (DOI) in mm OSCC and degree of dysplasia, basal cell destruction and apoptosis in OPMD were obtained from the histology report issued by the Consultant Histopathologist following the histopathological assessment of the tissue. The mean serum VEGF A level in OSCC was 486.5 pg/ml ±254.2 pg/ml,375.5 pg/ml ±240.7 pg/ml in OPMD, and 135.23 pg/ml ±44.91 pg/ml in controls. Serum VEGF A concentrations were significantly high in OSCC compared to controls (p=0.00). OPMD patients also had significantly high VEGF A concentrations compared to controls(p=0.00). Although the mean value was higher in OSCC compared to OPMD there was no significant difference observed between OSCC and OPMD patients (p=0.124). A correlation was noted between serum VEFG A level and stage of the cancer (r= 0.788 CI=0.527,0.913), histological grade (r=0.252, CI=0.166,0.593) and DOI (r=0.361, CI=0.053,0.669) in OSCC patients. A correlation between degree of dysplasia and VEGF A level in OPMDs was also observed (r=0.647, CI=0.301,0.843). Significantly high serum VEGF A levels in OSCC and OPMDs compared to controls indicates its value as a potential biomarker for OSCC and OPMDs. Further, the correlation between higher circulating level of serum VEGF A with adverse histopathological features including stage, histological grade and DOI in OSCC and degree of dysplasia in OPMDs shows the potential of VEGF A to be used as an additional aid to usual histopathological diagnosis in predicting disease progression and severity of OSCC.

Keywords: Angiogenesis: Biomarker; Oral Potentially Malignant Disorders; Oral Squamous Cell Carcinoma; VEGF A

Perceptions on Challenges to Practice Nila Vedakama among Traditional Practitioners in Sri Lanka: A Qualitative Study

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Abstract

Nila Vedakama is a distinct form of traditional medicine that has strong historical and cultural connections to Sri Lanka. However, despite its significance, the practice faces numerous challenges that threatens its continuation and integration into contemporary healthcare system. This qualitative study explores in to the perceptions of traditional practitioners regarding the challenges that Nila Vedakama encounters in the modern era. By conducting thorough interview, this research illuminates the intricate complexities associated with Nila Vedakama and suggests potential pathway for its preservation and advancement. Nila Vedakama, a complex traditional healing practice, is marked by its relatively minor presence within the contemporary healthcare system of Sri Lanka. Because there is lack of solid proof about Nila Vedakama, it is even more important to acknowledge and study it as a valuable way of treating things. This research aims to understand the difficulties Nila Vedakama is dealing with by looking at it from the viewpoint of traditional practitioners. Their thoughts are important because of the concerns of Nila Vedakama being not widely growing and accepted.

Employing a qualitative research approach, this study comprised of a total of 16 in-depth interviews conducted among traditional practitioners who practice Nila Vedakama, representing all provinces of Sri Lanka as follows; Western province – 03, Central province – 02, Southern province – 02, Sabaragamuwa province – 02,

Northern province – 01, Eastern province – 01, North-Central province – 02, North-Western province – 02, Uva province – 01. Data saturation was achieved with the last two interviews having similar data as previous interviews. Through in-depth interviews, participant's rich experiences and viewpoints were captured. Thematic analysis was employed as the analytical framework to identify recurring themes and patterns within the data, illuminating the challenges besetting Nila Vedakama. The study's findings uncover a network of interrelated challenges afflicting Nila Vedakama. Traditional practitioners, who are guardians of this ancient knowledge, have identified a variety of issues. Participants identified challenges embedded in following themes; governance-related challenges, transmission and inheritance of knowledge and public awareness and accessibility.

Governance- related challenges included the lack of state protection, and governmental support, emergence of counterfeit practitioners, which resulted in a lack of formal recognition and resources for the practice. The issues of transmission and inheritance of knowledge included, disruptions in knowledge transfer, monopoly over practice, limited systematic knowledge and theoretical explanation, scarcity of information on knowledge mechanism, misconception, threat of cultural bias against traditional practices, erosion of indigenous knowledge, fragmented transmission of knowledge with families. Moreover, the issues related to public awareness and accessibility included, lack of information among the general public and limited accessibility to intricacies of internal body.

The findings of this study underscore the vital role of government intervention and regulatory legislation in addressing the multifaceted challenges of Nila Vedakama. The results highlighted the immediate requirement to protect traditional knowledge and foster wider acceptance of Nila Vedakama within society. To preserve this complex practice, it's important for practitioners, policy makers and the wider community to work together, bridging the divide between ancient wisdom and modern healthcare. With Nila Vedakama facing the risk of becoming obsolete, it's crucial to take deliberate actions to secure its lasting legacy as a valuable part of Sri Lanka's cultural and healing heritage.

Keywords: Antioxidants; Diabetes Mellitus, Glucotoxicity; Insulin, Misfolding

Prevalence of Visible Dental Caries and Associated Factors in 15-Year-Old School Children in Kurunegala Educational Zone

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Abstract

Prevalence of dental caries is accompanying with various factors including poor oral hygiene, poor awareness on oral hygiene, bad tooth brushing techniques, low economy, low education level of the country, drinking water, familial conditions and difficult in accessibility to dental care centres etc. In Sri Lanka, a middle income country the national prevalence of dental caries in children including adolescents is comparatively low, still it is a health issue that has to be thoroughly assessed because it is a preventable disease, through simple and cost-effective interventions, whereas treatment is costly. Few studies have been done in Sri Lanka to find the prevalence of dental caries among children, adolescents and associated factors and those studies were also limited to Colombo district. In Sri Lanka during the school medical inspections (SMI), dental status is examined and treated in grade 1, 4,7,10. Despite these dental services the rate of dental caries is high. The probable reason may be that the children are not subjected to annual dental screening as child is screened once in three years. Since grade 10 is the final grade that is examined under the SMI. Therefore, this study was aimed to determine visible dental caries and associated factors among 15-year-old school children in Kurunegala educational zone. A descriptive cross-sectional study was conducted among 400 subjects of 15-year-old students in four selected schools in Kurunegala educational zone by convenience sampling on a basis that ensures the sample representing the target population. All 4 schools were selected from the peripheral urban schools using convenience sampling excluding the schools in the centre of the town and the most rural schools to reduce the bias to match with the normal population's demographic characteristics. Sample size was calculated using Open Epi, version 3, open source calculator. According to open Epi calculation sample size came as 384.15 which was rounded 400 for convenience. After obtaining ERC clearance from the ERC committee, faculty of medicine and getting permission from relevant authorities, a

clinical examination was conducted among all the students who gave written consent to find visible dental caries, distribution of the caries, extracted teeth and filled teeth and neglected dental caries. 25% of the calculated sample size was taken from each school. After the examination, two Self-administered questionnaires were given to students to assess associated factors of visible dental caries such as sex, race, residency, school, sweet food consumption, type of tooth paste used, frequency of tooth brushing, frequency of changing the tooth brush, currently wearing braces, frequency of visiting the dentist, distance to nearest dental clinic, house hold income, parent's education level and parent's occupation and to identify the level of awareness on oral hygiene among students.

The questionnaire used to assess the knowledge and awareness on oral hygiene. Out of the questionnaire, only 12 questions were selected which were appropriate for our setting and population and given 1 mark per each correct answer. The study scored the awareness in to 3 categories as, 0-4 poor knowledge, 5-8 average knowledge, 8-12 reflects good knowledge. The collected data was analysed using R Studio to determine the prevalence of dental caries and correlation of associated factor with dental caries. Out of 400 participants, 56.3% have dental caries. Decayed tooth were the main contributors of the caries as a percentage 59% while 33% filled and 8% missing teeth. Out of the affected teeth 75% were molars, 23% were premolars while incisors and canines were each 1%. According to the result analysis out of the assessed factors, prevalence of dental caries increased with sweet food consumption (P value – 0.003). Prevalence of dental caries decreased with increased frequency of tooth brushing (P value- 0.011), frequency of changing toothbrush (P value – 0.023), and frequency of visiting the dentist (P value – 0.013). Awareness score: 75.5%-good, 22% - average, 2.5% - poor and the level of awareness was not associated with the prevalence of dental caries in statistical significance testing. (P value=0.674).

The conclusion drawn by this study was that 56.3% of the study population have dental caries. Sweet food consumption significantly associated with increased prevalence of dental caries. Tooth brushing, changing toothbrush and visiting dentist were significantly associated with the decreased prevalence of dental caries. Majority of subjects had a good awareness score (75.5%) and the level of awareness was not associated with the prevalence of dental caries. Prevalence is high in spite of the good level of awareness implies the issues in knowledge versus the practices. There is a need to implement a system to bring the knowledge on oral hygiene to day-to-day practices among school children in Sri Lanka.

Keywords: Dental Caries; 15-year-old Students; Kurunegala Educational Zone

The Influence of Static Stretching Exercises to Flexibility of Hip Flexors, Calf Muscles among Male Football Players from Selected Football Clubs in Kegalle District

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Abstract

Football players need to have flexible lower limb muscles. Players should have average hip and leg flexibility because these muscles are used for kicking and passing the ball, especially in high-stress scenarios. Flexibility is also essential to prevent muscular injuries. It is reported that the flexibility of muscles in the lower limb of football players varied with age, playing additional sports, the person who supervised players, additional stretching sessions etc. There is not much evidence on the relationship between flexibility of hip flexors and calf muscles and variable factors such as age, playing additional sports, the person who supervises players, additional stretching sessions etc. Therefore, the objective of this study was to determine the influence of static stretching exercises and other factors on the flexibility of hip flexors and calf muscles among male football players from selected football clubs in Kegalle district. Sample size of study was calculated using the formula n= Z (1-α/2) 2SD2 /d2 and 117 participants were recruited for the study. Convenience & random sampling methods were used. Ethical approval was obtained by the Ethics Review committee of the Faculty of Medicine, University of Colombo. Permissions from each football players and coaches were obtained. Four football clubs were selected randomly from the Kegalle district. Recruitment of the sample was done with consecutive purposive sampling until the sample size was achieved. The flexibility of hip flexors & calf muscles of selected individuals was measured using the modified Thomas test & goniometry measurement of calf muscles respectively. Interviewer-administered questionnaire was given to collect data regarding involvement in static stretching exercises and practice sessions of football players. In the Modified Thomas test, each participant's hip joint angle was

measured from starting position, straight leg supine position considering as neutral position. Investigator had to take the joint angle as positive value when tested leg rose up from neutral position and negative value when tested leg drop down from neutral position. Calf muscle flexibility was measured with range of motion of active dorsiflexion of the ankle by using a standard goniometer. All the measurements were taken bilaterally.

The mean age of the sample, duration of playing football as a sport attached to sports clubs and the duration of a football practice session were 23.69±2.15 years, 7.35±2.92 years and 172.50±13.06 minutes respectively. The mean values of the number of football practice sessions per week, value of the hip joint angle of the dominant side, hip joint angle of the non-dominant side, ankle joint angle of the dominant side and ankle joint angle of the non-dominant side were 2.75±0.44, (-2.16±4.75^{o}), 1.395±4.851^{o}, 20.19±4.39^{o} and 18.02±3.76^{o} respectively.

Significant correlations were found between the hip flexor muscles and calf muscles flexibility of players and the number of practicing sessions that players participated per week ($p<0.05$), the hip flexor muscle flexibility and the duration of a particular stretch (static stretch) in the warm-up period ($p>0.01$). Furthermore hip flexors, calf muscles flexibilities showed a significant difference between who played additional sports and those who played football only ($p<0.05$). Significant correlation was found between the hip flexor muscles flexibility of players and the measured side of the body (dominant side or non-dominant side ($p<0.01$), the calf muscles flexibility of players and the measured side of the body (dominant side or non-dominant side ($p<0.05$). No significance was found between the hip flexor muscles and calf muscles flexibility with age and how long they have played ($p>0.05$).

Although most of the studied factors in this study affect the flexibility of hip flexors and calf muscles, the number of practical sessions that players participated per week, duration of a particular stretch in the warm-up period, and playing additional sports are the most powerful factors that affect the flexibility of hip flexors and calf muscles. The number of repetitions of stretching and age of the player do not directly affect the flexibility of hip flexors and calf muscles of the football players.

Keywords: Calf Muscles Flexibility; Football Players; Hip Flexor Flexibility; Stretching Exercises

Risk of Falls in Elderly Patients with Type 2 Diabetes Mellitus Attending Diabetes Clinic in Teaching Hospital Kegalle, Sri Lanka

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Abstract

Type 2 diabetes mellitus is a chronic metabolic disease and one of the major non-communicable diseases in the world. According to the International Diabetic Federation, in 2019 approximately 463 million adults (20-79 years) were living with diabetes. Complications of diabetes such as peripheral neuropathy, poor vision, sarcopenia, higher rate of morbidity and mortality, reduced muscle strength can contribute to falls in elderly population. The Epidemiology Unit of Sri Lanka reported that, over 80% of fall-related injuries among general population occur in low and middle-income countries and 60% with deaths. Therefore the main objective of this study was to determine the risk of falls in elderly patients with type 2 diabetes.

This study was a cross-sectional analytical study with a sample size of 100 calculated by the formula n= Z $(1\text{-}\alpha/2)^2$ SD^2 $/d^2$ and convenience sampling was used in this study. Approval was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Colombo. Permission was obtained from the Director of Kegalle Teaching Hospital in Sri Lanka to conduct the research and from the consultant of the diabetic clinic of Kegalle Teaching Hospital Sri Lanka. Balance, lower limb muscle strength and other risk factors for falls were evaluated. Balance was measured using a mobility test named Timed 'Up and Go' test. Participants were instructed to stand from a standard chair and walk a distance of 3 meters, turn, walk back to the chair, and sit down. The time taken to perform the test was measured using a stopwatch. Cut-off value of the test was 13.5 seconds (s) and patients who were taken >13.5 seconds to complete the test were considered as having high falls risk and patients who were taken <13.5 s to

complete the test were considered as having lower risk of falls. Lower limb muscle strength was measured using a digital hand-held dynamometer (Lafayette Manual Muscle tester) in bilateral knee extensors and ankle dorsiflexors. Dynamometer placed perpendicular to the test surface, instructed to perform maximum isometric contractions and maintain for 5s. The maximum force was recorded. Other information was gathered using an interviewer-administered questionnaire and it included questions regarding their personal information, health related information and risk factors for falls. Data was entered and analysed using the Statistical Package for the Social Sciences (SPSS) version 23.0. Descriptive analysis was done to identify the distribution of Timed "Up and Go" test completion time, lower limb muscle strength and other health-related information. Independent sample T-test, Chi-square test, Pearson correlation and one way ANOVA were used to analyse the data.

Mean age of the sample was 67(±4) years and mean balance test completion time was 10.57±1.93 s. According to the balance test cut-off value, 6% of the study population had a high falls risk as their test completion time was >13.5 s. Mean bilateral knee extensor and ankle dorsiflexor strengths were 18.29±3.61 kg and 9.36±2.04 kg respectively. Mean duration of diabetes of the patients was 9.5 years. More than half of the sample (55%) used insulin, 30% had high blood pressure, 9% had previous falls and 72% had self-reported vision impairments. Significant relationships were identified between knee extensor strength and test completion time ($p<0.05$), and use of insulin and test completion time ($p<0.05$). Furthermore significant correlation was found between previous falls and test completion time ($p<0.05$), vision impairments and test completion time ($p<0.05$), and knee extensor strength and previous falls ($p<0.01$). Participants who showed high falls risk had mean knee extensor strength of 14.56 kg which is lower than the patients with low falls risk (18.66 kg) and it was statistically significant ($p<0.05$). All the participants who had previous falls (6%) showed a greater risk of falls according to the cut-off values of the balance test ($p<0.05$).

Reduced bilateral knee extensor muscle strength, previous falls, vision impairments and use of insulin may affect the balance of this population. Furthermore higher duration of diabetes also can increase the risk of falls. But these risk factors could be different according to age and gender.

Keywords: Balance; Elders; Muscle Strength; Risk of Falls; Type 2 Diabetes

Distribution, Prevalence, and Patterns of Hand Injuries Presented to Teaching Hospital Kuliyapitiya – A Pilot Study

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Abstract

Hand injuries are among the most common type of injuries to the body. They account for 28.6% of all body injuries. It can cause a huge effect on activities of daily living of the patient. A descriptive observational cross-sectional study was conducted among the patients admitted to the surgical unit B of Teaching Hospital Kuliyapitiya for the period of three months from 1st of March to 31st of May in 2023. The study was designed to find the distribution, prevalence, and patterns of hand injuries. All the patients admitted to the surgical unit B with isolated wrist and hand injuries were included while patients with multiple injuries were excluded. A self- developed questionnaire which consist of 15 questions was used to get the basic demographic data, injury related details and outcome. All the data were collected by a house officer after explaining the study and obtaining informed written consent. Data was analysed using MiniTab18 software.

26 patients (3 females and 23 males) who fulfil the inclusion criteria were analysed in this Pilot study. Out of the total participants 88.5% were right handed and there were no ambidextrous people. 53.8% hand injuries were of right hand and 42.3% were of left hand while only 3.8% had both hands injured. Complete healing was observed in 57.7% injuries while 11.5% needed repeated wound toilet. From the remaining patients 3.8% of injuries were infected which needed repeated antibiotics courses; the rest of the patients could not be followed up. 11.5% of injuries were presented to the hospital 1h after the injury and 26.9% and 27% were presented after 2-6h and 6-12h respectively. 19.2% were presented after 12-24h of injury and 15.4% of injuries were presented after more than 24h of injury. The distribution and location of hand injuries are presented in Figure 1.1. Majority (50%) of the patients had their education up to GCE O/L while 11.5% had schooled up to grade 6,

another 11.5% up to grade 8, 3.8% and 11.5% up to grade 9 and 10 respectively. Only 3.8% of patients had followed higher studies. Out of these injuries 34.6% were direct machinery related injuries, while 30.8% accounts for domestic injuries. Road traffic accident accounted for 19.2% injuries and weights fallen on the hands and assaults contributed for each 7.7%.

These results match with the findings of a study done in Poland and study conducted in Sri Lanka, in 2020. This is a pilot study and it will be continued until a sufficient sample is collected for descriptive analysis.

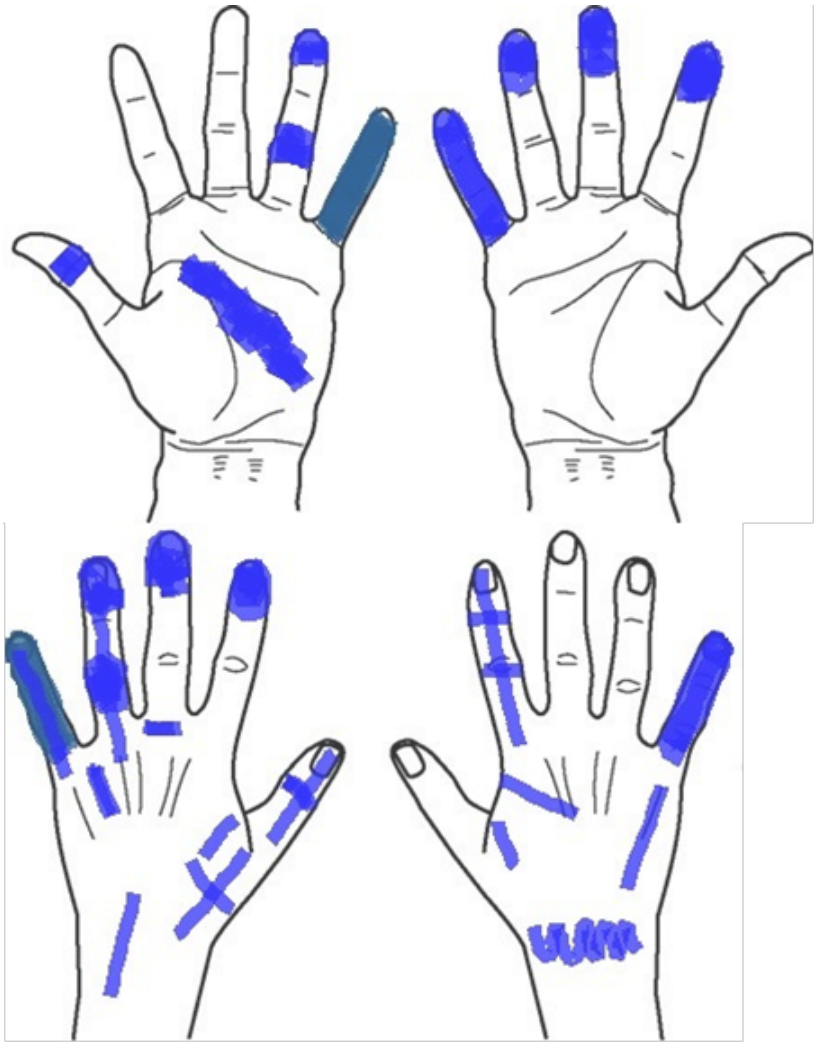

Figure 1: Pattern of hand injuries.

Keywords: Hand Injury; Teaching Hospital Kuliyapitiya

The Outcome of the Cellulitis Patients Presented to a Teaching Hospital in Sri Lanka – A Pilot Study

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Abstract

Cellulitis is a skin infection involving the skin's subcutaneous and superficial layers. A significant number of patients are admitted to the surgical wards with cellulitis. The specific objectives of this descriptive, cross-sectional study was to determine the underlying factors associated with cellulitis and the outcomes of these patients. Ethical clearance for the study was obtained from the ethical review committee of Teaching Hospital Kuliyapitiya. All the patients admitted to surgical unit B with a clinical diagnosis of cellulitis during the period of 3 months starting from 1st of March to 31st of May, 2023 were included in this study. The patients with cellulitis due to infected eczema and those on septic shock were excluded. Data was collected using a self-developed interviewer-administered questionnaire by a house officer after obtaining informed written consent. Data analysis was conducted using MiniTab 18 software.

The sample consisted of 39 females (mean age = 58.46±16.17) and 38 males (mean age = 58.95±15.43) with duration of illness ranging from 1 day to 35 days. Out of the total study group, 68.8% of the patients had not received any treatments before admission. The majority of the study group (45.5%) were having stage 2 cellulitis at the time of presentation. Out of the remaining patients, 33.8% had stage 1 cellulitis whereas 15.6% and 5.2% were in stage 3, and 4 respectively. All patients were assessed with inflammatory markers such as white cell count (WBC) and C-reactive protein (CRP). High WBC count was observed in 57.75% of patients and 57.89% of them had high neutrophil count. CRP was elevated in 95.65% of patients. Both inflammatory markers were elevated in 62.22% of patients. None of the markers were elevated in 4.44% of patients with a clinical diagnosis of cellulitis. 3.9% of patients with cellulitis underwent ultrasound imaging to assess the depth of extension and possible collection of pus. Serum creatinine (Scr) and fasting blood sugar (FBS) were tested in all patients. Out of the total 95.65% had increased serum creatinine without any past medical history of renal disease. While already

diagnosed diabetes patients accounted for 45.5% of the study group, 89.67% of the rest had elevated Fasting Blood Sugar levels.

The hospital stays of these patients ranged from day 1 to 30 with a mean of 6 days. The most commonly performed surgical intervention was incision and drainage for formed abscesses (18.2%). Wound toilet was carried out in 3.9 % of patients, whereas 2.6% of patients needed skin grafts. Of those skin grafts 1.3% had to undergo wound toilet after the necrosis of the grafted skin. Unfortunately, 2.6% of patients died due to complications of cellulitis, and 71.4% were managed with antibiotics alone. None of them underwent minor or major amputations. Identified reasons for cellulitis in these patients were ulcers (26%), secondary lymphoedema (14.3%), fissures (10.4%), trauma (6.5%), diabetes mellitus with neuropathy (2.6%), primary lymphedema (1.3%), varicose veins (1.3%), and fungal infections (1.3%) while an exact reason couldn't be identified in 36.3% of patients. In relation to the region of the body involved, the majority of the patients had cellulitis in the legs (71.4%) followed by hands (9.1%), thighs (1.3%), and feet (1.3%).

It is more important to stress that a significant number of patients had elevated serum creatinine without a previous history of renal impairment which did not return to normal levels even after recovery from cellulitis. Similarly, a considerable number of unrevealed diabetic patients were detected with routine testing of fasting blood sugar levels among cellulitis patients which did not return to normal levels during the follow-up period. Further studies are required to develop a more descriptive analysis and conclusions.

Keywords: Cellulitis; Skin Infection; Infection

Morphometric Comparison of Ancient Mandibles Excavated from the Prehistoric Sites of Sri Lanka with Modern Sri Lankan Mandibles

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Abstract

The human mandible is one of the facial bones, vital for creating facial architecture. The craniofacial morphology of humans has undergone considerable morphological and morphometric changes as they evolved. Therefore, comparing ancient and modern human mandibles will distinguish human evolutionary trends over time and reveal morphological and morphometrical variations of mandibles in different eras. In addition to that, this would discover the affinities between ancient and modern populations by the presence of ambiguous traits. Although numerous studies have been conducted internationally to compare ancient and modern human mandibles, only a small number of investigations have been conducted in Sri Lanka to determine the mandibular morphological and morphometrical variations between different eras. The objective of this study was to compare the morphometry of the prehistoric mandibles of the human skeletons discovered at Sri Lanka's prehistoric sites of Batadombalena, Belilena, Bellanbedipelessa, and Potana, which date back between 4,500 and 5,000 years ago, with the mandibles of the present-day population available at the medical faculties at Wayamba University and the University of Peradeniya. A total of 10 dry prehistoric mandibles, including 5 male mandibles and 5 female mandibles from the National Museum, Colombo, and National Museum, Sigiriya, and 39 dry modern mandibles including 16 female mandibles and 23 male mandibles from the Department of Anatomy, Faculty of Medicine Wayamba University Sri Lanka, and from the Department of Anatomy, Faculty of Medicine, University of Peradeniya were used in this study. Mandibles with pathological abnormalities were excluded. A total of 6 measurements were taken from the mandibles using the digital vernier calliper and the mandibular meter. A single observer did all the measurements, each measurement was taken thrice, and the mean was taken for analysis. The measurements of the prehistoric

mandibles were compared with the corresponding measurements of the modern mandibles according to gender, by using SPSS 23.0 version. Means were calculated and the comparisons were done using the independent samples t-test.

The mean mandibular length of the ancient male mandibles was 99.70± 6.45 mm and that of the modern male mandibles was 82.92±6.52 mm while the value of ancient female mandibles was 102.50 mm and that of the modern female mandibles was 80.08±5.75 mm. The mean bicondylar breadth of the ancient male mandibles was 121.56±11.56 mm while the measure of modern male mandibles was 114.81±4.34. The ancient male mandibles had a mean bigonial breath of 101.56±5.75mm, while the modern male mandibles had a value of 93.82±5.52mm. The mean bigonial breadth of ancient female mandibles was 98.00±2.82mm and that of modern female mandibles was 92.90±8.41mm. The mean breadth of the mandibular body of the ancient male mandibles was 13.26±0.80mm and of the modern male mandibles was10.78±1.88mm, while the value for ancient female mandibles was 12.15±1.36mm and modern female mandibles was 10.70±1.66mm. The ancient male mandibles had a mean minimum mandibular ramus breadth of 42.18±5.08mm while the value for the modern male mandibles was 31.52±2.41mm. The mean minimum mandibular ramus breadth of ancient female mandibles was 34.32 ±3.96mm while that of modern female mandibles was 31.32±3.41mm. The mean mandibular angle of the ancient male mandibles was 120 while that of the modern mandibles was 127.37±7.35. According to the study, there was a statistically significant difference in the mean mandibular length of males (p=0.00) and females(p=0.002), mean bicondylar breadth of males (p=0.05), mean bigonial breadth of males (p=0.032), mean breadth of the mandibular body of males (p=0.036) and the mandibular ramus breadth of males (p=0.00), between ancient and modern mandibles. The world literature has suggested that the mandible has become smaller during the evolution of humans due to environmental factors and specifically due to dietary habits. According to this study, it is evident that most of the measurements of the modern mandibles including the mandibular length of males and females, bicondylar breadth of males and females, bigonial breadth of males and females, breadth of the mandibular body of males and females, minimum mandibular ramus breadth of males and females, are lesser than that of the ancient mandibles. This study has proven the fact that there is a reduction in the general size of the mandible from ancient populations to the modern population of Sri Lanka, which is compatible with the studies done on the evolution of the mandible among different populations around the globe.

Keywords: Human Mandibles; Morphometry; Prehistory; Present Population

The Histopathological Assessment and Quantification of Thermal Bowel Injury in a Human Cadaveric Specimen

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Abstract

Iatrogenic accidental burns can occur in internal organs during surgery, especially in scenarios where the operative field is limited such as laparoscopy. The bowel is by far the most frequently vulnerable organ followed by stomach, liver and bladder depending on the surgical procedure. However, there are instances where inadvertent thermal bowel injury lead to significant post-op morbidity and mortality. Further, some of these injuries may go unnoticed as they occur outside the surgeons viewing field. As the exact incidence of accidental thermal bowel injury during laparoscopic surgery in Sri Lanka is unknown, the aim of this study was to explore the possible extent of these injuries in a cadaver. A healthy undamaged bowel extracted 12 hours after the death of a 70 years old female died due to intracranial haemorrhage following a road traffic accident was used. The ethics review committee of Faculty of Medicine, Wayamba University of Sri Lanka and the ethics review committee of teaching hospital Kuliyapitiya, has granted ethical approval for the study. The family of the deceased was informed before the post-mortem and their consent was taken for obtaining the bowel for research purpose.

The diathermy procedure was carried out 13 hours after the death. The cadaver was in a freezer until the time of post-mortem and the removed bowel was transferred to the theatre in normal saline. The bowel was kept for one hour in room temperature before the procedure. Different places along the small bowel and the large bowel were burnt using varying Wattages and times, by keeping Wattage constant for varying times (5W, 10W, 20W, and 40W for 1s, 3s, 5s and 10s) and vice versa.

Two points were burnt with same Wattage and time as controls using Covidien ValleyLab Force FX monopolar diathermy with standard coagulation diathermy setting, and the total sample number were 64. Once the procedure was completed, the bowel was transferred to the histology lab in formalin. The samples were cut and prepared after letting them stabilize in formalin for 48 hours. The histopathologist blindly observed the slides under light microscope and determined the tissue damage. 19 out of 64 slides were not readable due to technical errors. Slight post mortem lytic changes in the mucosa was noted and that did not affect the procedure or the observations as none of the burns were extending up to the mucosa. Despite the Wattage, the 1 second burns had not damaged the bowel except for 1 mm of serosa in small bowel with 40 W. Full thickness muscle burns up to a maximum of 9 mm was observed when the duration of burn was 10 seconds in all Wattages and in both small bowel and large bowel. Muscle outer layer was burnt up to a maximum of 5 mm when burnt for 5 seconds in all Wattages and in both small bowel and large bowel.

These observations suggest that sudden accidental touch of the bowel wall with the monopolar diathermy is unlikely to cause thermal bowel injuries if the contact time is 1 second whatever the voltage tested. Thereafter the degree of damage depends on the contact time and voltage. It was noted that the damage is more when the contact time and the voltage higher. This pilot study is expected to be repeated while minimizing all the technical issues.

Keywords: Bowel injury; Thermal Injury; Diathermy; Laparoscopic Tissue Damage; Iatrogenic Injury

Technology & Computer Applications

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Investigation of Coir Fiber Quality Among Diverse Sri Lankan Coconut Varieties: Determining The Optimal High-Strength Fiber Length For Enhancing Coir-Rubber Composite Performance

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Abstract

The field of materials science has a critical role to play in addressing the imperative of reducing dependence on conventional materials and mitigating their adverse environmental impacts. This investigation conducted a thorough and comprehensive exploration of the characteristics of coconut varieties through the analysis of their natural coir fibers. Different coconut varieties are prevalent in Sri Lanka; each coir fiber has varying strengths. Surprisingly, no prior research has been done on the thorough evaluation and characterization of these coir fiber qualities. Coir rubber composites exhibit a unique array of properties and characteristics, which encompass sustainability, excellent impact resistance, abrasion resistance, lightweight properties, and cost-effectiveness. These attributes stand in contrast to conventional rubber composites, which often suffer from limitations in cost-effectiveness, sustainability, and their ability to meet desired mechanical properties, such as low impact resistance and abrasion resistance. Notably, there is a noticeable absence of research aimed at determining the allowable fiber loading for various fiber length sizes and its impact on the property variations within rubber compounds.

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The primary objective of this study is to enhance the quality assessment and characterization of diverse Sri Lankan coconut varieties. In doing so, the study seeks to further investigate the optimal range of high-strength fiber lengths to maximize the mechanical properties of coir-rubber composites. An extensive evaluation was performed on coir fiber characteristics extracted from a diverse selection of Sri Lankan coconut varieties, including Tall x Tall (T x T), Dwarf x Tall (D x T), San Ramon, Green Dwarf, Yellow Dwarf, and Kamandala. Extracted fiber samples underwent assessments encompassing physical, chemical, and mechanical properties and determined the high-strength coir fiber variety. Furthermore, we investigated the chemical stability, functional groups, and thermal stability intrinsic to each coconut variety. Various coir fiber lengths, ranging from 0 to 0.5 mm and 0.5 to 1.0 mm, were employed in combination with different coir fiber loadings (ranging from 0 to 50 phr) to create rubber composites. In this process, carbon black was substituted with coir fibers to achieve different coir fiber-to-carbon black ratios, specifically 0:50, 10:40, 20:30, 30:20, 40:10, and 50:0, while maintaining a constant total filler loading of 50 phr. The coir fiber obtained from the Kamandala coconut variety exhibited the highest tensile strength of 188.05 ± 17.47 MPa. Statistical analysis indicated that there was no significant difference when compared to the Tall x Tall (T x T) variety, which had a tensile strength of 169.63 ± 15.76 MPa ($p > 0.05$). Fourier transform infrared spectroscopy analysis did not detect significant variations in functional groups among the different coconut varieties. The analysis showed that a rubber composite containing 50 parts per hundred rubber (phr) of carbon black exhibited a notably high tensile strength of 19.12 ± 1.33 MPa. Furthermore, when 10 phr of coir fiber (0–0.5 mm) was combined with 40 phr of carbon black, it resulted in higher tensile strength (13.67 ± 0.42 MPa), tear strength (42.23 ± 3.51 N/mm), hardness (59 ± 0.8 IRHD), and modulus (at 100%) (5.1 ± 0.2 MPa) compared to other composite (coir fiber and carbon) ratios, such as 20:30, 30:20, 40:10, and 50:0.

The study emphasizes the importance of selecting the appropriate coir fiber length for coir-rubber composite applications, highlighting the potential for enhancing composite performance. These findings provide valuable insights for composite material development and promoting the sustainable and responsible utilization of coconut resources.

Keywords: Coir Fiber; Coconut Varieties; Mechanical Properties; Rubber Composites; Sustainability

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Landing Pad Design for Accurate and Efficient Drone Landing: A Simulation Study

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Abstract

The use and adoption of drones have become increasingly common across diverse industries, necessitating the development of accurate and efficient automated operations. With the restricted battery life of drones being a known limitation, efficient landing operations can contribute to prolonged battery efficiency. A key challenge is optimizing the process of drone landing on docking stations. This study aimed to explore this aspect by optimizing Landing Pad design using Physics Simulations to enhance drone landing efficiency and accuracy. Existing mechanisms for drone landing vary, but this study introduces a novel metric to optimize the landing pad design.

The study utilized a landing pad length of 4m and evaluated five different leg lengths (6m, 6.5m, 6.75m, 7m, and 8m) for the drones, which were combined with various landing pad angles (10, 15, 20, 25, 30, and 35 degrees). These angles were selected based on preliminary tests, suggesting these ranges provided the most varied results for the drone leg lengths. The research adopted a resolution of .25m and simulated the drone's landing on a 4m landing pad at every .25m interval.

A unique metric, the Drone Leg-to-Pad Ratio (DLPR) [1], is defined as the ratio of the drone's leg length to the landing pad length using plastic construction with a friction coefficient of 0.35 and a restitution coefficient of 0.6.

DLPR= Drone's Leg Length (DL) / Landing Pad Length(LP) [1]

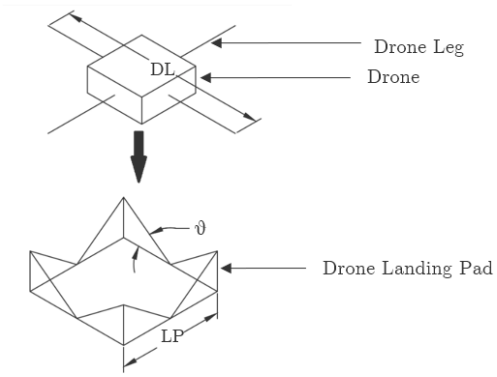

Figure 1: Isometric view of Drone and Drone Landing Pad.

Table 1: Drone Success Rate with Plastic Leg-to-Pad Ratio (DLPR) and Landing Pad Angle (Degrees)

Drone Leg-to-Pad Ratio (DLPR)	Landing Pad Angle (ϑ)						
	10°	15°	20°	25°	30°	35°	40°
1.5000	0%	43%	81%	89%	89%	89%	89%
1.6250	0%	62%	90%	98%	98%	98%	98%
1.6875	0%	81%	92%	98%	100%	100%	100%
1.7500	0%	92%	92%	99%	100%	100%	100%
2.0000	0%	96%	96%	100%	100%	100%	100%

The research found that a smaller landing pad angle and shorter drone leg size reduce the weight of both the landing pad and the drone, leading to increased landing success. Specifically, for plastic, the optimal landing pad angle and DLPR were 30 degrees and 1.6875, respectively, with a 100% landing success rate. However, these parameters might vary if the drone leg or landing pad materials change.

This research has notable applicability in the drone automation industry. It provides key insights into optimizing landing pad designs to improve drone landing efficiency and precision. These findings are vital for drone operators, developers, and industry stakeholders aiming to enhance drone services, making them more efficient and versatile. It's hoped that further studies will use different materials for drone legs and landing pads to identify the best parameters for these materials.

Keywords: Drone Landing Efficiency; Drone Leg-to-Pad Ratio; Landing Pad Design; Physics Simulation; Drone Landing Success Rate

Ayurvedic Leaf Recognition: A Classification and Comparison of CNN Architectures

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Abstract

Ayurveda, an ancient traditional healing system, relies on the use of medicinal plants and herbs for therapeutic purposes. Identifying plant species accurately is crucial to ensure the efficacy and safety of treatments. However, manual plant identification can be time-consuming and error-prone. To address this issue, this research focuses on utilizing Convolutional Neural Networks (CNNs) for Ayurvedic leaf recognition. In this research, we present a classification and comparison of Ayurvedic leaf recognition using three popular CNN architectures: VGG16, ResNet-50, and DenseNet121. The dataset consists of four classes: Artocarpus Heterophyllus (Jackfruit), Citrus Limon (Lemon), Mangifera Indica (Mango), and Piper Betel (Betel). The dataset is collected and stored in Google Drive, and the research is executed using the Google Colab Pro version.

The dataset comprises a collection of segmented Ayurvedic leaf images, meticulously curated and annotated for the research purpose. Each image contains only one leaf type. To enhance the model's generalization capability, real-time data augmentation techniques such as image shearing, zooming and horizontal flipping were employed. The images are resized to a standard 224x224 pixel size, a common requirement for many CNN architectures. For the classification task, three state-of-the-art CNN architectures, namely VGG16, ResNet-50, and DenseNet121, are selected. These models are renowned for their effectiveness in image recognition tasks and are well-suited for transfer learning. By utilizing transfer learning, the models are initialized with pre-trained weights from the ImageNet dataset, allowing them to leverage learned features and accelerate the training process. The training process involves passing the augmented images through the selected CNN architectures. The VGG16 model was trained using a batch size of 32 and the ResNet-50 and DenseNet121 models were trained with a batch size of 64. Each model undergoes 50 epochs of training. After training, the models are evaluated using the test dataset to assess their performance. These models are not base models they are updated versions.

Base model outcome was flattened and added few dense layers and used activations such as ReLU and Softmax for better performance. The performance of each model is evaluated and the results are as follows:

Table 1: Performance metrics of VGG16, ResNet-50, and DenseNet121 models.

Model	Accuracy	Precision	Recall	F1-score	Loss
VGG16	94%	93%	94%	93%	0.187
ResNet-50	91%	90%	91%	89%	0.234
DenseNet121	97%	97%	97%	97%	0.094

In addition to the tabular comparison, the figure 1 present the training accuracy and loss for each model over ten epochs. Figure 1 offers insights into the training behaviour and convergence rate of the models. After 10 epochs accuracy became nearly constant. The initial range was responsible for majority of observed variations. DenseNet121 outperforms both VGG16 and ResNet-50 in all metrics, achieving the highest accuracy, precision, recall, and F1-score. The model's ability to learn highly discriminative features and efficiently capture contextual information contributes to its superior performance.

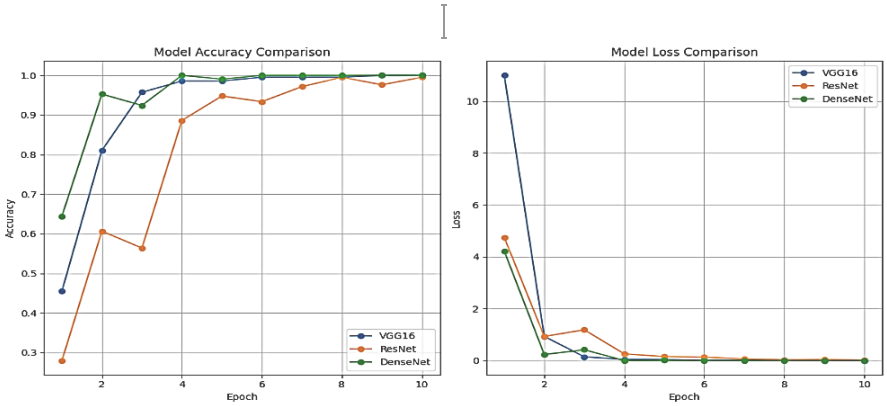

Figure 1: Model comparison.

In conclusion, this research compares three popular CNN architectures, VGG16, ResNet-50, and DenseNet121, for Ayurvedic leaf recognition. DenseNet121 emerges as the most accurate and reliable model, making it the preferred choice for real-time Ayurvedic leaf recognition systems. By leveraging the power of deep learning and transfer learning, researchers and practitioners can implement efficient and accurate Ayurvedic medicinal leaf recognition solutions to support Ayurvedic medicine practitioners and enhance the overall healthcare system.

Keywords: Ayurvedic Plant; CNN; Machine Learning

Feature Selection Based Augmentation for Short Text Classification

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Abstract

Short text classification is an important task in natural language processing (NLP) and machine learning. It poses unique challenges compared to traditional text classification due to the limited context available in short text segments. This limited context can make it harder to determine the true meaning or intent of the text. Therefore, in order to improve the context of the text, researchers used feature augmentation techniques to improve the classification performance after adding related features to the given text records. Adding features to text records can help improve classification performance by providing additional information and context to the model. While traditional machine learning models often work with structured numerical features, adding engineered or extracted features to text data allows the model to capture more nuanced patterns and relationships. when features were augmented with ontology it supported to improve the classification performances. Specially with wordnet ontology, adding related nouns and hypernyms boost the classification performances. But unfortunately, it created huge dimensionality. Computational complexity, increased memory usage and the overfitting are the common problems associated with huge dimensionality. Therefore, this research was focused on using feature selection-based augmentation to improve the classification performances while reducing the feature dimensionality. Seven datasets were identified to check the research objective. Those datasets were found from literature and with experimental data source platforms. Then hold out stratified Training and testing set was taken 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. 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 initial 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. F-measure was selected for measuring the accuracy as in some instances there is a slight imbalance dataset such as D4, D6, D7. Moreover, this helps to leave out the costs associated with the false positive as well as false negative. Three main algorithms were implemented to augment the features with the support of feature selection algorithms. Information gain algorithm was selected for this research as it outperformed other feature selection algorithms. Following three algorithms were implemented to augment the features with wordnet to improve the classification performances.

Fs before Aug: Augment before feature selection: this algorithm was implemented to select the features after completion of augmentation.
Fs after Aug: In here augmentation was done after selection of the features.
Hybrid: this approach was used for augmentation from original text after feature selection.

Table 1: Short text classification performances with implemented algorithms and baseline performances.

Augmentation Type	D1	D2	D3	D4	D5	D6	D7
Baseline	78.6	87.6	75.2	76.0	96.1	72.8	85.1
FS	78.6	87.6	75.2	76.0	96.1	72.8	85.1
Aug	81.3	88.6	77.2	78.3	96.9	84.1	86.3
FS Before Aug	81.7	89.2	78.3	79.2	97.0	85.5	86.7
FS After Aug	81.4	88.7	77.3	78.4	96.9	84.1	86.4
Hybrid	81.5	89.2	77.5	79,0	96.9	84.2	86.6

According to Table 1, Baselines and Aug experiments were conducted to compare the newly investigated algorithms. FS Before Aug generated highest classification performances with every dataset. We suggested that the highest performance level was link with the new feature selection strategy from external knowledge sources. In here new features were selected from ontology after selecting the best set of features [FS Before Aug] from feature selection algorithm from original feature set. So, we assume that those selected best features from original text would help to select the most appropriate feature set from ontology to improve the short text classification performances. Notably feature selection alone did not support to improve the classification performances. With the investigated algorithms classification performances was improved within the range of 1-12% which is significant.

Keywords: Classification; Feature Augmentation; Feature Selection; Wordnet

On-chip Synthesized CuI Semiconductor Microcrystals-based Gas Sensor for Formaldehyde Gas Detection: Al-IDE/CuI/CNT Electrode

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Abstract

Formaldehyde (HCHO) is a significantly hazardous compound, with ingestion of an only 20 ml of this substance being sufficient to induce rapid fatality. Wood-based industries mostly utilize this resource. The established threshold for formaldehyde concentration in the furniture sector and furniture exports is 0.124 parts per million (ppm). Therefore, the utilization of electrical-based sensors for the detection of low concentrations of HCHO holds great promise in the field of gas sensor-based research. The interdigitated electrode (IDE) exhibits significant potential as a sensor for applications requiring high sensitivity because to its extensive array of finger electrodes. Therefore, the sensor's sensitivity is affected by even minor fluctuations in current, which can be attributed to the response of the active material present on the sensor's surface. The observed phenomenon might be attributed to many factors, such as electrochemical reactions or gas reactions, which occur between the active semiconductor material present on the sensor surface.

The present study utilized aluminium interdigitated electrode (Al-IDE) as a primary sensor for the development of a gas sensor intended for the detection of HCHO gas as shown in the Figure 1. The Al-IDE was subjected to functionalization through the application of a thin coating of Copper Iodide (CuI) semiconductor nanomaterial, employing a chemical immersion technique. The gas adsorption material on the CuI layer consisted of a mixture of polytetrafluoroethylene (PTFE) conducting polymer binder and carbon nanotubes (CNTs). The spin coating process was employed to apply a layer of CNTs onto the CuI coating. PTFE was employed as an adhesion agent in conjunction with CuI in this study. The gas sensing performance was investigated by subjecting the AlIDE/CuI/CNT gas sensor, which was enclosed within a sealed chamber, to varying concentrations of HCHO gas. The

concentration within the gas chamber was assessed by employing an industrial-grade Formaldehyde gas detector, while the associated current values of the gas sensor were recorded using the Metrohm Autolab potentiostat equipment. The morphological and structural analysis performed utilization of SEM and XRD analysis, respectively.

Based on the SEM images, the presence of a CuI microcrystals layer on the Al-IDE substrate is evident, with an average crystallite size of 1037.29 nm, approximately equivalent to 1 μm. Based on the XRD spectrum analysis, it can be observed that the lattice fringes of CuI exhibit a distinct random orientation. The lattice fringes of CuI were seen to have a spacing of 3.6 Å, which corresponds to the (111) crystal plane of the cubic face as documented in the JCPDS 65–3288 reference. The determination of conductivity measurements, as well as the evaluation of response and recovery time, was carried out through the analysis of I-V characteristics and chronoamperometric curves. The chamber was purged using N_2 gas before introducing a measured concentration of formaldehyde (HCHO) gas. The gas concentration increased from 0.072 ppm to 1.63 ppm, resulting in a corresponding change in conductivity from 1.348 x 10^{-6} A to 4.79 x 10^{-5} A. Based on chronoamperometry analysis, the sensor has a reaction time of 12 seconds and a recovery time of 15.5 seconds.

Collectively, the outcomes of this study affirm the AlIDE/CuI/CNT gas sensor's remarkable efficacy in detecting low concentrations of formaldehyde (HCHO). This innovation holds substantial promise in advancing the state of gas sensing technology, particularly in contexts where detecting minute concentrations of hazardous gases is paramount.

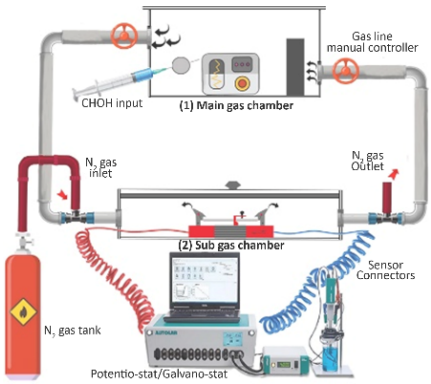

Figure 1: Schematic diagram of the main gas chamber (1) sub gas chamber and (2) showing all the gas supply lines, characterization visualize the diagram.

Keywords: CNT Coating; CuI Microcrystals; Formaldehyde Detection; Gas Sensor; Sensing Material

Cure Characteristics of Polyethylene Glycol Grafted Reduced Graphene Oxide (PEG-g-rGO) Filled Natural Rubber Composites

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Abstract

Reduced graphene oxide (rGO) consists of a two-dimensional (2D) network of sp^2 and sp^3 hybridization carbon atoms and it has excellent electrical, curing, and mechanical properties. However, rGO is a low-functional material and hence, it is not compatible with polymers. Therefore, the modification of rGO is particularly important to enhance the performance of polymer composites. In this study, rGO was chemically modified via the Diels–Alder reaction, thereby rendering the surface of rGO to yield several desirable functional groups. Then, natural rubber (NR) composites were prepared by varying the PEG-g-rGO loading from 0.2 phr (parts per hundred rubber) to 1.0 phr at 0.2 phr increments.

Minimum torque (M_L) is an indication of stock viscosity and processability of rubber composites. The composite prepared without PEG-g-rGO (control) shows the lowest M_L and indicates the lowest viscosity in comparison to the other composites. In contrast, the composite prepared with 1.0 phr loading of PEG-g-rGO presents the highest value of M_L and better stock viscosity and processability than the other counterparts. Maximum torque may give an idea of the maximum extent of curing such as crosslink density and the static/ shear modulus or the hardness of the fully vulcanized compound. As shown in Table 1, the maximum torque (M_H) values of the NR composites increase with the increase of the PEG-g-rGO loading and the highest M_H value is exhibited by the composite prepared with 0.2 phr PEG-g-rGO. It can be due to the improved reinforcing efficiency, better dispersion and distribution of filler in the NR composites and greater cross-link density. M_H- M_L torque is an indication of the cross-link density of rubber compounds. Other than that, when the loaded amount of PEG-g-rGO powder

increases, the delta cure value increases compared to the control composite and the highest torque value is shown by the composite prepared with 0.2 phr loading of PEG-g-rGO.

The variation of scorch time (ts_2) of the composites with PEG-g-rGO loading is shown in Table 1. These values give information about the premature cure for processing safety. According to Table 1, the addition of PEG-g-rGO from 0.2 phr to 1.0 phr shows an increasing trend in the scorch time. Although, the composite prepared with 1.0 phr loading of PEG-g-rGO presents the highest scorch value and it is implemented for better durability of the end product. According to Table 1, by adding PEG-g-rGO from 0.2 phr to 1.0 phr, the cure time (t_{90}) is increasing gradually. Moreover, the curing time of rubber composites depends on several factors such as filler polarity and size, viscosity of rubber compound, scorch safety, etc. However, the cure rate index (CRI) of rubber composites depends on the T_{90} and ts_2 and they are varied from 106.3 to 169.5 min^{-1}. The composite prepared with 0.2 phr loading PEG-g-rGO indicates the fastest cure rate index.

Table 1: Cure characteristics of PEG-g-rGO/NR composites

Property	PEG-g-rGO loading (phr)					
	0	0.2	0.4	0.6	0.8	1.0
Minimum torque (dNm)	0.49	0.58	0.53	0.63	0.53	0.67
Maximum torque (dNm)	6.19	6.73	6.41	6.59	6.43	6.53
Scorch time (Min)	0.61	0.82	0.84	0.85	0.88	0.94
Cure time (Min)	1.55	1.41	1.48	1.57	1.61	1.66
Cure rate index (Min^{-1})	106.3	169.5	156.2	138.9	137.0	138.9
Delta cure (max-min) (dNm)	5.70	6.15	5.88	5.96	5.9	5.86

Furthermore, the composite prepared with 1.0 phr loading of PEG-g-rGO showed the highest ts_2 indicating the highest processing safety. However, cure time t_{90} slightly increased with the increase of PEG-g-rGO loading and, slower cure rate was indicated at lower PEG-g-rGO loading. Overall, the composite prepared with 0.6 phr loading of PEG-g-rGO which exhibited moderate performance of cure characteristics in terms of scorch safety, curing time, stock viscosity and crosslink density.

Keywords: Cure Characteristics; Natural Rubber; PEG-g-rGO; rGO

Design, Development and Performance Evaluation of a Height Adjustable Camera Integrated Picker for Pepper, Clove, and Nutmeg

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Abstract

Pepper (*Piper nigrum* L.), clove (*Syzygium aromaticum*), and nutmeg (*Myristica fragrans*) are extensively cultivated spices in Sri Lanka. The economically valuable parts of these crops are commonly found at the terminal branches of the plants. However, many of these valuable parts are located at heights on the plant canopy that are difficult to reach from the ground. Consequently, manual hand picking is the method used for harvesting. This involves climbing the tree using supports or utilizing handmade tools like wooden billhooks. Despite its common use, manual harvesting is a labour-intensive and costly process in Sri Lankan spice production sector. This is due to the scarcity of labour and the high wages required for this task, which is also common for the harvesting of pepper, clove, and nutmeg. Although some mechanical harvesters have been introduced, they have not gained traction in the field mainly because farmers are dissatisfied with their performance. Hence, this study aimed to design, develop, and evaluate performance of a specialized harvesting device. Furthermore, the device was featured height-adjustable capabilities and incorporated a camera to enhance the efficiency and accuracy of harvesting pepper, clove, and nutmeg. Along with the primary focus of this study was to cater to the needs of Micro Small and Medium-scale (MSMs) farmers, who play a crucial role in Sri Lankan spice sector. These farmers cultivate more than 70% of the land in plot sizes ranging from 0.25 acres to 3 acres. The harvesting device was composed of the integration of four units: the lap support picker holder, height adjustable pole, plucking unit, and display and control unit. The picker holder was involved in bearing the weight of the harvester while it was operating. It hung around the hip area with the support of belts across the shoulders of the operator. The initial part of the height-adjustable pole could be finely

adjusted by a screwdriver mechanism. The rest of its height could be adjusted by roughly connecting the accessory poles whenever needed. The picking unit consisted of a motor-operated blade to detach the harvest from its canopy and a mini-Wi-Fi camera that helped send videos of the harvest to the display. The combination of the display and camera was involved in improving the visibility of the operator, which led to harvesting spices at the correct maturity. Meanwhile, the control panel facilitated the manipulation of the blade of the picker unit and the fine adjustment of the pole. The device could harvest fruits up to a height of 7 m from the ground level and weighed only 3.45 kg, including the picker holder. The performance evaluations were conducted in well-maintained pepper, clove, and nutmeg plantations in the *Rattota* area of the *Matale* district. Crop characteristics were observed for each type of spice, and plants with similar characteristics were selected for evaluation to reduce errors arising from plant structure. The evaluation comprised two harvesting levels: harvesting using the newly developed picker and manual hand picking, which involved climbing the tree using supports or using handmade tools like wooden billhooks. The effects of the treatments were analysed using a t-test at a 95% confidence interval. The mean actual harvesting capacity, field efficiency, and harvesting efficiency of manual and mechanical clove harvesting methods were: 4.69 kg h^{-1} and 5.91 kg h^{-1}, 88.89% and 93.36%, and 95.84% and 88.28%, respectively. The mechanical clove harvesting method proved significantly higher actual harvesting capacity compared to the manual method ($p \leq 0.05$), while other performance parameters were not significant differences between the two methods ($p \geq 0.05$). For pepper harvesting, the corresponding values for manual and mechanical methods were: 5.3 kg h^{-1} and 6.2 kg h^{-1}, 61% and 77%, and 97.61% and 96.57%, respectively. The mechanical method exhibited significantly higher actual harvesting capacity and field efficiency for pepper compared to the manual method ($p \leq 0.05$), while harvesting efficiency was not significant difference between the methods ($p \geq 0.05$). Similarly, for nutmeg harvesting, the values were: 143 fruits h^{-1} and 352 fruits h^{-1}, 83.61% and 85.2%, and 96.74% and 96.56%, respectively. The mechanical method verified significantly higher actual harvesting capacity for nutmeg compared to the manual method ($p \leq 0.05$), while other performance parameters showed no significant differences between the methods ($p \geq 0.05$). Furthermore, the break-even points of picker for the fresh harvests of pepper, clove, and nutmeg were 895.27 kg $year^{-1}$, 87.48 kg $year^{-1}$, and 7947 fruits $year^{-1}$, respectively. Accordingly, it can be concluded that the newly developed harvester is well-suited for MSMs spice farmers in Sri Lanka.

Keywords: Clove Harvesting; Harvesting Efficiency; Hight-Adjustable Picker; Nutmeg Harvesting; Pepper Harvesting

Designing a Modified Photovoltaic Inverter for Voltage Regulation

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Abstract

Power system operators face operational challenges due to the high penetration of solar photovoltaic (PV) generation into low-voltage distribution networks. During the time of least loads, solar PV might result in reverse power flow violating the voltage limits. The literature reveals that active power curtailment, grid enforcement, and reactive power generated by solar PV inverters can support the grid voltage. Also, according to IEEE Std. 1547-2018, rooftop solar systems can contribute to grid voltage support while supplying active power to the grid. However, oversizing the power electronic inverters is limited by economic factors. Therefore, the goal of this study is to design a modified inverter to improve voltage regulation at the consumer location without oversizing existing solar PV inverters.

Inverters connected to variable renewable sources such as solar PV are not always operating at their full capacity. Also, an inverter can produce reactive power through its freewheeling diodes. Thus, this study considers the unused capacity of the solar PV inverter during its operation to inject or absorb reactive power to improve the voltage. The solar PV system under consideration consists of a maximum power point tracker, a boost converter, and an inverter. The boost converter modifies its input voltage in accordance with the signal provided by the maximum power point tracker to extract the maximum power. The DC link voltage and output RMS voltage are controlled at the reference values by a decoupled control system in dq frame where the d axis regulates the current contributing to the active power while the q axis regulates the current contributing to the reactive power. The proposed control system considers a limiting circuit to constrain the q-axis current according to the instantaneous d-axis reference to avoid the overload

of the inverter. Finally, the control system outputs inverter-side voltage references to generate PWM pulses.

Proposed modified inverter is tested on PSCAD/EMTDC v4.5 transient simulation platform. A test system consisting of a 7 MW solar PV system connected to a consumer premises derived based on a real distribution system is considered to examine the performance of the proposed inverter. A cable connects the local area to a 33/11 kV primary substation. The load is assumed to be constant at 1.673 MW and 0.810 MVAr, and solar irradiance is varied from 0 to 1000 W/m^2. Figure 1 illustrates the RMS local voltage at the consumer premises upon the variation of solar irradiance under normal and modified solar PV inverters. When the solar irradiance is between 0 and 320 W/m^2, the modified solar PV inverter maintains voltage at 1 p.u where the consumer experiences under-voltage with the normal PV inverter. However, when the active power generation increases, the usable capacity of the inverter for reactive power generation declines. Therefore, the capability of the modified solar PV inverter to generate reactive power reduces, and thus, RMS voltage increases when solar irradiance exceeds 700 W/m^2. However, the modified PV inverter improves the voltage profile irrespective of the level of solar irradiance and minimizes the overvoltage at the standard irradiance of 1000 W/m^2 by 40% compared to that of the normal inverter.

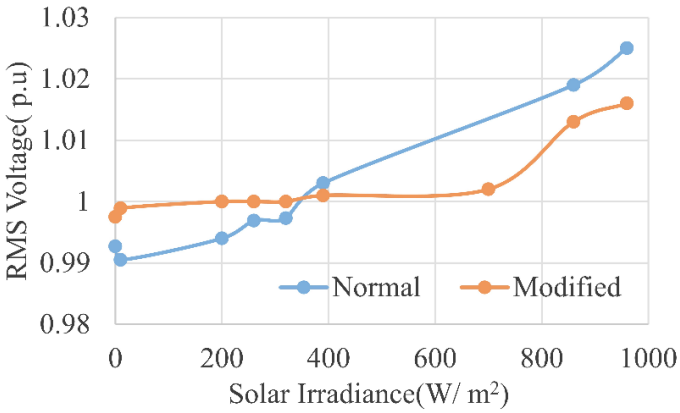

Figure 1: Variation of the RMS voltage with the solar irradiance.

Finally, it can be concluded that existing solar PV inverters can effectively participate in improving the voltage profile of the distribution network with minimum control changes.

Keywords: Converter; Penetration; Reactive Power; Renewable Energy

Comparison of the Performance of Biased Linear Regression Estimators in the Presence of Autocorrelated Errors: A Case Study

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Abstract

Estimators such as r-k Class Estimator, Almost Unbiased Ridge Estimator (AURE), Liu Estimator, Almost Unbiased Liu Estimator (AULE), and r-d Class Estimator are biased estimators which are used to combat the effect of multicollinearity. When dealing with real-world data, not only multicollinearity, but also autocorrelated errors in linear regression, is a major issue. This study intends to compare the performance of said biased estimators when both multicollinearity and autocorrelation occur simultaneously using a real world example. Quarterly US data on Gross Domestic Product(Y), Personal Disposable Income(X1), Personal Consumption Expenditure(X2), Corporate Profits after Tax(X3) and Net Corporate Dividend(X4) were considered for the period of 1970-1991 and the data was taken from Gujarati (2002) and lately used in Tyagi & Chandra (2017). The regressor matrix X was standardized and the Eigenvalues of $X'X$ were found as 324.65, 21.87, 1.24 and 0.24, and condition index of $X'X$ was 696.41 which indicates strong multicollinearity. Further, the Durbin Watson (DW) statistics was 0.49 which indicated the presence of positive autocorrelation at 5% significance level. It is evident that the data set contains both autocorrelation and multicollinearity problems. The error structure was found to be an Autoregressive process of order 1, AR (1), with the estimated autocorrelation $\rho = 0.7551$ and variance $\sigma_\varepsilon^2 = 0.002662$. Thus, the covariance matrix V was calculated and the condition index of $X'V^{-1}X$ was found to be 171.84 which indicates a strong multicolliniarity in data and the Eigen values were found to be 56.46, 7.25, 0.58 and 0.23. r was chosen as 2, which accounts for 99.89% of variation in the data. A grid of shrinkage parameter, k/d values was taken from 0.1 to 0.9 and Mean Square Error (MSE) values for the five estimators were calculated and illustrated in figure 1(a). The results obtained

through the numerical example were compared with the simulation result obtained at $\rho = 0.7$ and variance $\sigma_\varepsilon^2 = 0.01$ and depicted in figure 1(b).

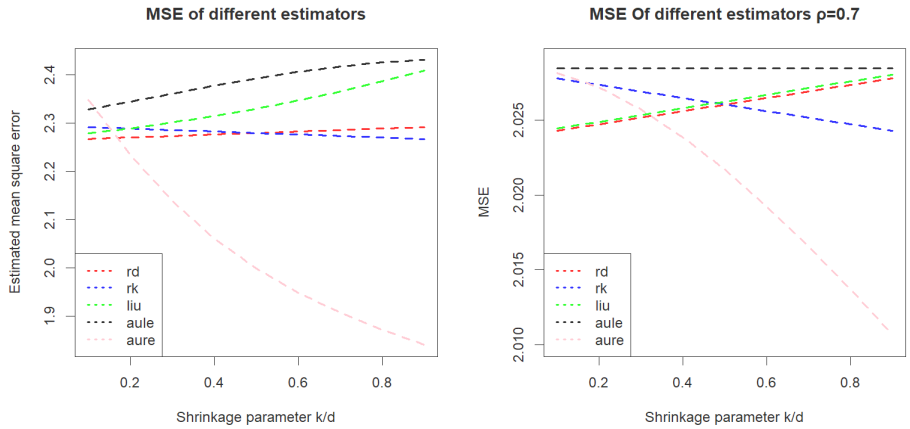

Figure 1: Comparing performance in the example and the simulation study.

Both the Numerical example and the simulation results suggested that the performance of the AURE was better than the other four estimators with the increment of the shrinkage parameter k/d under moderate autocorrelation. AURE outperforms the other variables for the higher shrinkage parameter values when the errors are moderately autocorrelated. When k/d $>$ .5 , r-d class estimator is better than the r-k class estimator and AULE has the highest MSE value of all. Comparing Liu and AULE, Liu estimator always performs better than AULE when both multicollinearity and autocorrelation occur together. This study shows that when the data are collinear and error variance is low, AURE outperforms the other estimators in the presence of autocorrelated errors.

Keywords: Autocorrelation; Multicollinearity; Biased Estimators

Simulink Implementation of Rate Splitting based Non-Orthogonal Multiple Access (NOMA) over Additive White Gaussian Noise (AWGN) Channels

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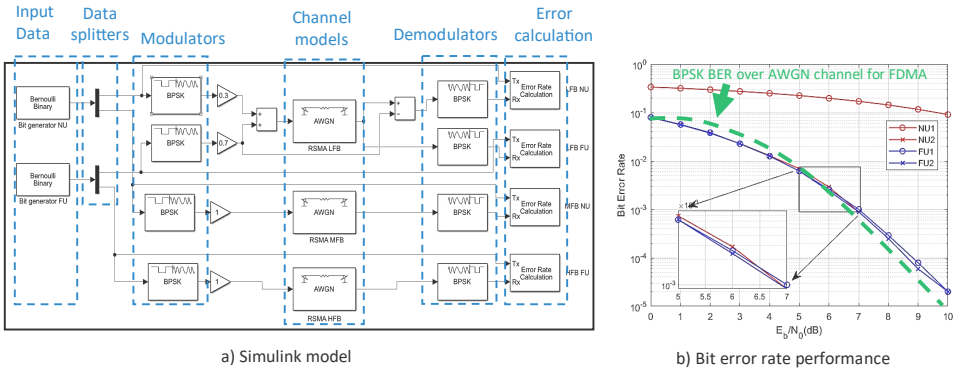
Abstract

Non-orthogonal multiple access (NOMA) has emerged as a promising multiple access (MA) method for fifth-generation (5G) and upcoming sixth-generation (6G) communication systems as it utilizes the resources of the systems effectively and efficiently. In the power domain NOMA, the same frequency band, and same time slot are utilized for both near user (NU) and far user (FU). However, a superimposed signal of both NU and FU symbols is transmitted by keeping the power allocation for the FU much greater than the NU. Therefore, FU can decode its own symbol while treating the NU signal as noise whereas, NU can decode its own symbol by applying successive interference cancelation (SIC) to the received superimposed signal. Communication security is compromised in NOMA systems because NU decodes the FU signal during SIC operation, which is a vulnerable point in the system. RS-NOMA has been employed as a solution, effectively ensuring the security of data communication. This novel rate-splitting multiple access (RSMA) is emerging as an efficient, robust, scalable, and flexible MA method for future communication systems.

This study implements a MATLAB Simulink model for RS-based NOMA over additive white Gaussian noise (AWGN) channels as depicted in Figure 01. a. Also, all users' bit error rate (BER) performance is obtained. As shown in the model, the binary inputs of two users are split into two parts by using a binary data splitter. Then each splatted binary data input is mapped into a binary phase shift key (BPSK) consolation symbol. Here, two symbols, an NU symbol, and an FU symbol are superimposed as per the power domain-NOMA and transmitted in a NOMA manner. In contrast, the other two remaining NU and FU symbols are transmitted separately in an OMA manner. The superimposition of NOMA signals is performed after the power allocation according to the NOMA principles. For the transmitted

signal over the AWGN channel, NOMA is applied for the lower frequency band (LFB), while frequency division multiple access (FDMA) is applied to the NU and FU symbols in the middle-frequency band (MFB) and higher frequency band (HFB), respectively. The SIC was applied to decode the LFB NU symbol at the NU. However, FU is able to decode the LFB FU symbol, while treating the NU symbol as noise.



a) Simulink model

b) Bit error rate performance

Figure 1: (a) Simulink model of the overall communication system: (b) Bit error rate performance.

The error performance of the implemented Simulink model is obtained with respect to the split symbols of FU and NU and shown in Figure 01. b. The NU symbols that are sent applying NOMA show the worst error performance compared to the error performance of other symbols. The reason for this performance degradation is the allocation of less power to the NU symbol in LFB according to the NOMA principle. The BER of the other three symbols are showing similar error performance. It is noteworthy that, the BER of the FU of LFB that utilizes the NOMA shows similar behaviour to the BER of the FU in HFB that utilizes the OMA. Moreover, the error performance of the implemented model is compared to a typical error performance of BPSK symbols over the AWGN channel transmitted using frequency division multiple access (FDMA). All the symbols of the developed model show close concurrences of BERs to the typical BER curve except the BER of the NU symbol in LFB. This analysis provides validity to the implemented Simulink model of RS-based NOMA over additive white Gaussian noise (AWGN) channels.

Keywords: Fading Channels; MATLAB Simulink; Non-orthogonal Multiple Access (NOMA); Rate Splitting Multiple Access (RSMA)

Management and Social Sciences

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Identifying the Role of Digital Technologies in Education in Sri Lanka: A Review

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Abstract

Education is a human right, a powerful driver of development, and one of the strongest instruments for reducing poverty and improving health, gender equality, peace, and stability. It delivers large, consistent returns in terms of income and is the most important factor to ensure equity and inclusion. At present Digital technologies have emerged as an essential tool for education. These technologies have shown a powerful impact on the education system. The recent COVID-19 pandemic has further institutionalized the applications of digital technologies in education in Sri Lanka the introduction of new technology-assisted learning tools. such as mobile devices, smartboards, MOOCs, tablets, laptops, simulations, dynamic visualizations, and virtual laboratories has altered education in schools and institutions. These digital technologies have made a paradigm shift in the entire education system in Sri Lanka. It is not only a knowledge provider but also a co-creator of information, a mentor, and an assessor. Technological improvements in education have made life easier for students. This study explores the need for digital technologies in education and identifies the significant challenges of digital technologies in education in Sri Lanka. This study was based on the literature review. Altogether, 40 articles published were selected for the review.

The globalization of education has already necessitated the application of digital technologies. The COVID-19 pandemic has forced the institutes to adopt the online teaching mode to sustain the education system. Developed countries were well-equipped to deal with this crisis. However, developing countries like Sri Lanka worked hard to meet this requirement. Digital technologies assist in developing abilities that will require students' professional performance, such as problem-solving, thinking structure creation, and process comprehension.

The researcher reviewed that digital technology in the classroom refers to various software and gadgets meant to help students with particular accessibility needs.

The most effective way to reduce the number of repetitive, time-consuming duties a teacher undertakes is to use technology in the classroom. Educational technology applications may save a lot of time and energy by automating or partially automating day-to-day operations like attendance tracking and performance monitoring. The digital classroom uses electronic devices and software to instruct students and incorporates technology into education. A traditional classroom is transformed into a digital classroom through computers and the Internet. Students can learn more efficiently and track their progress with the help of technology and sophisticated equipment. In the upcoming days, these technologies will successfully be implemented in education to enhance the students' digital learning environment and performance. These technologies refer to innovation that considers natural resources while also promoting economic and social growth. These technologies aim to dramatically decrease environmental and ecological concerns while producing a long-term product.

Keywords: Digital Class Room; Education; Sri Lanka; Technology

Impact of Lean Practices on Business Performance in the Sri Lankan Apparel Industry: The Mediating Role of Operational Performance

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Abstract

The apparel industry is one of the key players contributing to the Sri Lankan economy. The industry faces several challenges in competing with leading players in the global apparel market. To survive and prosper in the dynamic global market, Sri Lankan apparel manufacturers are now attempting modern production philosophies such as Lean Manufacturing. This study focused on the apparel manufacturers in Sri Lanka and their adoption of Lean practices. A preliminary survey was conducted among the apparel companies in the western province of Sri Lanka to evaluate their achievement of the key performance indicators. It identified that although several apparel manufacturers in Sri Lanka have implemented Lean practices, they have not yet achieved the expected level of performance. Therefore, this study aimed to investigate the adopted Lean practices and their impact on the business performance of the Sri Lankan apparel industry. The conceptual model is shown below in Figure 1.

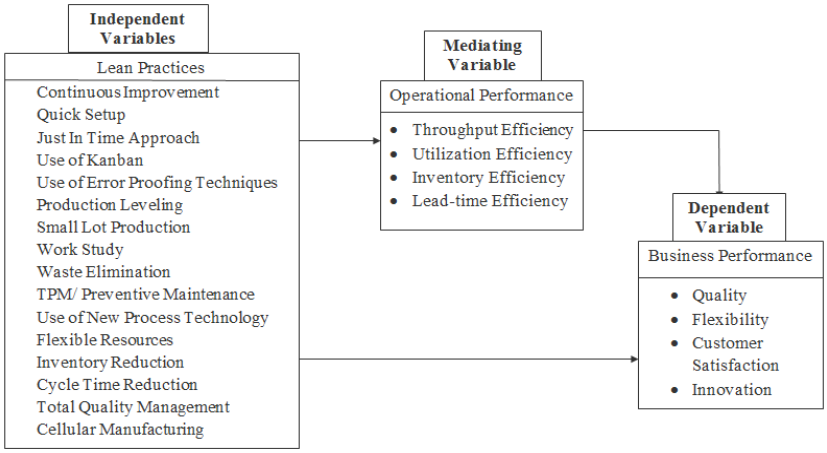

Figure 1: The conceptual framework

Further, this study investigated the mediating role of operational performance on the relationship between Lean practices and business performance. An extensive literature review identified lean practices used in the apparel industry and suitable measures for operational and business performance. This research was designed following the Sounder's Research Onion model. The study adopted a quantitative approach based on a purposively selected sample of 360 out of 714 Lean adopted apparel manufacturers in the country. Data were collected from managerial level employees using a questionnaire measured with the Likert scale. The effective response rate was 71%. These responses confirmed that only the large apparel manufacturers have adopted Lean Manufacturing and that they too have only partially adopted the Lean concept. Data were further analysed using the Structural Equation Modelling method on SPSS-AMOSS 23. The exploratory factor analysis identified only eight unidimensional Lean practices to be significant in the Sri Lankan context. They were continuous improvement, quick setup, Just-in-time approach, work study, waste elimination, Total Productive Maintenance, flexible resources, and Total Quality Management. Also, the efficiencies of throughput, utilization, inventory, and lead time were identified as significant operational performance measures while quality, flexibility, and customer satisfaction were identified as significant business performance measures in the Sri Lankan apparel industry. The analysis was then continued with confirmatory factor analysis. The convergent validity was tested and verified using average variance extracted and composite reliability. The reliability of the data was measured using Cronbach's Alpha which was 0.790. The goodness-of-fit of the respective measurement model was tested using absolute fit indices and model fit indices and an average fit was confirmed. Further, the structural model showed positive direct relationships between Lean practices and operational performance and also between Lean practices and business performance. Further, there was an indirect relationship where operational performance mediated the relationship between Lean manufacturing and business performance. Based on this mediating impact, this study recommends the Sri Lankan apparel manufacturers to implement Lean practices focusing on operational performance which eventually improve business performance at a higher rate. Moreover, this study revealed that the Sri Lankan apparel industry currently lacks innovation which should be developed in future. Another important finding was the presence of multi-collinearity among the selected Lean practices. This result reassured the holistic nature of implementing Lean Manufacturing in the apparel industry.

Keywords: Business Performance; Lean Adoption; Lean Practices; Operational Performance; Sri Lankan Apparel Industry

Identifying the Most Suitable Learning Strategies for Tertiary Education Based on Psychological Behaviour

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Abstract

Teaching is one of the primary mechanisms used in the tertiary education process to transmit knowledge. The rapid popularization and advancement of technology have increased using different types of intelligent teaching systems and methods. Variety of classifications for teaching and learning methods emerged causing their various characteristics. Some researchers have mentioned that active learning is better than passive learning and vice versa. It may differ with the learning content, student's education level, class size, and teacher's characteristics.

Identifying the effectiveness of teaching methods is another major challenge in education. The psychological behaviour of the student is a very prominent way to determine the effectiveness of the teaching method since the autonomous nervous system cannot be controlled consciously. Thus, this study aimed to identify the ideal learning tactics for tertiary education in the science field for small classes based on the psychological behaviour of the students.

An experiment was conducted with four sessions to determine the effective teaching method. Two active learning sessions were conducted separately as a team and individually under the Problem-Based Learning (PBL) technique. A lecture session was conducted as a passive learning session. The last session was conducted by combining both active and passive learning. The subjects were selected randomly among the final-year students at a state university. Ten male and ten female subjects engaged in the experiment. All the subjects underwent the same experimental conditions and participated in the small lecture room during the regular daily lectures. Three bio-medical instruments were attached to each subject to obtain the Electroencephalogram (EEG), Electrocardiogram (ECG), and Galvanic Skin Response (GSR) values as mentioned in Figure 01. The EEG, ECG,

and GSR data were extracted from all the subjects during the experiment to measure their psychological behaviour. The participants' brainwaves were captured using the EEG to analyse the brain's electrical activity pattern. Gamma, Beta (β), Alpha (α), and Delta (δ) waves were obtained and analysed by using Neuro Experimenter. The GSR sensor measured the sweat glands of the participants and the heart rate variations of the students were recorded using ECG during the sessions.

Figure 1: The experiment with attaching bio-medical instruments

The students' attention levels were derived through EEG data, and the highest level of attention level was visualized in the last session, which was conducted using both active and passive learning. The student's attention level was better at the active learning session than the passive learning session. The EEG data indicated that combining active and passive learning can yield higher productivity. Further, teamwork was noted to be more effective than participating in a lecture and doing work individually. According to the GSR values, the combination of lecture sessions and teamwork was better than problem-based learning since the consistency level of the GSR values was recorded in the last session. The variation of the heart rate values was identified with the ECG, indicating that teamwork was better than listening to lectures and individual work. Combining both passive and active learning was good since higher variations in ECG were recorded in the last session.

The combination of a lecture session and teamwork was the best session of this study. Teamwork was much more effective than individual work, and if teamwork was conducted after the lecture session, a higher level of cognitive performance could be achieved. Moreover, combining passive and active teaching techniques was the best strategy for tertiary education in the science field for small classes.

Keywords: EEG; ECG; GSR; Tertiary Education; PBL

Strategic Reading Instruction as an Effective Means to Uplift the Academic Reading Skills of Undergraduates

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Abstract

Many undergraduates who have switched from their mother tongue to English medium do not possess adequate reading skills, and this impairs academic performance at the university. Traditional reading courses offered in the ESL (English as a Second Language) class often focus on cognitive skills such as word recognition, memory, attention, glossary-based vocabulary building and reading comprehension exercises; however, metacognitive strategies like taking charge and monitoring one's own reading process are also equally vital for successful reading comprehension particularly when the learners deal with cognitively demanding subject related texts. The main objective of this study was to introduce strategic reading instruction that creates such metacognitive awareness among undergraduates and to measure its effectiveness in uplifting their reading proficiency.

A stratified sample of 300 first-year undergraduates representing six different faculties of the Wayamba University of Sri Lanka: Agriculture and Plantation Management, Applied Sciences, Business Studies & Finance, Livestock Fisheries & Nutrition, Medicine, and Technology, who belonged to three proficiency levels: high proficiency, intermediate proficiency, and low proficiency, participated in ten strategic reading instructional sessions of two hours each for a period of three weeks during the latter part of the English Intensive Course. The sessions were conducted either physically or online via Zoom by the instructors specially trained for the purpose.

This research was both a survey and a quasi-experimental study in design. During the reading course, the learners were explicitly taught 4 pre-reading, 8 while-reading, and 8 post-reading strategies that covered global reading, problem-solving, and support reading techniques by utilizing standard academic reading texts in both of their respective subjects and other disciplines, and opportunities were

provided for them to practice those on their own. Pre and post-diagnostic reading tests were conducted to measure the growth in the reading proficiency level and a survey questionnaire and a reflective diary were administered to identify how effective the instruction was in the participants' perception. The pre and post-tests comprised standard reading comprehension passages with 30 MCQ-type questions to be completed within one hour and fifteen minutes while the survey questionnaire comprised sixteen MCQ-type questions of the Likert five-point scale.

The mixed method was used for the analysis. First, the pre and post-test data analyzed separately for the three proficiency levels through paired t-tests proved that the reading proficiencies of all learner categories had improved at a 5% level of significance. Next, the quantitative data from the questionnaire analyzed separately for the three proficiency levels through the Wilcoxon signed–rank test also revealed that the strategic reading instructions had improved the academic reading competency of all learners at a 5% level of significance. Finally, the qualitative data from reflective diaries initially coded under the three major categories: 'strategies acquired at the pre-reading phase', 'strategies acquired at the while-reading phase, and 'strategies acquired at the post-reading phase' and further coded under 21 sub-themes provided evidence that the learners had well acquired the expected strategies of the intervention.

In conclusion, quantitative analysis of pre-post tests revealed that strategic reading instruction accounted for a statistically significant growth in the academic reading skills of the undergraduates and was thereby successful from teachers' point of view. Similarly, the quantitative analysis of the questionnaire and the qualitative analysis of reflective diaries elicited quite positive responses from the participants and manifested that the instruction was beneficial from the learners' point of view. Moreover, irrespective of the fact that a common course was offered, the instruction matched all proficiency levels of learners. Thus, reading strategies that create metacognitive awareness should explicitly be taught to undergraduates to equip them with the necessary skills to handle complex academic texts efficiently, effectively, and confidently.

Keywords: Reading Strategies; Metacognitive Awareness; Global Reading; Support Reading; Academic Reading

Causes for Low Motivation for Learning English at the G.C.E. (A/L) Curriculum: Perspectives of the Students in the Kurunegala District

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Abstract

Due to its cumulative ultimatum in varied fields in the country and globally, several implementations have unremittingly been incorporated into the field of English language teaching in Sri Lanka. One such application is the inclusion of the General English subject to the advanced level curriculum in 1998, focusing on enhancing the school leavers' employability prospects, academic advancements, and instituting ethnic harmony in the country. However, the performance analysis of the subject at the G.C.E. (A/L) examination of the Department of Examinations ascertains that nearly 50% of the candidates fail the subject every year. The complexity of the problem then lies with this inadequate performance, leading to a yet-unsolved issue in the education sector. The scholars accentuate the requisite of learners' positive motivation for successful second language learning. However, there is a dearth of studies, conducted to observe the demotivation factors to learn English in the advanced level curriculum in Sri Lanka. Thus, the present study was conducted to investigate the root causes for the low motivation of A/L students to learn English to find remedial measures to achieve the targeted learning outcomes.

A qualitative research paradigm was used in the study, conducting semi-structured interviews with 60 randomly selected students from the Art stream in the National Schools of the Kurunegala district. The thematic content analysis technique was used for the systematic coding of the responses, employing the inductive method based on grounded theory.

The outcomes reveal that educational policies namely the non-requirement of a compulsory pass for English at the examination and the university admissions, and the more emphasis given only to the core subjects hinder student motivation to learn English. Many respondents had considered learning English a waste of time

and neglected learning due to this subject flexibility. Moreover, the use of a common textbook for all proficiency levels, insufficient modern learning facilities, ineffective pedagogy, inadequate time allocation to teach, using English periods to teach core subjects, and over-populated classes were identified as management-related issues that drop learner motivation. The findings revealed that the nonexistence of selection to learn from differentiated textbooks consistent with the level of proficiency had declined the motivation of the learners with low proficiencies. Lessons had been teacher-centered and the respondents highlighted their necessity for learner-centered and activity-based teaching approaches, using modern technology. Similarly, the participants complained of the lack of modern learning facilities such as computers, free internet, learning software, and extra time for practice in the class. Further, another demotivation factor was the overpopulated classes that created issues such as less individual attention, inability to use different teaching techniques, access to technology, and organizing extra-curricular activities.

In addition, the study also found learners' negative attitudes towards English, lack of basic grammar, and vocabulary, exposure outside the school, and pressure on core subjects as causes that obstructed learner motivation. Some students expressed that English was not needed for them due to mother tongue usage in schools and communication in their monolingual contexts. They seemed uninformed of the position of English locally and globally owing to their less exposure to the outside world. Further, caused by the lesson complications and the English language generally, they were not integratively or instrumentally motivated and seemed to disdain learning English. Furthermore, the learners' insufficient grammar and vocabulary knowledge and pronunciation difficulties have demotivated them and they seem reluctant to speak in English. Similarly, some respondents were found demotivated by the misconception that learning English depended on learning grammar, which they believed was difficult, owing to the structural differences between the mother tongue and the English language.

The study found issues related to educational policy decisions, management, and learner attitudes as motivation hindering causes to learn English. Thus, it is additionally suggested to find instantaneous remedial measures to increase learner motivation for achieving the targeted English proficiencies.

Keywords: Education Management; General English Subject; Motivation; Policies; Learning Outcome

The Correlation Between University Sports Participation and Early Career Success: A Case Study Done at Wayamba University of Sri Lanka

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Abstract

Physical and mental fitness, coupled with a healthy lifestyle and a solid understanding of good dietary habits and leisure activities, are widely recognized as essential components of an undergraduate's holistic development. However, the participation of undergraduates in sports activities remains inconsistent, with a significant portion of engagement limited to those representing their university or faculty in competitive sports. Moreover, active involvement in sports has been linked to the cultivation of leadership skills, discipline, and other valuable attributes. It is noteworthy that both academic and sporting achievements play pivotal roles in enhancing employability prospects post-graduation.

Hence, this study endeavours to explore the intricate relationship between sports participation and employability. A total of 127 graduates, spanning across four faculties of Wayamba University in Sri Lanka, were randomly selected as the study's sample population. The measurement of sports-related activities was accomplished through the formulation of a "Sports Achievement Index" (SAI). This index assigned marks to various sports-related activities in which the participants were engaged. The study's methodology involved the calculation of the SAI for the selected sample, utilizing the prescribed index.

By examining the correlation between sports involvement and employability, this research aims to shed light on the role sports play in shaping an individual's future career prospects. It seeks to contribute valuable insights into the multifaceted benefits of sports participation beyond the physical and mental well-being of undergraduates. The findings from this study may have implications for the development of strategies to enhance students' employability skills and their overall university experience.

This study delves into the relationship between sports participation during undergraduate studies and early career outcomes, focusing on a specific university. A sample of 127 graduates from diverse faculties at the university was analysed. At approximately three months' post-final examination results, their job availability was assessed, yielding valuable insights (Table 1).

Table 1: Relationships between participation in sports activities and job availability.

Faculty	Total Students	Sportsmen /women	Percentage %	Job Availability for sportsmen/women	Percentage %
FAS	31	06	19.35	06	100
FAPM	30	12	40	10	83.33
FBSF	32	19	59.38	18	94.74
FLFN	34	08	23.53	08	100
Total	127	45	35.43	42	93.33

The data revealed that 45 out of the 127 students, or 35.43%, had actively participated in sports during their university tenure. Remarkably, when examining job availability at the time of convocation, it was observed that 42 out of these 45 sports-involved students, constituting 93.33%, had successfully secured employment within this brief period.

These findings underscore a strong positive association between university sports involvement and early career success. Evidently, students who engaged in sports during their academic journey demonstrated a significantly higher likelihood of securing employment before their convocation, emphasizing the tangible benefits of sports participation beyond the confines of physical and mental well-being.

Considering the pivotal role that university students play as future leaders responsible for shaping their nations' cultural values and identity, this study suggests that sports participation may enhance academic performance and expedite the transition into the job market. However, it is imperative to acknowledge the limitations of this research, which primarily centred on a single university and a relatively small sample size. Future investigations should aim to expand this inquiry across diverse universities and larger student populations to generalize and corroborate these noteworthy findings.

Keywords: Index; Job Availability; Sports; Sports Achievements

Determinants of Employee Transition to Entrepreneurship: A Test of Theory of Planned Behaviour and the Dualistic Model of Passion

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Abstract

Entrepreneurial initiatives become active at different stages and milestones of an individual's life. They can be affected by numerous motives, such as macro-level environmental factors, characteristics of entrepreneurial opportunities, and individual motivations. Among them, individual motives are recognized to be the most common and challenging pathway toward new venture formation. Promoting Employee Transition to Entrepreneurship (ETE) is one of the many channels to boost the entrepreneurial development of any nation. The determinants of ETE in the context of developed countries have been satisfactorily investigated, while such empirical shreds of evidence are scant concerning developing countries, where the entrepreneurial-friendly setup is barely evidenced (Velamuri & Venkataraman, 2005; Stuart & Ding, 2006; Rachmawan et al., 2015; Antawati, 2017). Specifically, Sri Lankan entrepreneurial penetration was shallow compared to other countries in the neighbouring region (De Silva & Wright, 2019). Although the lower penetration of ETE is reported, the determinants of ETE are unlikely to be explored in low-income countries where economic, political, and social infrastructure are less conducive to new venture creation. Due to the paucity of studies, the present study aimed to investigate the determinants of ETE in the Sri Lankan context.

Within the theoretical frameworks of the Theory of Planned Behaviour (TPB) and the Dualistic Model of Passion (DMP), the current study studied the determinants of ETE intention (Figure 1). The study follows a quantitative methodology. A field survey objectively collects and evaluates quantitative data. Predictors of TPB and DMP were the determinants of ETE intention (i.e., attitude, subjective norms, perceived behavioural control, harmonious passion, and obsessive passion). The objective assessment of study variables was achieved through pre-tested

instruments. Randomly drawn employees from Sri Lankan private and state institutions made the sample (n = 218). The instruments with acceptable reliability and validity properties measured the study variables. Attitude, subjective norms, perceived behavioural control, harmonious passion, obsessive passion, and ETE intention were scaled on a seven-point Likert scale. Structural equation modelling analysed the data.

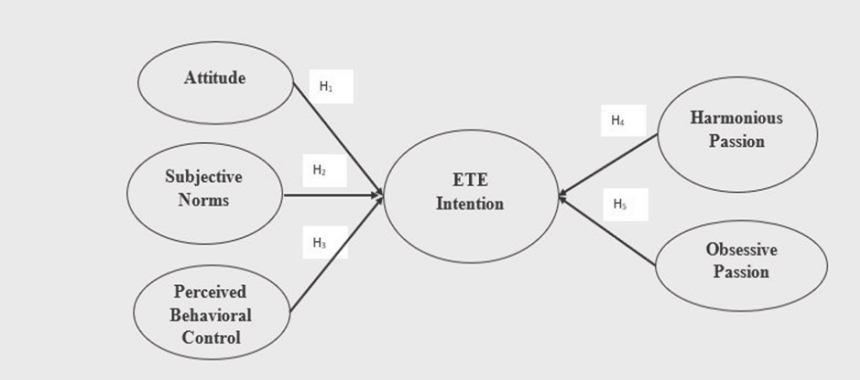

Figure 1: The Integrated Model of TPB and DMP.

According to the demographics of the respondents, men outnumber women (62%). The majority of respondents (67%) are between the ages of 28 and 41. There were 67% married respondents, with 47% having children. More than half of the sample (57%) were executives with significant economic and career stability. Furthermore, 45% had a bachelor's degree or higher, allowing them to compare employment and entrepreneurship rationally. The findings showed that employees' ETE intention is positively affected by all the tested variables other than perceived behavioural control. Notably, the results demonstrated that obsessive passion had a beneficial impact on ETE intention, although it is often thought to influence behavioural intention negatively. Thus, the study suggests that the ETE can emphasise any nation's entrepreneurial development by shaping employees' attitudes, perceived social influences, favourable interests, and even adverse interests to form a combined force to promote start-ups. The study's implications demonstrated the ability to model the ETE by integrating various theoretical frames that predict behavioural intentions.

Keywords: Developing Countries; Dualistic Model of Passion (DMP); Employee Transition to Entrepreneurship (ETE); Structural Equation Modelling (SEM); Theory of Planned Behaviour (TPB)

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Business, Economics and Finance

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Financial Network Topology Based on Minimum Spanning Tree: A Case of Stock Markets

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Abstract

Financial interconnectedness has been instrumented for capital generation and economic growth especially in emerging and developing countries. However, the recent global financial crisis underscored the potential role of financial connectedness financial distress. Further, financial linkages are vaunted to clarify the contagion patterns as channels of transmission. Hence, financial networks are extensively constructed to identify the ties existing within the markets and its vulnerabilities. In tandem, Sri Lankan stock market, the major equity generator of the country is exposed to the adversities of the global financial markets. However, there are limited local studies on financial networks and contagion effects of financial crisis on the Sri Lankan stock market. Thus, the study aimed to identify the financial connectedness of the Sri Lankan stock market with the prominent global stock markets in identifying the vulnerability of the Sri Lankan stock market to contagion of a financial distress.

The study used the daily returns of prominent stock indices of the United States (DJIA), the United Kingdom (FTSE), Germany (DAX), France (CAC40), Japan (NIKKEI), China (SSE), South Korea (KOSPI), India (NSE) and the All-Share Price Index (ASPI) of the Colombo Stock Exchange from January 1995 to December 2020 in determining the financial linkages through conditional correlations. As per prior studies, and non-normal behaviour in the stock indices, an Autoregressive Moving Average- Glosten, Jagannathan and Runkle- Generalized Autoregressive Conditional Heteroscedasticity (ARMA-GJR-GARCH) approach was used in determining the volatilities in individual indices. Further, the standardized residuals of the Univariate GARCH models were analysed for dynamic conditional correlation (DCC) through a bivariate DCC-GARCH model pairwise. The extracted correlations were transformed to weight metrics in the development of minimum spanning tree (MST). Further, the Kruskal's algorithm was utilized in constructing the MST.

MST identified CAC40 with the strongest financial links. Thus, it is highly vulnerable in transferring uncertainty. ASPI is linked to NSE and has the longest distance. It corresponded to the size and the contribution of the Sri Lankan stock market in the global financial market. Thus, ASPI is relatively less prone to the financial distress passed among the financial markets. Further, the financial network was centralised around the Eurozone and European markets connecting the Asian and American markets. Corresponding to the findings of prior studies, the financial topology except for KOSPI depicted the geographical locations of the countries of the indices. Therein it confirmed the contribution of the geographical location of the stock markets in correlations. Further, the topological representation of financial linkages further reinforced that the conditional correlations among the stock indices were predominantly based on the regional issues. The linkages of NIKKEI – SSE and ASPI – NSE further evinced this clustering behaviour.

The study identified the vulnerability of the Sri Lankan stock market to the transmission of financial distress from global stock markets through conditional correlations. However, the study only maps the overall connection of the countries instead of the changes occurred through turmoil. Future study directions may include the identification of contagion through financial networks.

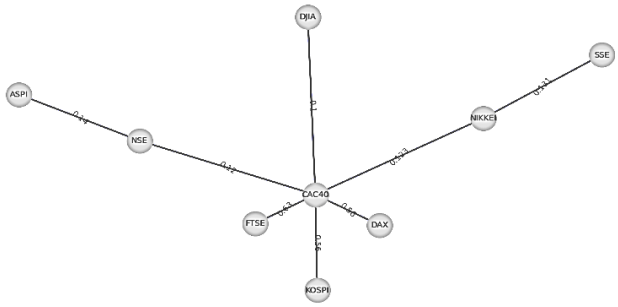

Figure 1: Financial network of the stock indices.

Keywords: Conditional Correlation; Financial Network; Kruskal's Algorithm; Minimum Spanning Tree

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Effect of SDG Reporting on Firms' Financial Performance: A Study in Sri Lankan Publicly Listed Companies

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Abstract

Sustainability reporting has gained much significance in global markets as investors have realized the benefits of disclosing sustainability aspects. Various sustainability frameworks have been introduced to facilitate corporate sustainability reporting practices, and considerable attention has recently been drawn to specific stakeholder requirements for sustainability reporting. The guidelines by the Global Reporting Initiative (GRI) have been identified as the most commonly used framework in Sri Lanka and numerous studies have been conducted on examining the sustainability reporting practices based on the GRI framework. Business companies are also attentive to incorporating Sustainable Development Goals (SDGs) introduced in 2015 as guidelines for sustainability disclosures in their companies as a measure to show their commitment towards achieving the global agenda by 2030. Stakeholders such as investors are in need to identify the effect of the sustainability reporting practices, particularly incorporating SDGs, on firm performance. Nevertheless, there is a dearth of studies in the Sri Lankan context examining the effect of the SDGs incorporated sustainability reporting on firms' financial performance. This study intends to add knowledge to previous studies and will contribute to the existing literature by identifying whether there is a significant effect of SDGs incorporated sustainability reporting on firm financial performance.

A sample of 100 publicly listed companies, listed in the Colombo Stock Exchange as of June 2020 was selected, based on market capitalization. Secondary data were collected on the Return on Assets (ROA), Return on Equity (ROE), and net profit margin and were used as the dependent variable whereas the sustainability reporting score was used as the independent variable in the analysis. Ordinary Least Square (OLS) Regression and two-stage least square(2SLS) regression were employed to determine whether there is an effect of sustainability reporting

practices on firms' financial performance. A sustainability reporting score was developed using the results of the content analysis of the sustainability reports using the 17 SDGs as the performance indicators incorporating GRI guidelines.

The results show that there is no significant effect of the SDGs incorporated sustainability reporting on a firm's financial performance. The model specified was checked if the OLS assumptions were held, and 2SLS regression was used to control for heterogeneity. Both models specified had insignificant relationship with the financial performance indicators such as ROA, ROE, and net profit margin. These indicators were observed to be unaffected by the sustainability reporting practices incorporating SDGs in the Sri Lankan context.

The results conclude that the firm financial performance will not possibly be affected by SDGs incorporated sustainability reporting in the Sri Lankan context. However, the result could not be viewed as having no relationship of SDG incorporated reporting with corporate financial performance. As per prior literature, sustainability reporting practices are meant to increase firm reputation, firm efficiency, productivity, customer and brand loyalty and employee retention. Firms with superior financial performance that perform well in the sustainability aspects were found to create more value for their stakeholders in the long run. Hence, based on the results, it could be suggested that sustainability reporting practices incorporating the global SDGs could positively influence corporate financial performance in the long term. Furthermore, as the immediate financial benefits from practicing SDG-incorporated sustainability reporting could be lesser or insignificant, regulators and practitioners could encourage the practice of SDGs-incorporated sustainability reporting as a mode of enhancing the wealth of shareholders in the long term and as a tool to attract future investment opportunity. Incorporating SDGs in business strategies and sustainability reporting could benefit corporates in achieving long-term economic growth and enhancing corporate reputation, which will in turn attract new business opportunities in the global arena.

Keywords: SDGs; Sustainability Reporting; Firm Performance; ROA; ROE

Systematic Literature Review on Developing a Financial Management Competency Framework for Nurse Managers at Public Hospitals in Sri Lanka

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Abstract

Financial management is an essential function of nurse managers (NMs) who are responsible for managing the financial resources of their units and for ensuring the delivery of high-quality and safe patient care. Evidence shows that many NMs lack the necessary financial management competencies to perform their roles effectively. This may lead to poor financial outcomes, such as overspending, underutilization, wastage, and inefficiency. Therefore, there is a need to develop a financial management competency framework for NMs that could be suitable and applicable to the context of public hospitals in Sri Lanka, where NMs encounter various issues such as insufficient funds, inadequate staff, outdated equipment, and high patient demand. There was no evidence of research in the Sri Lankan setting on the financial management skills of NMs in state hospitals. This research will provide information about the daily financial management activities of NMs in public health care organizations, the current workplace challenges they face, and the perceived skills they need to have in order to effectively manage their health care organization as a business.

The aim of the systematic literature review is to conduct a literature review on the existing financial management competency frameworks for NMs and to identify the gaps and limitations in the existing literature.

A systematic search of electronic databases, such as PubMed, CINAHL, Scopus, and Google Scholar, was conducted using keywords such as "financial management", "competency framework", "nurse manager", and "public hospital". The PRISMA check list was used to validate the systematic review. The inclusion criterion was

the articles published in English from 2010 to 2020 that focused on the development or evaluation of financial management competency frameworks for NMs in any setting. The exclusion criterion was the articles that did not focus on financial management competencies or NMs, or that were not relevant to the context of public hospitals in Sri Lanka. The quality of the articles was assessed using the Critical Appraisal Skills Program (CASP) checklist. The data extraction and synthesis were performed using a thematic analysis approach.

The literature search generated 18 articles that met the inclusion criteria. The articles were found from several countries, such as South Africa, and the China. The articles apply different methods to develop or evaluate the financial management competency frameworks, such as literature review, Delphi technique, grounded theory, and mixed methods. The articles identify various dimensions and domains of financial management competencies for NMs, such as financial knowledge, financial skills, financial attitudes, and financial behaviours. However, the studies also reveal some gaps and limitations in the existing literature, such as: 1) the lack of a clear and consistent definition of financial management competencies for NMs, 2) the lack of a comprehensive and contextualized framework that covers all aspects of financial management competencies for NMs, 3) the lack of empirical evidence on the validity and reliability of the frameworks, 4) the lack of evaluation of the impact of the frameworks on financial performance and patient outcomes and 5) the lack of consideration of the cultural and organizational factors that influence the financial management competencies of NMs.

The literature review showed that there are some existing financial management competency frameworks for NMs, but they are not adequate or applicable to the context of public hospitals in Sri Lanka due to health care funding and rules and regulation of ministry of health in Sri Lanka regarding nursing management. There is a need to develop a new framework that is based on the perspectives and experiences of NMs, senior nurses, and hospital administrators in Sri Lanka. The new framework should also be validated and evaluated for its effectiveness and impact on financial outcomes and patient satisfaction.

Keywords: Competency; Nurse Manager; Financial Management Framework

Systematic Literature Review on Cost Effective Leadership among Nurse Managers

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Abstract

Effective leadership within healthcare organizations, particularly in public hospitals, plays a pivotal role in ensuring the delivery of quality patient care while optimizing resource utilization. This systematic literature review aims to synthesize existing research on cost-effective leadership strategies employed by nurse managers. The review explores the various leadership approaches, skills, and practices that nurse managers employ to enhance healthcare quality and financial efficiency.

Like many other countries, faces challenges in achieving optimal patient outcomes while managing limited resources. Nurse managers (NMs), as front-line leaders, are tasked with the responsibility of translating strategic goals into actionable plans and fostering a work environment that promotes both clinical excellence and cost-effectiveness. According to the American Nurses Association (ANA), financial management and cost-effective leadership skills are considered core competencies for nurse managers. Furthermore, ANA's description of the scope standard of practice, and financial competencies are essential for the effective managerial role of recourses in high-standard nursing practice. On the other hand, it is crucial to expand clinical services and improve delivery efficiently, while constraining costs to keep pace with modernized.

The purpose of this systematic review is to explore the gap and restrictions with the aim to develop a cost-effective leadership (CEL) model for Nurse Managers. This review seeks to shed light on the strategies adopted by nurse managers to address these challenges. Method - The review employs a comprehensive search strategy to identify relevant studies from electronic databases, academic journals, and grey literature sources in different online platforms such as PubMed, CINHAL, Scopus, and Google Scholar. Inclusion criteria encompass primary research articles, reviews, and case studies published in English within the last decade (i.e., 2010 and

2020). The exclusion criterion was the article that did not focus on cost effective leadership of nurse managers or that were not relevant to cost effectiveness. The PRISMA check list was used to validate the systematic review.

The selected studies undergo a rigorous screening process based on predefined criteria to ensure their relevance and methodological quality. Key themes emerging from the literature are analyzed and synthesized to provide insights into the CEL practices of nurse managers. The identified themes include (1) strategic financial planning and budget management, (2) staff development and empowerment, (3) communication and collaboration, (4) patient-centered care, and (5) continuous quality improvement. These themes collectively contribute to achieving enhanced patient outcomes, efficient resource allocation, and sustainable healthcare delivery.

This exploration generated 15 articles that encountered the inclusion criteria. The literature review is from various countries, such as South Korea, South Africa, United States and Sri Lanka. The articles used various methodologies to develop or evaluate the Leadership and Managerial Competency Framework (LMCF) and CEL competencies or CEL model. Delphi technique, grounded theory, and mix method are used as methodologies. Articles reviewed different dimensions and domains of financial management skills for NMs such as changing NMs' attitudes and behaviours, CEL, and cost-effective competencies related to the nursing arena. The findings of this systematic literature review have implications for nurse managers, hospital administrators, policymakers, and researchers.

This systematic literature review aims to contribute to the current understanding of CEL among nurse managers in public hospitals in Sri Lanka. By identifying and analysing key strategies and practices, the review offers valuable insights into how nurse managers can navigate the complex healthcare landscape, optimize resource utilization, and ensure the delivery of high-quality patient care.

Keywords: Cost Effective Leadership; Cost Effective Competencies; Nurse Manager; Public Hospitals

Trends and Challenges of Incorporating Data Analysis and Information Systems into Management Degree Programs: Bibliometric Analysis

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Abstract

Data analysis and information systems are rapidly developing fields that have transformed various sectors, including management education. Therefore, this study aims to investigate the trends, challenges, and implications of incorporating data analysis and information systems into management education, using bibliometric analysis. This study provides a novel and comprehensive overview of the trends and challenges of incorporating data analysis and information systems into management degree programs, using the Scopus database, and articles published between 2015 and 2023. The findings have significant implications for educators and policymakers who seek to prepare students for the demands of the modern workforce. To identify relevant scholarly documents for the bibliometric analysis, a search strategy was performed, using a combination of keywords and operators. The keywords were related to data analysis and information systems, and the operators were used to include or exclude certain words from the search. The dataset encompasses 825 documents, authored by 2495 individuals, sourced from 387 references. These documents were extracted from different keyword strings related to management education, data analysis, and information systems. Table 1 shows the annual scientific production of articles related to data analysis and information systems in management education from 2010 to 2023. The number of articles generally increased over time (year) by 34%, indicating a growing interest and importance of this topic. The number of articles recovered and grew remarkably from 2016 to 2022, reflecting the adaptation and innovation of researchers and practitioners in this field.

Table 1: The annual scientific production.

Year	Articles
2015	49
2016	68
2017	61
2018	64
2019	80
2020	86
2021	107
2022	176
2023	134

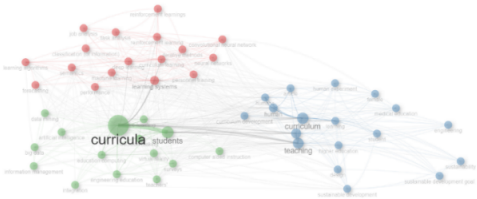

Figure 1: The Keyword Co-occurrence network.

The paper uses a network analysis to identify and visualize the main topics and connections related to data analysis, information systems, and curriculum development in management education. Figure 1 shows the co-occurrence network of the keywords, where each node represents a keyword and each edge represents the frequency of co-occurrence between two keywords. The network reveals four major clusters of keywords, which correspond to four themes: learning systems and methods, data analysis techniques and applications, information systems design and management, and curriculum development and evaluation which has been discussed and used by scholars. The analysis reveals that there are only a few scholarly literature available in the field of identifying the Trends and challenges of incorporating data analysis and information systems into management degree programs. The text is a literature review that examines how management education integrates data science and analytics. The main challenges are faculty training, curriculum design, and technological infrastructure. The main trends are business analytics, digital transformation, and data-driven decision-making. These trends show the interdisciplinary nature of the field and the alignment with industry demands. The influential sources are authors and publications that contribute to the advancement of knowledge in this field and improve management education for future challenges.

Keywords: Bibliometric Analysis; Curriculum Development; Data Analysis; Information Systems; Management Education

The Impact of Macroeconomic Stability on Profitability of Commercial Banks: Evidence from Sri Lanka

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Abstract

Financial system allocates funds between lenders and borrowers and it plays a vital role for promoting economic growth. Within the financial system, banking sector is the dominant sector and banks play an important role in promoting financial system stability and economic growth. During the last decades, there was a great deal of attention on evaluation of bank performance, particularly on commercial banks. The existing literature on this nature is quite large and focused on the effect of bank specific, industry specific and macroeconomic factors as determinants of bank profitability based on country specific and cross country analysis. These factors are broadly discussed under internal and external factors. The external factors which explain macroeconomic stability factors are broad base in nature represent financial and macroeconomic condition of the country is common to all banks. Although the negative consequences of macroeconomic instability are not confined to banking sector, failure of financial system may have severe impact on both real and monetary sector in the long run. In this context, weak macroeconomic fundamentals may have significant impact on banking sector than non-financial institutions as those institutions are mainly driven by public trust and confidence. Simply, unstable economic and financial environment might collapse banking sector due to risk and uncertainty. Thus, it is more important to understand uncontrollable macroeconomic influence on the profitability of banks. However, empirical literature on profitability of banks on economic stability has been inconclusive and ambiguous as the previous findings were mixed in nature. In the Sri Lankan context, studies focused on the macroeconomic factors on bank profitability are still scanty. Thus, a country specific analysis is important in this nature enabling to address above issues. Therefore, the main objective of this study is to investigate the impact of macroeconomic stability on commercial bank's profitability in Sri Lanka. This paper argues that macroeconomic stability is more important in determining banking sector performance in Sri Lanka being a small economy.

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This study uses panel data and applies panel pool regression analysis for the period 2010-2021 to achieve the research objective. Accordingly, economic growth, inflation rate, interest rate and money supply are used as an internal stability variables and exchange rate is used as an external stability variable against the profitability of commercial banks in Sri Lanka. The model framework of the study enriches with the mediating variable, non-performing loans (NPL) and a control variable, bank assets. All these variables are selected based on the literature. Out of the population of 24 commercial banks, this study uses 6 systematically important commercial banks as a sample. The relevant data has been collected from Central Bank annual reports and commercial bank annual reports for the study period. The mediating effect via NPL tested using an uncertainty index. This index is developed as a proxy of macroeconomic stability based on the standard deviation of internal and external stability variables. The significance of mediating effect is tested using Sobel test indicator. Return on equity (ROE) is used as proxy for measuring profitability of banks.

Findings of the study confirmed that foreign exchange rate has strong negative impact on the bank profitability. Economic growth and size of the bank have strong positive impact on Bank profitability. Further money supply has positive significant impact on bank profitability. However, inflation rate and interest rate are not statistically significant in the model. The expected sign of the relationship between the explanatory variables and the dependent variables are comply with the theory. Sobel test indicates that there is a significant negative mediating impact from macroeconomic stability index on profitability of commercial banks through the non-performing loans (NPL). According to the composite index, there is an upward trend in the uncertainty index throughout the study period and trend become more robust after 2017 onwards. This indicates that the risk and uncertainty has increased in the external macroeconomic environment throughout the study period. Overall, the findings provide interesting new insights for the better understanding of the mechanisms in explaining the route causes of the profitability of commercial banks in Sri Lanka. In conclusion, macroeconomic stability is more important in explaining the profitability of commercial banks in Sri Lanka. Thus, policy makers should pay attention on the stability of the macroeconomic environment enabling financial system to function properly and attain the economic sustainability in the longer term.

Keywords: Economic Stability; Profitability; Commercial Banks; Sobel Tests; Sri Lanka

Efficiency and Performance of Microfinance Institutions: A Systematic Literature Review

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Abstract

The existence of well-performing **microfinance institutions (MFIs)** is vital for financial systems because limited access to traditional financial services is a significant obstacle to the economic well-being of low-income communities. Although numerous studies have analysed the financial-social performance and efficiency of MFIs, it is found that limited studies have conducted literature reviews, especially in the *systematic literature review (SLR)* context. Synthesizing of the existing knowledge is required to direct potential scientific studies to the correct focus. Accordingly, this study attempted to bridge the gap and explore the most recent knowledge structure in the performance and efficiency of MFIs. Therefore, the objectives of this research were to find (1) the common knowledge and (2) the areas that should be considered for future research in performance and efficiency in microfinancing. The study incorporated the Bibliometric analysis using Biblioshiny and VOSviewer applications. The article selection and findings were generated following the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)* guidelines. Articles selected from the Scopus database. The limiting features included the year range 2013-2023, document type: articles, source type: journal, and language: English. The search terms were, "performance," "efficiency," and "microfinance institutions." Initially,98 articles were suggested and after including limiting options, 75 articles were selected for manual screening. Each abstract was reviewed against the inclusion criteria and 69 articles were selected for the present study. According to the analysis, there has been a consistent rise in annual article output since 2013, with minor fluctuations. However, the trend for individual article citations showed a decline over the timeframe. In terms of

countries frequently cited, Spain, Malaysia, the United Kingdom, Norway, France, the Netherlands, and India occupied the top positions. Further, India and Malaysia have produced comparatively highest number of articles within this timeframe. Three common clusters were found based on the keyword co-occurrence network visualization (Figure 01-A). Thus, by addressing the mentioned first objective, three common themes were identified in the available literature; (1) The performance of MFIs, (2) The efficiency of MFIs, (3) Sustainable microfinancing. The keyword density visualization (Figure 01-B) demonstrated that performance assessment, efficiency measurement, profitability, productivity, sustainability, financial sustainability, and outreach of MFIs are infrequently investigated and identified as gaps in the existing literature. Financial efficiency, social efficiency, financial performance, and social performance of MFIs, are also averagely investigated.

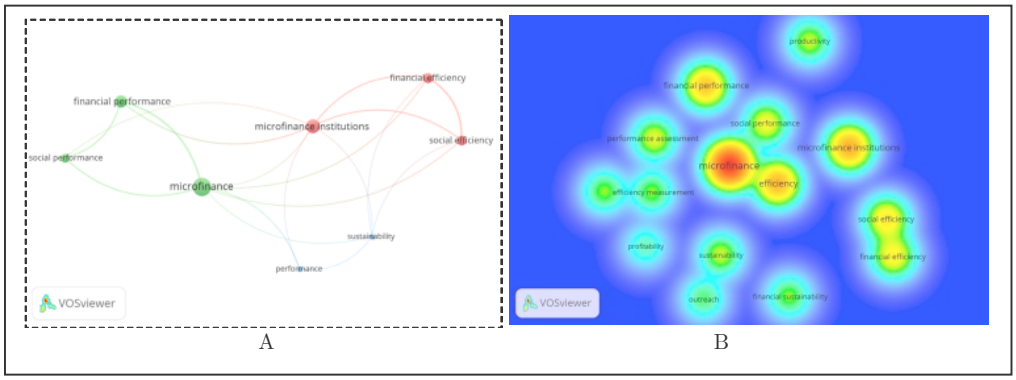

Figure 1: Keyword Co-occurrence and Keyword density visualizations.

The study observed that efficiency and traditional performance analysis of MFIs differ in methodologies and perspectives. Efficiency is quantified as output-to-input ratios, with subjective selection of input-output variables. Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are commonly used for efficiency assessment, whereas financial performance relies on accounting & financial measures. Social performance indicators such as client numbers, women borrowers, loan size, and branch count, contribute to social goals. Efficiency can be identified as a subset of sustainable microfinance performance. Thus, the review revealed the areas to be researched further to build a strong knowledge for the microfinance industry since there is a need to ensure the sustainability of MFIs. Further, the review emphasizes the need to diversify the perspectives on overall MFI performance to ensure lasting success, because the Microfinance sector viability rests on robust MFI overall performance.

Keywords: Efficiency; Microfinance Institutions; Performance; PRISMA; Systematic Literature Review

Senate Research and Higher Degrees Committee
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