ABSTRACTS

"Innovations in Food and Nutrition Research"

Undergraduate Research Symposium - 2017

September 08, 2017

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Faculty of Livestock, Fisheries and Nutrition
Wayamba University of Sri Lanka

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Fifth Undergraduate Research Symposium

Faculty of Livestock, Fisheries and Nutrition
Wayamba University of Sri Lanka
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Message from the Editor-in-Chief

It is a great pleasure for me to welcome you to the proceedings of the Undergraduate Research Symposium (UReS - 2017) of the Faculty of Livestock, Fisheries and Nutrition in the Wayamba University of Sri Lanka. All undergraduates in the Faculty of Livestock, Fisheries and Nutrition following the BSc. in Food Production and Technology Management and BSc. in Food Science and Nutrition successfully completed their final year research projects are presenting their research findings today. The UReS is a golden platform for undergraduates to exchange ideas, discover novel opportunities, networking with industrial professionals and entrepreneurs to broaden their knowledge and experience.

This year the proceedings consist of 122 abstracts covering the disciplines of applied nutrition, aquaculture and fisheries, food science and technology and livestock and avian sciences under the theme of "Innovations in Food and Nutrition Research". These abstracts are the results of persistent effort of undergraduates and their supervisors, both internal and external.

On behalf of the editorial committee, I wish to thank all the authors and reviewers for their contribution. Finally, I wish to thank the Dean of the Faculty and the organising committee of UReS-2017.

MDST de Croos (PhD)
Editor-in-Chief
Undergraduate Research Symposium – 2017

08th September 2017

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

I send my greetings with this message to the Fifth Undergraduate Research Symposium (UReS 2017) of the Faculty of Livestock, Fisheries and Nutrition with immense pleasure. UReS, the most glamorous annual event of the faculty, is a platform for final year students to demonstrate their higher order academic skills and experiences in social engagement.

The fifth UReS is themed "Innovations in food and nutrition" and more than 120 research papers covering fields of Food Science and Technology, Applied Nutrition, Livestock and Avian Sciences and Aquaculture and Fisheries will be presented at the technical sessions. Other than the technical knowledge, students get a great opportunity to network with researchers, academics of universities and industries.

Academics and undergraduates are creatively and effectively involved in research in casting their image in the research arena. As a rapidly growing entity in the Wayamba University of Sri Lanka, the faculty has well recognized its social responsibility of promoting scientific research and innovation. In this connection, the faculty added a novel feature of "Award for the Best School Inventor" to the symposium programme in 2016. Such appreciations encourage the new generation towards research and inventions.

I extend my congratulations to all undergraduates who are presenting their research at UReS 2017. I also take this opportunity to thank all those who contributed to make URes 2017 a success and I wish UReS-2017 all the best.

Dr. M.S.D.W. De Silva
Dean, Faculty of Livestock, Fisheries and Nutrition
Wayamba University of Sri Lanka

Message from the Vice Chancellor
Wayamba University of Sri Lanka

I am very much pleased to write this message for the Proceedings of the Undergraduate Research Symposium (UReS) 2017 on this important occasion of the undergraduates of the Faculty of Livestock, Fisheries and Nutrition making their research presentations to a distinguished audience of scientists.

Food production and nutrition are undoubtedly areas of national importance. The present batch of undergraduates trained in research and dissemination of knowledge will be an invaluable asset to the country, in producing and sustaining a healthy food production towards building a healthy nation.

I take this opportunity to commend the efforts of the Dean, Heads of Departments and other academic, academic support and non-academic staff of the Faculty since it was their expertise and contributions which made the achievements of the undergraduates possible.

I would like to congratulate the undergraduates who have reached an important milepost in their academic careers and will venture out to pursue their chosen career paths. Many of them will, I am sure, select an academic career. The training and skills imparted by the staff will enable them to establish their careers and upward mobility. I wish them well in their future academic activities.

Prof. E.M.P. Ekanayake
Vice Chancellor
Wayamba University of Sri Lanka

Contents

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Perception of school teachers and caterers on challenges and barriers in implementation of school meal programmes

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School meal programmes increase school enrollment, attendance and improve the nutrition status of children by addressing micronutrient deficiencies[1]. Cash based meal programme and providing milk are two types of school meal programmes that are fully funded by the government of Sri Lanka. The modalities of these programmes have been changed several times without conducting systematic monitoring and evaluation or studying the impact of the school meal programme. Aims of this study were to determine the perception of teachers and caterers regarding achieving the targeted objectives and identify the challenges and barriers in implementation of the meal programme. A qualitative study was conducted in eleven schools from Giriulla, Kegalle and Mawanella educational zones. Focus group discussions were conducted with school teachers. Individual interviews were conducted with the caterers and principals of the schools. The conversations were transcribed verbatim including questions, answers and probes and the transcripts were analysed using NVivo10.

The most significant challenges in implementing the meal programmes are financial constraints of the caterers and availability of limited number of caterers willing to provide the services. Teachers perceived that improper practices in catering such as not adhering to menu at certain circumstances, bringing unmatched food items and providing foods without concerning the preference of the students, may unintentionally result in a negative influence on students' eating behaviours. Teachers and the principals perceived that these challenges negatively affect in achieving the objectives of the school meal programme. However, the teachers appreciated this programme as it satisfied the hunger of most of the students and also it helped to develop good food habits. The teachers faced problems in providing the milk packets to the students as it did not have a place to insert the straw and when the students spilled the milk in class rooms it was a burden for the teachers to clean the classes. The low preference of the students to drink milk was also a challenge for the teachers in implementation of the programmes. Teachers strongly believed that support of the parents is vital in successfully implementing the milk programme. The identified challenges should be addressed to implement the school meal programmes successfully. The programmes should be strengthened through proper monitoring and coordination with the stakeholders involving in the implementation.

[1]World Food Programme (WFP) (2013) *State of School Feeding Worldwide 2013*, WFP: Rome.

Keywords: Barriers and challenges, Perceptions, School meal programmes

Mineral contents and antioxidant activities of selected newly improved Sri Lankan rice varieties as affected by fertilization

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Nutrients and bioactive compounds from natural food sources play a vital role in attenuating non-communicable diseases caused by malnutrition and oxidative stress. Rice is the staple food for more than half of the world's population providing nutrients and bioactive compounds. The present study was designed to compare the mineral contents (MCs) and antioxidant activities (AOAs) between selected fertilized and non-fertilized newly improved Sri Lankan rice varieties. Bran and kernel fractions of twenty fertilized and corresponding non-fertilized rice varieties were used. The soluble phenolic fractions of the bran samples were analyzed for total phenolic content (TPC), total flavonoid content (TFC) and antioxidant activities (AOA). 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity (DRSA), reducing power (RP) and ferrous ion chelating activity (FICA) were adopted to evaluate the antioxidant potential. Rice bran and rice kernels were analyzed for following MCs; calcium (Ca), magnesium (Mg), zinc (Zn), manganese (Mn), cadmium (Cd) and lead (Pb).

Compound	Fertilized rice brans	Non-fertilized rice brans
TPC (μmoles of ferulic acid equivalents/g of defatted bran (DB))	3.76 – 141.28	2.38 – 134.92
TFC (μmoles of catechin equivalents/g of DB)	0.26 – 29.44	1.14 – 32.41
DRSA (μmoles of trolox equivalents/g of DB)	4.49 – 87.78	5.15 – 81.94
RP (μmoles of ascorbic acid equivalents/g of DB)	12.32 – 35.32	8.39 – 35.13
FICA (μmoles of EDTA equivalents/g of DB)	0.40 – 4.32	1.53 – 4.06
Calcium (mg/kg dry matter (DM))	952.5 – 1604.9	492.2 – 1441.3
Magnesium (mg/kg DM)	1124.3 – 1229.6	1068.2 – 1192.6
Zinc (mg/kg DM)	121.1 – 192.2	106.7 – 210.5
Manganese (mg/kg DM)	122.0 – 273.1	85.8 – 176.5
Cadmium (mg/kg DM)	0.3 – 2.9	0.6 – 1.7
Lead (mg/kg DM)	15.1 – 60.2	11.7 – 60.7

There were significant variations in TFC, RP and FCA as affected by fertilization ($p < 0.05$), while TPC and DRSA were comparable in many varieties ($p > 0.05$). Ca, Mg, Zn, Mn and Pb contents were significantly high in fertilized varieties ($p < 0.05$). This may probably be linked with the presence of major and minor elements in chemical fertilizers. The results so obtained conclude that fertilization increases MCs and have an impact on the AOAs in rice.

Acknowledgement: University Research Grant Scheme Wayamba University of Sri Lanka (SRHDC/RP/04/15-20) for financial assistance.

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Meharg, A.A., Norton, G., Deacon, C., Williams, P., Adomako, E.E., Price, A., Zhu, Y., Li, G., Zhao, F.J. and McGrath, S. (2013). Variation in rice cadmium related to human exposure. *Environmental Science Technology,* 47(11):5613–5618.

Keywords: Atomic absorption spectrophotometry, DPPH radical scavenging activity, TPC, TFC

Effects of dietary intake on nutritional status of pregnant women

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Pregnancy is the period of remarkable adaptations that impact upon physiology and metabolism unlike other stages of the life cycle. During pregnancy, proper nutrition is important because it affects to the nutritional status of both mother and the fetus. The objective of this study was to assess the effects of dietary intake on nutritional status of pregnant women. A total number of 150 pregnant women who attended the maternal clinics located in Pannala and Kuliyapitiya (West) Medical Officer of Health (MOH) areas, were in their second trimester and willing to participate after briefing the study by giving their written consent were recruited. A pre-tested interviewer administered questionnaire, anthropometric measurements; height (cm) and weight (kg), information in pregnancy records; Mid-Upper-Arm-Circumference (MUAC), pre-pregnancy height and weight, biochemical parameters; hemoglobin levels by using hemocue meter, 1ml of blood taken by trained person for analyzing serum total protein: biuret test, serum albumin: bromocresol green test, three-day diet diary and a 24-hour recalls were used to collect information. Nutritional status was determined using pre-pregnancy Body-Mass-Index (BMI), MUAC and nutrient intake. Nutrient intake was analyzed by Foodbase 2000 software and compared with Recommended Dietary Allowances (RDA)[1] for pregnancy. The mean age of the study sample was 26 (SD 4.58) years. According to the pre-pregnancy BMI 28.7%,56.4%, 10.9% and 3.96% were underweight, normal, overweight and obese respectively. Based on MUAC, 89% were in normal nutritional status ($\geq$23cm). Out of the total, 62% had normal level of hemoglobin ($\geq$11g/dL), 79% were having normal serum total protein status (6.7-8.7g/dL) and 66% were having normal albumin status (3.5-5.5g/dL). Mean daily intake of energy, carbohydrates and protein were2383kcal (SD 556.6), 380g (SD 89.7) and 63.7g (23.3) respectively and they were higher than RDA for pregnancy. Their dietary intake of iron, calcium, iodine, folic acid, vitamin C and vitamin A were15.5mg (SD 5.1), 632.3mg (SD 228.6), 62.55μg (SD 18.4), 226.5μg (SD 85.7), 47.8mg (SD 32.9) and 439.7μg (SD 214.5) respectively and they were lower than RDA. The results showed that dietary intake of carbohydrates positively affect ($p<0.05$) on MUAC, protein effects on pre-pregnancy BMI, hemoglobin level, and serum total protein and albumin status. Further, dietary intake of iron positively effects on hemoglobin and serum total protein levels while calcium intake affects with serum total protein level. The results of the study concluded that the importance of having adequate dietary intake through balanced diet during pregnancy for proper health and nutritional status of both mother and the baby.

[1]Medical Research Institute (2007), Recommended Dietary Allowances for Sri-Lankans, Colombo

Keywords: Anthropometry, Biochemical parameters, Dietary intake, Nutritional status, Pregnant women

Knowledge, attitude and practices of diabetic patients on their glycemic control

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Type 2 Diabetes Mellitus (T2DM) is one of the major public health problems in the world. Nearly seventy five percentage of adults with T2DM are now living in low and middle income countries. T2DM contributes to increased morbidity due to long term micro and macro vascular complications and reduced quality of life[1]. Glycaemic control plays an important role in delaying complications and improving quality of life of T2DM. Good glycaemic control can be achieved only when T2DM have appropriate knowledge, attitudes and practices (KAPs). However, limited studies were conducted on KAPs of DM on glycemic control in Sri Lanka. Therefore, the present study was conducted with the objective of assessing the KAPs of diabetic patients on their glycemic control. A cross sectional study was conducted to assess the level of KAPs on glycaemic control using 120 T2DM patients attending a diabetic clinic. Information on KAPs was collected using a pretested interviewer administered questionnaire. A scoring system was used to assess the KAPs on glycaemic control of T2DM.

Mean score for knowledge, attitudes and practices were 65%, 81% and 54%, respectively. According to the score, knowledge of the subjects was in good level. Correct attitudes toward the glycaemic control were in excellent level. However, their practice level was lower than knowledge and attitudes. Self-monitoring of their blood glucose levels was poor (<1%) among the T2DM. Eighty five percent of the T2DM checked their fasting plasma glucose at the monthly diabetic clinic, but only 57% of DM patients knew target blood glucose values. Majority of T2DM used the oral hypoglycaemic agents for their glycaemic control. Although, they had the knowledge on use of planned diet for glycaemic control only 42% of T2DM had practiced it. However, significant proportion (84%) of diabetics was involved in moderate physical activity which would contribute for their glycaemic control. There were positive relationships observed between diabetic duration with attitudes ($r = 0.520$; $p = 0.009$) and family history with practices ($r = 0.312$; $p = 0.039$).

In conclusion, although the level of knowledge in achieving proper glycemic control was good, T2DM of the present study showed poor adherence for proper practices. Therefore, it is essential to improve patients understanding on proper glycaemic control via maintaining the compliance for planned diet and regular physical activity along with the drugs. In improving the use of planned diets, provision of adequate information and support for T2DM has to be ensured at the diabetic clinics.

[1]World Health Organization (2006) Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycemia. *World health organization 2*, p.50.

Keywords: Attitudes, Diabetes mellitus, Glyceamic control, Knowledge, Practices

Impact of individual dietary counselling on nutritional status of oncology patients receiving chemotherapy

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Chemotherapy is commonly used as a successful treatment for many types of cancers. Although effective in disease management, it has an additional unfavorable effects on the nutritional status of patients. Many side-effects of chemotherapy which leads to deteriorate the nutritional status, can be controlled by proper nutrition interventions[1]. The aim of the study was to evaluate the impact of individualized dietary counselling on nutritional status, quality of life (QOL), functional capacity and dietary intake of medical oncology patients. A randomized control clinical trial was conducted with patients in the age range of 25-75 years registered in Oncology unit, Teaching Hospital, Kandy. Patients were randomized to receive either dietary counselling (DC) (n = 10) or usual care (UC) (n = 10) at the commencement of chemotherapy and followed up for three consecutive cycles. Following outcome measures were assessed at baseline and after 3 and 6 weeks of treatment: change in dietary intake, blood parameters, weight, Mid Upper Arm Circumference (MUAC), Patient Generated Subjective Global Assessment (PG-SGA) score[2], physical functioning score, QOL score and symptom score (measured by European Organization for Research and Treatment of Cancer [EORTC] quality of life questionnaire[3]). Dietary intake was assessed using 24-hour recall at the baseline and 3-day diet diary during follow-ups. Impact of DC between two groups with the time was analyzed using repeated measures ANOVA. Statistically significant improvements were observed in mean values of body weight, MUAC, energy, protein and fat intake and White Blood Cell (WBC) count in DC group compared to UC ($p < 0.05$). The QOL and functional capacity of the patients in DC group indicated a continuous, but statistically insignificant improvement compared to UC group with the time. There were significant reductions in constipation and appetite loss in DC group compared to UC group ($p < 0.05$). In conclusion, dietary counselling has a positive impact on body weight, muscle mass, dietary intake, immune functions, constipation and appetite loss of patients receiving chemotherapy.

[1]American Cancer Society (2013) Nutrition for the Person With Cancer During Treatment : A Guide for Patients and Families Benefits of good nutrition. *, pp.1–46.*

[2]Ottery, F. (1996) Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition,* 12:s15-s19.

[3]Aaronson, N., Ahmedzai, S. and Bergman, B. (1993) The European Organization for Research and Treatment of Cancer QLQ-C30: A quality-of-life instrument for use in international clinical trials in oncology. *Journal of the National Cancer Institute*. 85:365-76.

Keywords: EORTC quality of life, Oncology, PG-SGA, Dietary counselling

Effect of *Murraya koenigii* (curry leaves) on blood lipids in dyslipidemic female adults: preliminary results of a randomized double blind placebo control trial

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Cardiovascular disease (CVD) is the largest single cause of death in all around the world and most common cause of death in hospitalized patients in Sri Lanka. Dyslipidemia is a risk factor of CVD. Some of the commonly used pharmacological therapies for dyslipidemia have shown various side effects in long term use and management of the complications of this chronic disease is an economic burden for patients. Curry leaves is a commonly used spice in Sri Lanka which shows hypolipidemic effect according to some animal studies and limited number of human studies. Therefore, a double blind placebo control clinical study was conducted to investigate the effect of dried curry leaf supplement on blood lipids of dyslipidemic individuals.

Ten adult females (mean age 47.7 years) with dyslipidemia were randomly assigned into treatment (2g of dried curry leaf/day) and control (placebo). Subjects were asked to take capsules for 60 consecutive days (2g of curry leaves/day). Fasting blood samples collected at the baseline and on 4th week of the intervention period were analysed for total cholesterol (TC), LDL-cholesterol, HDL-cholesterol, and triacylglycerol (TAG). Demographic variables, dietary information and physical activity level of the subjects were also assessed. This abstract presents the results of the 8-week intervention study at the 4th week.

There was a significant decrease in TC (202.6 vs 172.8mg/dl), LDL-cholesterol (141.6 vs 101.2mg/dl) and TC:HDL-cholesterol (5.6 vs 4.4) and no significant change in HDL-cholesterol and TAG in subject group after 4th week of consumption of curry leaf supplement compared with baseline. None of the blood lipids showed significant changes in control group compared with the baseline. There was a significant decrease in TC:HDL-cholesterol in subjects who followed 4 weeks of curry leaf supplement compared with control group. None of the other blood lipid variables tested were significantly different between supplement group and control group. There was no significant changes in systolic and diastolic blood pressure, body composition and body weight in both groups.

Although four weeks of intervention is not adequate to observe the effects of curry leaves, the modest improvement in TC:HDL-cholesterol by the curry leaf supplement warrants further investigations.

Acknowledgment: Astron Limited, Ratmalana for manufacturing curry leaf supplement; Ms Dhammika Menike, Ms Priyangika Prabodhini, Jayani Samaranayake for assistance in laboratory analysis and clinical study

Keywords: Cardiovascular disease, Dyslipidemia, Curry leaves, Fasting blood lipids

In vitro bioaccessibility and bioavailability of phenolics in selected cereal and legume mixed diets

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Cereals are the staple for most of the populations in the world. Cereals and legumes are traditionally consumed together in many cultures. They contain various types of phenolic compounds. Cooked cereal and legume mixed diets (cowpea *Pittu*, cowpea milk rice, cowpea parboiled rice, mungbean *Pittu*, mungbean milk rice, mungbean parboiled rice) were subjected to *in vitro* enzymatic digestion and dynamic model to determine the bioaccessibility, bioavailability and antioxidant activities of phenolic compounds. Digesta were used for the determination of their total phenolic content (TPC) and total flavonoid content (TFC) as well as 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (DRSA) and ferrous ion chelating activity (FICA). TPC, TFC and antioxidant activities were determined using colorimetric methods. At the end of intestinal digestion, TPC ranged from 30.47 to 40.15 μmol of ferulic acid equivalent per gram of cooked diet, dry weight (dw) whereas TFC ranged from 6.00 to 37.94 μmol of catechin equivalent per gram of cooked diet, (dw) (Table).

Table: Bioavailability percentage of total phenolic content, total flavonoid content and antioxidant activities of bioavailable fraction of cereal and legume mixed diets

Diet	TPC Mean ± SD	TFC Mean ± SD	DRSA Mean ± SD	FICA Mean ± SD
Cowpea Pittu	83.0 ± 4.7^{a}	77.4 ± 6.6^{a}	81.4 ± 1.0^{a}	89.2 ± 0.0^{ad}
Mungbean Pittu	44.6 ±4.3^{b}	38.6 ± 3.6^{bd}	62.9 ± 4.8^{bc}	78.1 ± 0.0^{bc}
Cowpea milk rice	60.3 ± 6.0^{c}	50.3 ± 0.0^{b}	72.3 ± 10.6^{ab}	87.3 ± 0.2^{ab}
Mungbean milk rice	47.5 ± 10.1^{b}	38.6 ± 5.8^{bd}	70.0 ± 0.5^{ab}	72.9 ± 6.2^{c}
Cowpea parboiled rice	82.1 ± 7.4^{a}	63.7 ± 6.2^{c}	79.6 ± 8.0^{a}	81.8 ± 0.6^{bd}
Mungbean parboiled rice	35.4 ± 1.7^{b}	28.59 ± 3.2^{d}	50.3 ± 8.3^{c}	86.6 ± 5.0^{ad}

Values in each column having the same subscript letter are not significantly different ($p > 0.05$). Total phenolic content (TPC), total flavonoid content (TFC), and DPPH radical scavenging activity (DRSA) and ferrous ion chelating activity (FCA).

The study demonstrated that phenolic compounds of cowpea *Pittu* were more bioavailable than other diets studied. Antioxidant capacity was higher in cowpea *Pittu* diet compared with others. In conclusion, mode of cooking affects the bioaccessibility, bioavailability and antioxidant activities of phenolic compounds of cereal and legume mixed diets.

Acknowledgement: University Research Grant Scheme Wayamba University of Sri Lanka (SRHDC/RP/04/15-20) for financial assistance

Keywords: Bioaccessibility, Cereal and legume, DPPH, Dynamic model, Phenolics

Development and evaluation of a software for dieticians to assess the nutritional status and plan diets for patients with chronic kidney disease

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Chronic Kidney Disease (CKD) is an emerging health problem in Sri Lanka. Malnutrition is one of major issues in patients with CKD. Assessment of nutritional status and dietary management are important for the reduction of malnutrition incidence and to slow the disease progression. Although dietary management plays a major role in CKD management, there is no any specific published software for assessment of nutritional status and planning diets for patients with CKD in Sri Lanka. This research was aimed to develop a user-friendly software for dieticians to assess the nutritional status and plan the diets for patients with CKD. The research was conducted in three phases. In the first phase, available nutrition assessment methods, tools, and dietary management practices were gathered by reviewing literature and conducting a preliminary survey among dieticians in the hospital setups. In the second phase, the software was developed according to Software Development Lifecycle (SDLC). Visual Studio 2013 was used as an Integrated Development Environment (IDE) and C Sharp (C#) used as a programming language. In the third phase, developed software was evaluated by experts in the field of nutrition and dietetics. According to the responses obtained by the preliminary survey, all the dieticians used manual methods for assessment of nutritional status and plan diets for patients with CKD. Presently average time spends for the dietary management of a CKD patient was 30 minutes. The developed software named as "kidney diet plus" contains four major sections in the main interface. They were nutritional status assessment, Subjective Global Assessment (SGA), dietary calculations, and report section. Nutritional status assessment section was used in identification of CKD patient current nutritional status. In the SGA section, modified SGA was used for assessment of malnutrition conditions of the CKD patients. In the third section, food exchange list used for dietary calculation for meal planning of CKD patients. The final section of the software was used to generate reports containing details of nutritional status assessment and patient's history of each visits to the dietician. Dietitians who participated in the evaluation of the developed software revealed that the developed software increases the efficiency of the nutritional status assessment and planning diets for the patients with CKD comparing with present manual methods.

Keywords: Chronic kidney disease, Dieticians, Diet planning, Nutritional status, Software development

Adherence to national food based dietary guidelines by a group of healthy individuals

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At present, diet related non-communicable diseases (NCDs) are on rise. Traditional plant based diet of the Sri Lankans now have been replaced with more western type of diet. Therefore, refined food items, edible fat and oils and foods rich in sugar and salt have more access to the daily menus leading to develop NCDs. Food based dietary guidelines[1] have been developed to give recommendations about types of foods and quantities that have to be consumed daily or weekly to promote the general health and wellbeing and prevent the NCDs. Since dietary patterns are changing with the time, periodical monitoring is needed to identify the changing trends in food intake and the adherence to dietary guidelines by the population. Therefore, present study was conducted to evaluate the adherence to national FBDG by healthy individuals. A cross-sectional study was conducted with a group of 100 healthy individuals aged 20-55 years living in Pannala DS Division. Food intake data were collected using a semi quantitative food frequency questionnaire.

Results showed that, exception of fat and oil intake (adherence rate of 64%) adherence to national FBDG was low: 17% for fruits; 22% for milk; 41% for vegetables; 38% for cereals and cereal products, and 30% for fish, pulses, meat and eggs. The daily intake of fruits (1.5), milk and milk products (0.9) and vegetables (2.9) servings were below the national recommendations. The study population consumed 12.5 servings of rice, bread, other cereal products and yams, 4.0 servings of fish, pulses, meat and eggs and 4.2 servings of added sugars daily. Banana and papaw were the commonest types of fruits consumed. Milk powder and yoghurt were the common milk and milk products consumed. Rice was the major food item consumed under cereal group and additionally hoppers, string hoppers and bread were consumed. Most of them were refined grains. Dried fish, small fish, mysore dhal, chicken and large fish were the mostly consumed items from fish, pulses, meat and eggs group. Coconut milk and oil were the major fat sources of their diet. Average daily energy intake was 2121kcal. Average daily calorie intake from carbohydrates, fats and proteins was 65%, 23% and 12%, respectively.

In conclusion, adherence to the national FBDG by the study population is poor. They have not consumed adequate quantities of vegetables, fruits, fish, pulses, meat and poultry whereas intake of cereals and cereal products was in excess.

[1]Food Based Dietary Guidelines for Sri Lanka (2011) Nutrition Division, Ministry of Health, Sri Lanka

Keywords: Food based dietary guideline, Food frequency questionnaire, Healthy adults

Functional and nutritional properties of horse gram and cereal mixed porridges

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Horse gram is an underutilized legume which is renowned as poor man's meat. Horse gram is rich with protein, dietary fiber, iron, calcium, molybdenum. Cereals are consisted of macro and micronutrients and serve as staple for many populations around world. Cereals and legumes are rich with bioactive compounds such as phenolic compounds which are potential antioxidants in biological systems. The objective of the present study was to determine the nutritional composition and functional properties, namely antioxidant activity (AOA), glycemic response and the alpha amylase inhibitory activities of horse gram and cereal mixed porridges. Four types of cereals including rice, fingermillet, proso and foxtail millets were used in the study. Further, *in vitro* bioavailability and bioaccessibility of porridges were determined. The porridges were prepared on the ingredient ratio of legumes to cereal as 3: 1 based on series of preliminary trials and sensory evaluation. In the proximate analysis, moisture, ash, crude fat and crude protein were analyzed. Phenolic contents of the samples were analyzed using total phenolic content (TPC) and total flavonoid content (TFC). TPC of porridges ranged from 43.06 to 51.06 µmol of ferulic acid equiv/g of defatted meal. TFC ranged from 32.00 to 60.74 µmol of catechin equiv/g of defatted meal. AOA was analyzed using reducing power and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging (DRSA) activity. The DPPH values ranged from 10.19 to 15.19 of µmol of trolox equiv/g of defatted meal. The reducing power values ranged from 18.76 to C20.60 µmol of ascorbic acid equivalents/g of defatted meal. Depending on the type of porridge TPC, TF and AOA test values varied. Crude protein and crude fat values of porridges ranged from 9.38 to 12.51% and 7.11 to 8.40%, respectively. Crude protein content was highest in foxtail millets mixed horse gram (FOHG) porridge. Glycemic index of finger millets mixed horse gram (FIHG) porridge and rice mixed horse gram (RHG) porridge were 45 and 50, respectively. Bioavailable percentage of TPC of FIHG porridge and RHG porridge were 41.3 to 65.91%, respectively. The DRSA of FIHG and RHG porridges were 31.51 and 78.40%, respectively. The alpha amylase inhibitory activities of FIHG porridge and RHG porridge were 31.51 and 73.42%, respectively. The results indicate that horse gram can be effectively used as an ingredient for the development of foods with health promoting properties.

Key words: Horse gram, Finger millets, Porridges, Rice, Antioxidant activity, TPC, TFC

Effect of processing on bound phenolic contents of legumes

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Consumption of legumes has increased due to their myriad of health benefits. Legumes are rich sources of nutrients as well as non-nutrient compounds. There are evidences that legumes can prevent non-communicable diseases due to the phenolic compounds and their antioxidant activities [(1)]. The aim of present study was to determine the effect of different processing methods on bound phenolic content of legume varieties commonly used in Sri Lanka. Seventeen varieties namely green gram (Ari, MI5, and MI6), black gram (Anuradha, and MI1), soybean (PBI, and PM13), cowpea (Varuni, MICP1, MI35, Dawala, Bombe, and Vijaya), Maisoor black, horse gram, and chickpea (Red and Yellow) were used. Different processing conditions were used namely peeling, soaking, boiling and germination. Phenolic content was determined as total phenolic content (TPC) and total flavonoid content (TFC). Antioxidant activities were assessed by 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (DRSA) and ferrous ion chelating activity (FICA). TPC ranged from 0.4 to 21.67μmoles of gallic acid equiv (GAE) per gram of defatted legume meal. The highest TPC was reported for the peel of MI1-black gram. TFC was ranged from 0.12 to 16.43μmoles of catechin equiv per gram of defatted legume meal. The ranges of DRSA and FICA per gram of defatted legume meal, were 0.09 to 23.60 μmoles of trolox equivalents, and 0.12 to 19.35 μmoles of ethylene diamine tetra acetic acid (EDTA) equivalents respectively. Legumes with coloured seed coat contained high amount of bound phenolic compounds compared with light coloured seed coat. In conclusion, both processing method and variety influence the contents and antioxidant activities of bound phenolics of legume seeds.

Acknowledgement: University Research Grant Scheme Wayamba University of Sri Lanka (SRHDC/RP/04/15-20) for financial assistance.

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Keywords: Total phenolic content, Total flavonoid content, DPPH, Ferrous ion chelating activity, Antioxidant activity

Factors influencing food choices of urban adolescent school girls

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Adolescents undergo a rapid phase of physical development along with behavioral changes. Adopting healthy behavioral pattern is a major challenge during adolescent period. Furthermore, as adolescents are becoming more autonomous, perceptions and behavioral changes acquired during this period are likely to influence long term behaviors[1,2]. Female adolescents are more vulnerable for nutritional problems which affect the future stages of their life cycle. Therefore, this study was conducted to investigate school adolescent girls' perceptions regarding the factors that influence their food choices. Data collection was done through focus group discussions. We studied 84 school adolescent girls from grade 8 to 11 from two urban schools in Puttalam district. Data were analyzed using NVivo10 software. According to the organized data, adolescents' opinions were categorized around three main questions: reasons for food choices, barriers and suggestions for 'healthful food habits'.

The reasons for food selection according to high to low frequency are: hunger and food cravings, appeal of food (taste, appearance and smell), time considerations, convenience, availability, parent influence, situation specific factors, benefits of foods (for health, energy), mood, body image, habit and media. Major barriers to eating more fruits, vegetables, dairy products and eating high-fat foods included a lack of sense of urgency about their personal health, not having taste as other options like cake, biscuits etc, and less convenience. Suggestions for helping adolescents eat a more healthful diet included making healthful food tasty and look better, limiting the availability of unhealthful options while making healthful food more available and conveniently available at places where school adolescent girls eat away from home such as school cafeteria, changing social norms to make "cool to eat" healthfully through advertisements and teaching children good eating habits at an early age.

Therefore, make aware school adolescent girls of urban areas about healthy food choices is necessary through effective intervention programs to promote good nutritional behavioral practices. In conclusion, the findings highlight the need for nutrition service providers to recognize the actual food behaviors and perceptions of the school adolescent girls to address a broad range of factors that lead the adoption of healthy behaviors.

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[2]Neumark-Sztainer D, Story M, Perry C, Casey MA.(1999). Factors influencing food choices of adolescents : Findings from Focus-group discussions with adolescents.J Am Diet Assoc. 99(8):929-37.

Keywords: Adolescent school girls, Food choices, Healthy behavior

Knowledge, Attitudes and Practices (KAPs) of functional foods by young adults

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Concerns of people on their foods to prevent disease conditions and to be healthy are increasing. Functional foods are those foods or dietary components that provide health benefits beyond basic nutritional functions[1]. The aim of this cross-sectional study was to determine the level of KAPs on functional foods by young adults. The data were collected from students enrolling at Wayamba University of Sri Lanka and selected Agriculture schools, namely Kundasale, Vavuniya and Pelwehera (n = 760) using pre-tested, self-administered, content validated, structured questionnaire. Content validity of the questionnaire was done by 10 functional food experts. Each question was checked for their relevance, clarity, simplicity and ambiguity. Overall content validity index for the questionnaire was 0.93. Collected information was analyzed using descriptive statistics. KAPs were analyzed using a scoring system. The results showed that only 13, 59 and 73% of participants got adequate (> = 50) marks for knowledge, attitudes and practices respectively. None of participants scored more than 80 and 14.7% of participants scored less than 20 in knowledge section. About 48% of the subjects indicated that functional foods provide additional health benefits. About 69% of the participants responded vitamin as functional foods component. Among participants 41.2% and 37.1% identified banana and Cassia (*Kohila*), respectively as foods which contain dietary fiber. Majority (76%) of the participants agreed with the usage of functional foods as a disease treatment or management agent. Among those 49.7% of the participants agreed that diabetes as a disease condition while 46.4% reported gastro intestinal diseases can be managed using functional foods. Sensory properties and health benefits of the food items are major concerns in food choices of participants. Majority of the participants consume fruits as whole fruits while egg as omelet form. Results showed that level of knowledge was associated with age and institute. Level of attitude was associated with age and gender while family income and institute were associated with the level of practices. Students of Agriculture schools have high level of knowledge, attitudes and practices than university students. In conclusion, only about 13% of young adults have fair knowledge level on functional foods. Sensory characteristics of the food and health benefits are major concerns in food choices.

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Keywords: Agriculture schools, Content validity, Functional foods, Sensory characters, Sri Lanka, University students

Antioxidant and α-amylase inhibitory activities of millet and sorghum phenolics

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Cereal crops received increased interest due to their potential health benefits. Millet and sorghum are coarse grains, beneficial to prevention and management of non-communicable diseases due to their nutritive and non-nutrient compounds, which serve as potential source of antioxidants[1] and αamylase inhibitors[2]. This study aimed to find out the antioxidant and α-amylase inhibitory activity of whole grains (WG), hulls and dehulled grains (DG) of millets (proso millet cultivars: local proso millet, Sudu, Kaha, Sakunthameneri, little and kodo millet) and sorghum (sweet sorghum and ISCV) varieties grown in Sri Lanka. In this study, soluble phenolics of WG, hulls and DG were extracted. The total phenolic content (TPC) and total flavonoid content (TFC) were determined using colorimetric methods. The antioxidant activities were measured by 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (DRSA), ferrous ion chelating ability (FICA), reducing power (RP) and trolox equivalent antioxidant capacity (TEAC). The α amylase inhibitory activities were determined by starch iodine method. Current study showed that TPC of soluble phenolic extracts ranged from 4.6 to 418.9 μmol ferulic acid equivalents/g dry matter (dm). TFC of soluble phenolic extracts ranged from 0.5 to 222.5 μmol of catechin equivalents/g dm. DRSA of soluble phenolic extracts ranged from 0.9 to 57.5 μmol of trolox equiv/g dm. Hulls of each grain had higher TPC, TFC and antioxidant activities compared to their WG and DG. Among the samples, sweet sorghum showed the highest TPC, TFC and antioxidant activities. Little and kodo millet had highest TPC and TFC while proso millet varieties especially Sudu and Kahameneri showed the lowest. Dehulled fraction of little millet had higher αamylase inhibitory activities among the other grains. Results showed that TPC of soluble extracts of WG and hulls of millets ($r=0.687$; $r=0.865$, $p<0.01$) and WG, hulls and DG of sorghum had significant positive association with TFC ($r=0.961$; $r=0.999$, $r=0.989$, $p<0.01$). It emphasizes that, WG and hulls, may serve as potential sources of nutraceutical and functional food ingredients in health promotion.

Acknowledgement: National Research grant (12-096) for financial assistance.

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Keywords: Alpha-amylase inhibition, Antioxidants, Millet, Processing method, Sorghum

Antioxidant properties of selected underutilized fruits in Sri Lanka

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The objective of this study was to determine the antioxidant content and antioxidant capacity of bioactive compounds in selected underutilized and common fruits grown in Sri Lanka. Fruit samples collected from local market and agricultural lands include: Cashew apple (*Anacardium occidentale*), Naminam (*Cynometra cauliflora*), Governor's plum (*Flacourtia indica*), Pink flesh guava (*Psidium guajava*), Ceylon bignay (*Antidesma alexiteria*), Sour guava (*Psidium myrtaceae*), Strawberry guava (*Psidium cattleyanum*), Bael fruit (*Aegle marmelos*), Sapodilla (*Manilkara zapota*), Lovi (*Flacourtia inermis*), Mulberry/Embiliya (*Morus rubra*), Lavulu (*Pouteria campechiana*), Dan (*Syzygium caryophyllatum*), Jamson (*Carissa carandas*), Mango 'karthakolomban' (*Mangifera indica*), Dragon fruit (*Hylocereusundatus*), Soursop (*Annona muricata*), Velvet apple (*Diospyrosblancoi*), Sugar apple (*Annona squamosa*) and Star fruit (*Averrhoa carambola*). Total phenolic content (TPC), total flavonoid content (TFC), 2,2 diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, trolox equivalent antioxidant power (TEAC) and ferric reducing antioxidant power (FRAP) were determined.

Bael fruit showed the highest total phenolic and total flavonoid content. Sapodilla showed the highest FRAP, TEAC and DPPH values (Table). Among the selected fruit items Sapodilla showed the highest overall antioxidant potential, followed by Pink flesh guava, Bael fruit and Dan, respectively.

Table: Antioxidant content and antioxidant capacity (per gram) of fresh fruits

Fruit name	TPC (mg GAE)		TFC (mg CE)		DPPH (mg AEAC)		TEAC (µmol trolox)		FRAP (µmol FeSO4)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cashew apple	3.1	0.1	0.7	0.0	5.2	0.2	15.5	0.8	27.3	1.6
Naminam	5.2	0.2	7.1	0.2	4.0	0.0	36.9	1.7	60.5	0.8
Governor's plum	4.3	0.1	6.4	0.3	4.2	0.2	21.6	0.7	46.2	1.2
Pink flesh guava	7.8	0.1	7.4	0.3	10.6	0.5	45.5	0.6	83.8	1.3
Ceylon bignay	6.6	0.1	3.4	0.2	6.6	0.3	44.2	1.2	81.4	1.2
Sour guava	2.6	0.1	1.2	0.1	5.3	0.1	19.1	0.6	39.3	1.2
Strawberry guava	4.2	0.2	2.2	0.1	6.3	0.2	30.7	1.0	50.5	2.3
Bael fruit	16.4	0.4	11.1	0.6	9.8	0.1	45.2	1.2	71.6	2.6
Sapodilla	14.2	0.7	7.4	0.4	17.5	0.2	46.9	1.0	124.3	0.6
Lovi	3.2	0.1	2.7	0.0	4.4	0.2	18.6	1.1	28.4	1.8
Mulberry	1.0	0.0	0.8	0.0	1.0	0.0	5.4	0.1	19.5	0.9
Lavulu	2.0	0.1	1.3	0.1	3.7	0.1	14.2	0.7	42.0	0.7
Dan	7.7	0.3	3.5	0.2	10.4	0.5	42.8	2.3	106.5	1.3
Jamson	1.3	0.0	0.9	0.0	0.6	0.0	4.8	0.3	16.0	1.0
Mango	2.5	0.1	0.7	0.0	3.3	0.1	7.9	0.2	35.5	1.4
Dragon fruit	1.7	0.0	0.8	0.0	1.7	0.1	1.4	0.0	23.5	1.0
Soursop	0.7	0.0	0.7	0.0	1.3	0.1	2.5	0.1	57.1	2.6
Velvet apple	2.6	0.1	1.8	0.0	5.3	0.3	20.1	1.0	91.3	4.3
Sugar apple	2.7	0.0	1.6	0.1	4.4	0.2	10.3	0.2	49.9	1.0
Star fruit	1.4	0.1	1.7	0.1	4.0	1.4	9.1	0.5	57.5	1.8

AEAC - ascorbic acid equivalents antioxidant capacity; GAE - Gallic acid equivalents; CE - catechin equivalents

Keywords: Bioactive compounds, Flavonoids, FRAP, Phenolics, Total phenolic content

Mid-day meals for preschoolers attending child development centers in tea estates

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High prevalence of child undernutrition was found in the estate sector. Several nutrition programs have been implemented in the tea estates to reduce child malnutrition but most have been unsuccessful in achieving their objectives. The objectives of this study were to identify diet related problems among preschoolers attending Child Development Centers (CDC) in tea estates in Hatton and to plan mid-day meals to increase their energy, protein and micronutrients intake. Information on nutrition related practices of CDCs were collected using the rapid appraisal method. The recipes planned for underweight children by World Vision Lanka (WVL) were modified to provide 1/3 of the RDA for energy, protein and selected micronutrients such as zinc, iron, vitamin C and vitamin A. Nutrient contents of the recipes were calculated using Foodbase 2000 software. Both the existing and modified recipes were tested in the field to compare the preference of the preschoolers. Preschoolers in CDCs consume nutritionally poor meals. Children preferred modified recipes of rice, noodles and rotti were more than the existing recipes, but not the modified uppma. All modified recipes had greater protein and zinc content. Except uppma, all other modified recipes had greater energy content. Except rotti, all the other modified recipes had higher iron content. All modified recipes had lesser vitamin A and vitamin C compared to existing recipes (Table)

Table: Comparison of nutrient content of existing (WVL) and modified recipes

Recipe	Nutrients (1/3 of the daily requirements)	Energy kcal (434)	Protein g (7.0)	Iron mg (2.0)	Zinc mg (1.7)	Vitamin A (RAE) (200)	Vitamin C mg (10.0)
Rice	WVL recipe	330	6.4	1.9	0.5	258	6.5
	Improved	448	9.3	2.2	1.0	233	4.7
Uppma	WVL recipe	783	11.0	3.0	1.2	296	9.8
	Improved	713	13.8	3.5	1.7	245	6.5
Noodles	WVL recipe	481	7.0	1.8	0.9	259	6.5
	Improved	522	10.0	2.1	1.2	230	3.2
Rotti	WVL recipe	441	9.0	2.8	0.9	258	7.0
	Improved	495	9.9	2.6	1.0	184	3.7

It can be concluded that, the preschoolers attending CDCs in tea estates consume nutritionally poor diet. Modified recipes generally have better nutritional composition than the recipes given at present and were accepted by most of the children. While addressing other issues in CDCs, providing nutritious meals is recommended to overcome the nutritional problem of preschoolers attending CDCs.

Keywords: Child development centers, Mid-day meal, Modified recipes, Preschoolers, Tea estates

Dietary and life style changes among breast cancer survivors in Sri Lanka

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Breast cancer is the commonest gynecological cancer both globally and locally[1]. The breast cancer survivorship is comparatively longer than that of other cancers. Survivors are at increased risk of recurrences and other non-communicable diseases[2]. Life style changes are important to reduce the risk of recurrences and improve the quality of life[2]. The aims of this study were to identify changes in diet, life style, beliefs and practices related to disease management in breast cancer survivors after diagnosis and to evaluate their associations with socio demographic characteristics. A cross sectional study was conducted among 101 breast cancer survivors aged between 35-75 years registered at oncology unit, Teaching Hospital, Kandy. An interviewer administered pre-tested questionnaire was used to collect information. There was a significant difference in practice of vegetarianism, and chicken and sweet consumption before and after diagnosis ($p<0.05$). Statistically insignificant but notable improvements in frequency of fruit (by 17%) and, vegetable intake (by 8.9%) and reductions in soy food and dairy intake were observed after diagnosis of cancer. Physical activity level of the survivors has significantly decreased with cancer diagnosis ($p<0.05$). Survivors have developed a habit of taking dietary supplements and special foods and engaging in religious and, spiritual activities after the diagnosis of cancer. The older survivors (>56 years) were less likely to reduce coconut oil consumption compared to younger (OR=0.43, 95% CI, 0.19-0.97, $p<0.05$). Patients with longer survivorship (>2 years) were less likely to reduce their physical activity levels than their other counterpart (OR= 0.29; 95% CI, 0.12-0.69, $p<0.05$). Majority of survivors (65%) believed dietary and life style changes positively affect their health. But the level of adherence to recommended dietary and physical activity guidelines by survivors was not satisfactory. Several misbeliefs on consumption or avoidance of foods were identified in the population. The present study highlights the need of credible guidance by dietetic and healthcare professionals for good follow-up care with proper dietary and life style management in breast cancer survivors.

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Keywords: Follow-up care, Fruit intake, Physical activity, Recurrence, Survivorship

Glycemic response of rice, mung bean, and cowpea based mixed diets in normoglycemic subjects

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Sri Lankan diet traditionally include boiled rice and rice associated food dishes. Next to rice legumes play a vital role in the everyday diet. Diets with low glycemic indices (GI) and glycemic loads prevent number of noncommunicable diseases (NCDs). The objectives of the present study were to determine glycemic response of rice (BG 358), mung bean (Ari) and cowpea (Varuni) based mixed diets in healthy adults, and to determine the effect of different processing methods, namely parboiling of rice, open boiling and steaming on their glycemic response. A randomized cross over clinical trial was performed with 15 healthy normoglycemic subjects. After 12hours fasting, blood glucose level (BGL) was measured by using the glucometer. A food portion containing 50g of available carbohydrate in mung bean mixed parboiled rice (MPR), cowpea mixed parboiled rice (CPR), mung bean mixed milk rice (MMR), cowpea mixed milk rice (CMR), mung bean mixed rice flour *Pittu* (MRP), cowpea mixed rice flour *Pittu* (CRP), and glucose (reference food) were given to subjects and their postprandial BGL were measured at time intervals. GI and Alpha amylase inhibitory activities of diets were measured.

Mixed diets	GI	SEM	GL (g)
MPR	38^{a}	3	5
CPR	51^{abc}	3	7
MMR	50^{abc}	2	6
CMR	42^{a}	3	5
MRP	53^{b}	4	17
CRP	55^{b}	4	17

Common superscripts indicate no significant difference ($p > 0.05$) GI; glycemic index, GL; glycemic load, SEM; Standard error of means

MPR, CPR, MMR, CMR, and MRP diets were in low GI range while CRP diet indicated GI in moderate range (Table). *Pittu* types had moderate GL while other four recipes indicated low GL. MPR diet had the lowest GI. Different processing methods affect the GI of mixed recipes. There was a strong negative relationship between GI values and percentage of alpha amylase inhibitory activities. Consumption of diets combining rice and legumes is beneficial for good glycemic control among normoglycemic subjects.

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Keywords: Glycemic Index, Glycemic Load, Blood glucose level, Alpha amylase Inhibitory activity

Dietary folate intake of primary school children and non-pregnant adult women in a rural community

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Folate deficiency is one of the major micronutrient deficiencies in the world. Previous findings have showed low serum folate level among adolescent girls and women in child bearing age[1]. Dietary folate intake of different population groups is not available in Sri Lanka. Therefore, the objective of the present study was to assess the dietary folate intake of primary school children and their mothers (non-pregnant). A cross sectional study was conducted using 185 primary school children and their mothers as subjects representing Sinhala and Moor ethnic groups at Pannala DS division in Kurunegala district. Data on dietary intakes of mothers and their children were collected using three-day diet diary.

Table: Nutrient intake of children and mother pairs

	Primary school children			Women		
	Mean intake	SD	RDA	Mean intake	SD	RDA
Energy (kcal/day)	1301	345	1775	1468	359	2350
Energy from Carbohydrate (%)	62.0	5.2	45-65	63.9	5.2	45-65
Energy from Fat (%)	26.7	4.7	25-35	25.3	4.8	25-35
Protein (g/day)	38.5	18.2	34	41.1	16.9	46
Folate (μg/day)	161.0	76.9	300	182.1	90.2	400
Iron (mg/day)	8.3	3.8	8.9	8.9	3.4	18
Vitamin C (mg/day)	27.4	21.8	35	27.7	20.6	45
Vitamin B12 (μg/day)	1.7	0.9	1.8	1.7	0.9	2.4
Vitamin A (mg/day)	373.0	286.4	500	357.6	214.3	700

Mean dietary folate intake of primary school children (161.0, SD 76.9 μg/day) and women (182.1, SD 90.2 μg/day) were significantly lower than the respective Recommended Dietary Allowance (RDA). There was no significant difference in dietary folate intake between two ethnic groups (data not shown). Of the primary school children and women, 87% and 95% has consumed folate less than RDA. Mean folate intake of primary school children and women from plant sources was 140.5μg/day and 162.4μg/day. Dietary Diversity Score (DDS) among primary school children and women was 8.57 and 8.50, respectively. Food Variety Score (FVS) among primary school children and women was 13.04 and 12.82, respectively. DDS and FVS did not show any significant association with dietary folate intake in both study groups. In conclusion, mean dietary folate intake of primary school children and women in study area was lower than the RDA.

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Keywords: Dietary diversity score, Dietary folate intake, Food variety score, Non-pregnant adult women, Primary school children

Validity of the Malnutrition Universal Screening Tool (MUST) to predict the nutritional risk in cancer patients receiving chemotherapy

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Malnutrition is a frequent complication in patients with cancer. It is associated with increased risk of complications, decreased response to treatments, lower quality of life, higher health care costs and reduced survival. Early identification of malnutrition is imperative for effective patient management. Malnutrition Universal Screening Tool (MUST)[1] is a quick and simple screening tool making it more suitable to Sri Lankan oncology set up. The objective of the study was to determine validity of MUST to predict the nutritional risk in cancer patients receiving chemotherapy in Sri Lanka. A cross sectional study was conducted in Kandy Teaching Hospital with 100 medical oncology out patients. Body Mass Index (BMI) and unintentional weight loss percentage in the last 3-6 months were calculated. Nutritional status of each patient was assessed using both Patient Generated Subjective Global Assessment (PG-SGA)[2] and MUST. Sensitivity, specificity, predictive values, kappa agreement and Receiver Operating Characteristics (ROC) curve were used to validate MUST against PG-SGA. The prevalence of malnutrition among the subjects was 45% as detected by PG-SGA. According to Youden statistics, BMI against PG-SGA showed a low capacity to detect undernutrition. Unintentional weight loss percentage in the last 3-6 months against PG-SGA was more effective than BMI. MUST against PG-SGA successfully detected patients at risk of malnutrition with 86.7% sensitivity and 94.5% specificity (Table). MUST indicated a statistically significant perfect agreement with PG-SGA ($k = 0.817$, $p < 0.05$) and highest area under the ROC curve suggesting excellent ability to detect malnutrition (AUC ROC $= 0.906$).

Characteristic	MUST	Weight loss % in last 3-6 months	BMI
Sensitivity%	86.7	55.6	28.9
Specificity%	94.5	98.2	96.4
Positive predictive values%	92.9	96.2	86.7
Negative predictive values%	89.7	73	62.4
Kappa	0.817	0.559	0.269
AUC of ROC	0.906	0.769	0.626

MUST has acceptable relative validity to detect chemotherapy outpatients at risk of malnutrition. Thus, it can be incorporated as a malnutrition detection tool in routine clinical practice in oncology wards.

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Keywords: Nutrition assessment, PG-SGA, Oncology, MUST

Knowledge, Attitudes, and Practices (KAPs) of functional food usage by housewives

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The increase of the burden of non-communicable diseases (NCDs) in every stratum of the population encompasses a challenge to health care system in the country. Functional foods play a vital role in the prevention and management of NCDs. Understanding current perspectives and practices about the functional food usage by housewives is important in designing health promotion interventions. Housewives are the key people involve in selection of foods and modify dietary pattern within the family. A cross sectional study was conducted to investigate the level of KAPs among 150 Tamil and 150 Muslim housewives in Jaffna, Vavuniya, Kilinochchi, Kurunegala, Batticaloa, and Nuwaraeliya. The participants were conveniently recruited and no any limitation to age, education level, occupation, and family income were considered. Those who do not involve in the food preparation were excluded from the study. A pretested, interviewer administrated questionnaire was used to collect information. The study showed that an average of housewives had adequate knowledge (52%), whereas the most of housewives had positive attitudes (89%), and good practices (76%) on functional foods. Further, though participants demonstrated adequate ($\geq$50% score) attitudes and practices, knowledge ($<$50%) level was observed as inadequate regarding functional foods. Majority of them got the information from parents/family members (89%), and media and friends (85%). In addition, majority of them knew about functions of calcium (78%) and dietary fiber (64%), but a very few heard about omega-3fatty acids, carotenoids, and flavonoids. There was a positive relationship among scores of overall KAPs. However, knowledge with attitudes had moderate positive relationship, while knowledge with practices and attitudes with practices showed weak positive relationships. About 61% of them involved in purchasing food items, and 96% of them considered to stay healthy and 90% thought about health of their children when purchasing foods. About 91% of housewives knew functional food can prevent or controlled diabetes and weight management. Usually, 83% of them had tea with evening snack, whereas 77% consumed whole fruits without adding sugar. Further, 50% preferred to prepare leafy vegetables as fresh salads. Good practices and attitudes toward functional foods could be due to existing tradition food culture in the country. Inadequate knowledge score among participants demands for a well organized effective nutrition education about functional foods.

Keywords: Consumers, KAPs, Interviewer administrated questionnaire, Sri Lanka

Nutrition related knowledge, attitudes and behaviour of young adults

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Nutrition plays a vital role in health promotion, disease prevention and management of chronic diseases. Young adults are at an important stage of their life[1]. Improved nutrition knowledge, attitudes and behaviour (KAB) are critical for them to ensure healthy lifestyle. Present study was designed to assess the level of nutrition KAB of young adults. The study adopted a cross sectional study design. A total of 775 young adults participated from two tertiary education institutes, namely Wayamba University of Sri Lanka and some selected Agriculture Schools. Pretested, self-administered questionnaire was used for the data collection. The questionnaire was evaluated by ten nutrition experts for the content validity. Relevance, clarity, simplicity and ambiguity of each question was checked. The content validity index of the questionnaire was 0.92[2]. According to the experts' advices questionnaire was modified. The information collected includes demographic characteristics, nutrition knowledge, attitudes and behaviours toward nutrition. The data were coded and analyzed using SPSS software package with the p value for statistical significance being set at < 0.05. Descriptive and non-parametric tests were used for the analysis.

Table: The level of nutrition related knowledge, attitudes, and behaviour of young adults

Rank	Knowledge (%)	Attitudes (%)	Behaviour (%)
High (>70)	26.5	77.8	29.7
Moderate (41-69)	71.7	21.4	70.2
Low (<40)	1.7	0.8	0.1

Results showed that majority of the young adults had a moderate level of nutrition knowledge, moderate level of good behaviour and high level of positive attitudes toward nutrition (Table). There was a significant difference in nutrition knowledge and attitudes between Wayamba University of Sri Lanka and Agriculture Schools, even though no any significant difference in nutrition behaviour was observed between young adults from two institutes. There was no association between gender and nutrition KAB. There was a positive interrelationship among the scores of nutrition KAB. In conclusion, young adults show good attitudes towards nutrition issues with the moderate level of knowledge and practices. This information support for the need of nutrition intervention programmes to improve knowledge as well as practices among young adults.

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Keywords: Agriculture schools, Self-administered, Sri Lanka, Tertiary, University students

Validation of Subjective Global Assessment (SGA) tool among hospitalized adult surgical patients

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Surgical patients are a risk group which is highly prone for malnutrition. Approximately 50% of adult are hospitalized worldwide[1]. Malnutrition in hospitalized patients is generally related to decreased muscle, immune, and respiratory functions, quality of life and impaired wound healing. Subjective Global Assessment (SGA) tool assesses nutritional status based on features of the medical history and physical examination. The objectives of the study were to assess the nutritional status among hospitalized adult surgical patients at the time of admission to the hospital, and to validate the SGA tool among them. A cross sectional study was conducted using 100 surgical patients who were conveniently recruited within the age more than 19 years from Jaffna Teaching Hospital. SGA tool, and a pre-tested interviewer administered general questionnaire were used to collect information. SGA rating system was used to find out the nutritional status of the patients[2]. Concurrent and predictive validity and sensitivity, specificity, positive predictive and negative predictive value, and kappa agreement were used to validate the SGA tool for hospitalized surgical patients. Findings of current study indicated that 85, 14, and 1% of surgical patients were identified as well-nourished, moderately malnourished, and severely malnourished, respectively. There was a relationship with outcomes of the SGA with Body Mass Index (BMI), mid upper arm circumference, triceps skinfold thickness, and haemoglobin. Hospital stay showed no association with outcomes of the SGA. In this study, the sensitivity, specificity, positive predictive value, and negative predictive value were 73.3, 96.5, 78.6, and 95.3% respectively when comparing the outcomes of SGA with BMI. There was good reliability (Kappa = 0.71; $p < 0.05$). SGA was a valid and reliable tool for the assessment of the nutritional status of Sri Lankan hospitalized adult surgical patients and it can be used for clinical applications and for research purposes in the Sri Lankan population.

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Keywords: Concurrent validity, Malnutrition, Nutritional assessment, Predictive validity, Sensitivity, Specificity

Dietary intake pattern of households with patients having Chronic Kidney Disease

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Chronic Kidney Disease (CKD) is one of the major kidney diseases among others. It is an emerging health problem in Sri Lanka. Several geographical areas in Sri Lanka is highly affected by this condition and the exact reason is not clear. The purpose of this study was to examine the difference of dietary intake patterns between CKD and non-CKD households. The study included 50 households with CKD patients and 50 control households those free of CKD patients. Dietary intake pattern and nutrient intake of individuals of those households were determined using 24-hour dietary recall and food inventory method. Consumption of different food groups of CKD households were compared with non-CKD households. Results of food inventory method showed that there was no difference in consumption of food groups between CKD and control households except consumption of yams and tubers ($p < 0.008$) and pulses ($p < 0.005$). However, results from 24 recalls indicated significant differences in energy percentage obtained from fat, saturated fat and carbohydrate between tested groups. Further significant differences were not obtained for total energy intake, percentage energy from protein and added sugars between CKD and non-CKD households.

Table: Energy intake of CKD and non-CKD groups

Energy	CKD (n = 50)	Non-CKD (n = 50)	P
Total energy (Kcal)	1563.32 ± 565.69	1632.53 ± 493.57	0.329
% energy from carbohydrate	70.17 ± 8.38	67.13 ± 13.72	0.043
% energy from fat	20.64 ± 6.99	24.21 ± 13.14	0.025
% energy from protein	9.96 ± 2.59	9.93 ± 2.98	0.932
% energy from saturated fat	13.87 ± 5.44	16.48 ± 11.06	0.012
% energy from added sugar	7.91 ± 5.38	8.31 ± 5.42	0.572

In conclusion, irrespective of the CKD condition, nutrient intake and food consumption pattern shows a similar trend in both groups. Further studies on other components in the diet such as water, is warranted to see an association of diet with CKD.

Keywords: Dietary recall, Food inventory method, Ginnoruwa, Nutrient intake

Determinants of micronutrient status and micronutrient intake of pregnant women in Pannala and Kuliyapitiya (West) Medical Officer of Health (MOH) areas

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The objective of this study was to identify the determinants of micronutrients intake and status of pregnant women in Pannala and Kuliyapitiya (West) MOH areas. An interviewer administered questionnaire and a three-day diet diary were used to collect information from pregnant women. Serum zinc level was determined by 5-Bromo-PAPS colorimetric method. Zn deficiency status was defined as serum Zn level $< 66 \mu g/dL$[1]. Hemoglobin levels recorded in pregnancy records were used to determine the anemia[2]. Dietary intakes were analyzed by Foodbase 2000 software and adequacy was determined comparing with RDA. Mean age of the sample (n = 126) was 30 (SD 5) years. Out of total, 60% had education up to grade 11, 45% were employed and 18% were vegetarians. Of the subjects, 30% were underweight, 40% were anemic and 61% had low serum zinc status. Mean dietary intakes of carbohydrate and protein were higher and energy, zinc, iron, calcium, folate, iodine and vitamin A were lower than the RDAs. Table shows determinants that had significant (95%CI, $p < 0.05$)

Table: Determinants relationship with selected micronutrient status of the study sample

Determinants	Zinc Status		Iron Status	
	Odds	CI	Odds	CI
Maternal education level (up to Grade 11)	3.8	2.2-5.5	2.79	1.0-8.8
Monthly family income (15,000 – 25, 000 LKR)	3.0	2.1-4.7	2.233	1.3-12.5
Pre-Pregnancy BMI (normal)	5.101	2.6-14.8	2.327	1.9-5.7
Vegetarianism	0.345	0-1.34	0.814	0-4.3
Meat avoidance	0.598	0.3-12.8	0.202	0.1-14.6
Zinc intake (< 11 mg)	0.15	0.6-1.1	-	-
Iron intake (< 33 mg)	-	-	3.45	1.4-10.7

The mean dietary nutrient intakes of iron, zinc, iodine, calcium, vitamin A, and folate had positive associations ($p < 0.05$) with monthly income, monthly expenditure for food, maternal educational level and pre-pregnancy BMI and negative associations with vegetarianism, food avoidance, parity and number of children. In conclusion, the determinants for status of Zinc and Iron and micronutrient intakes of pregnant women in study areas were monthly family income, maternal educational level, pre-pregnancy BMI, vegetarianism and food avoidance.

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Keywords: Determinants, Micronutrient intake, Pregnant women, RDAs

Acute plasma antioxidant capacity and glycemic response of herbal teas in normoglycemic individuals

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The global exponential growth of diabetes has led to a concurrent rise in the usage of herbal teas to treat diabetes due to their natural origin, free availability and lesser side effects[1]. Among the 21,000 herbs listed by the World Health Organization (WHO) as herbal remedies, only 150 species are utilized in preparation of large scale commercial herbal products[1]. The aim of this study was to determine the acute plasma antioxidant capacity and glycemic response of herbal teas in normoglycemic individuals and determine the in vitro total phenolic and antioxidant content of herbal teas. A randomized crossover study was conducted using 15 normoglycemic individuals (age between 20-26 years; with fasting blood glucose between 70-110mg/dl) who consumed four types of 250mL herbal teas with 50g glucose (*Artocarpus heterophyllus* leaves (W), *Cassia auriculata* flowers (R), *Aegle marmelos* immature fruit (B), *Artocarpus heterophyllus* leaves + *Cassia auriculata* flowers (W + R)) and the standard (50g glucose + 250mL water) randomly for five visits following a washout period of four days. Blood samples were collected at different time intervals (fasting, 30,45,60,90, and 120 min) using micro capillary tubes. Plasma was separated for glucose (GOD-PAP method) and antioxidant capacity (Trolox equivalent antioxidant capacity; TEAC) assay. There was a reduction in mean plasma glucose concentration for herbal teas compared to standard at each time point. W + R and W teas showed more reduction in plasma glucose concentration compared to those of B and R herbal teas. W + R tea and R tea showed significant reduction in plasma glucose concentration at 45, 60 and 120 min after consumption, respectively ($p < 0.05$) compared to the standard. After consumption of W, R, B and W + R teas plasma antioxidant capacity increased from 320 to 342, 258 to 329, 200 to 345, and 390 to 428 μmol of trolox equiv/mL, respectively. B tea showed a higher total antioxidant activity compared to other teas tested. W + R tea showed higher content of phenolic. The results indicate the potential of herbal teas in the glycaemic control of healthy individuals. Further studies are needed to determine the effect of herbal teas on glycemic control of pre-diabetic and diabetic individuals.

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Keywords: Glycemic response, Herbal teas, Plasma antioxidant capacity, Phenolics

Effect of *Murraya koenigii* (curry leaves) on fasting glucose and plasma antioxidant capacity in dyslipidemic females

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Curry leaves (*Murraya koenigii*) is one of the most common spices used in Sri Lanka. Numerous studies have demonstrated that curry leaves as a rich source of antioxidant and dietary fiber. Such bioactive compounds from curry leaves may play a vital role in attenuating risk markers of non-communicable disease. A randomized control double blind clinical trial was conducted to find out the effect of curry leaves powder on fasting glucose concentration and plasma antioxidant capacity level in dyslipidemic individuals. Ten dyslipidemic, centrally obese, adult female volunteers (mean age 47.7 y) were recruited and randomized to receive curry leaf powder supplement (2g/day) provided as capsules or control (placebo) for a period of 2 months (8 weeks). Fasting plasma glucose (FPG) and plasma antioxidant capacity (Ferric Reducing Ability of Plasma – FRAP) were determined at the beginning (t0) and 4 weeks (t4). Both groups were similar in anthropometry, biochemical and clinical variables at the beginning of the intervention. The abstract presents the results at the end of 4th week of 8 week-intervention period.
There was no significant difference in FPG in both groups of subjects after 4th week compared with baseline. There was a significant increase in FRAP in subject group consumed curry leaf supplement at 4th week (t4) compared with baseline (t0). Control group did not show any significant change in FPG and FRAP at 4th week compared with baseline. There was no significant changes in systolic and diastolic blood pressure, body composition and body weight in both groups during the intervention period.
In conclusion, consumption of curry leaf (2g/day) for 4 weeks significantly increase plasma antioxidant capacity measured as FRAP and it has no hypoglycemic effect.

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Keywords: Cardiovascular disease, Dyslipidemia, Curry leaves, Fasting blood lipids

Nutritional status and nutrition related side effects in cancer patients receiving chemotherapy

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Cancer and chemotherapy (CT) treatments are important nutritional risk factors. This study aimed to determine the nutritional status, prevalence of nutrition related side effects, and their associations with nutritional status and quality of life (QOL) of the cancer patients receiving CT. A cross-sectional study was conducted among 106 cancer patients registered at Kandy Teaching Hospital in the age range of 25 to 75 years receiving CT. Demographic profile, nutritional status assessment by scored Patient Generated-Subjective Global Assessment (PG-SGA)[1], and QOL assessment by the European Organization for Research and Treatment of Cancer QOL-version3 questionnaire (EORTC QLQ)[2], biochemical data from medical records and one day-24 hours dietary recalls were obtained. Out of total, 65% were females and 35% were males. The prevalence of malnutrition in the population was 83%. Further 65% and 18% were moderately and severely malnourished, respectively as assessed by PG-SGA. The mean global QOL score was 57 (SD 21), indicating low QOL[3]. The most common nutrition related side effects were weight loss (76%), pain (63%), loss of appetite (59%), and early satiety (59%). There were statistically significant associations between nutritional status and presence of all nutrition related side effects ($p < 0.05$) except for diarrhoea. It was revealed that there were significant differences in the global QOL, physical, role, and cognitive functioning; presence of fatigue, nausea and vomiting, constipation, and appetite loss, total lymphocyte counts and dietary intake in different nutritional status ($p < 0.05$). A significant inverse relationship was observed between intake of energy and all macronutrients and PG-SGA score. CT causes nutrition related side effects and negative impacts on patients' nutritional status, QOL, biochemical parameters and dietary intake. The findings highlight the necessity of integrating nutritional care in the management of oncology patients receiving CT.

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Keywords: Dietary intake, Oncology, QOL, Scored PG-SGA, Sri Lanka

Dietary iron intake of primary school children in a rural community

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In Sri Lanka, prevalence of anaemia among primary school children was 16.5%[1]. Iron deficiency which occurs due to low intake of iron rich foods is the most prominent cause for anaemia. Therefore, a cross sectional study was conducted to determine the dietary iron intake of primary school children aged 5-10 years in households of a rural community in North-Western Province. Dietary Diversity Score (DDS; no. of food groups consumed in the previous 24 h) and Food Variety Score (FVS; no. of food items consumed in the previous 24h) were used as indicators of diversity of the diet. The subjects were 185 primary school children in Pannala Divisional Secretariat division representing rural setting. Data on dietary intake of children was collected by a three-day diet diary which was filled by their mothers. Foodbase 2000 software was used to assess dietary nutrients intake.

Table: The dietary intake of primary school children

Energy/ Nutrients	Mean	SD	RDA
Energy (kcal/day)	1301	345	1775
Energy from carbohydrate (%)	62	5	55
Protein (g/day)	38.5	18.2	34
Energy from fat (%)	26.7	4.7	30
Iron (mg/day)	8.34	3.85	10
Folate (μg/day)	161	76	300
Vitamin C (mg/day)	27.4	21.8	35
Vitamin B12 (mg/day)	1.6	0.9	1.8
Vitamin A (μg/day)	373	286	500

Primary school children have achieved only the Recommended Dietary Allowance (RDA) for carbohydrate and protein intake. The mean dietary iron intake was 8.34 mg/day (SD 3.85) and it was significantly lower than the respective RDA. There was no significant difference in mean dietary iron intake between male and female children (data not shown). DDS and FVS for this study population were 8.6 (SD 1.1) out of 12 and 13.0 (SD 2.4), respectively. There was no any significant association between dietary iron intake and FVS and DDS. Major contribution of dietary iron intake (88%) was from plant based foods. Greater family income level was positively associated with the dietary iron intake of children (Odds Ratio = 2.84, CI:1.39-5.82). In conclusion, mean daily dietary iron and several other micronutrient intakes are insufficient among primary school children. Higher family income is associated with greater dietary iron consumption.

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Keywords: Diet diary, Dietary diversity, Dietary iron intake, Primary school children

Dietary iron intake of non-pregnant women in a rural community in North Western Province

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Second, highest anemia prevalence was reported in North Western Province (NWP) in 2006[1]. Iron deficiency anemia among non-pregnant women of age 19-50 years is mainly caused due to inadequate dietary iron intake, problems in iron absorption in the gastro-intestinal tract and form of dietary iron that they intake. Although, for the intervention programs the estimate of dietary iron intake is necessary, such data is scarce in Sri Lanka. The objectives of the study were to assess the dietary iron intake of non-pregnant women in a rural community in NWP and to determine the contribution of plant and animal sources of iron in the diet. A cross sectional study was conducted in Pannala DS division with the participation of 185 adult non- pregnant women selected from rural households. Three-day diet diary was used to collect data on diet. Nutrient intakes were determined using Foodbase 2000 software.

Table: The dietary iron and other nutrient intakes of non-pregnant women compared with Recommended Dietary Allowance (RDA)

Nutrient	Mean dietary intake	SD	RDA
Energy (kcal/day)	1468	359	2350
Energy from Carbohydrate (%)	63.9	5.2	45-65
Energy from Fat (%)	25.3	4.8	25-35
Protein (g/day)	41.1	16.9	46
Iron (mg/day)	8.9	3.4	18
Vitamin B_{12} (μg/day)	1.7	0.9	2.4
Folate (μg/day)	182.1	90.2	400
Vitamin C (mg/day)	27.7	20.6	45
Vitamin A (mg/day)	357.6	214.3	700

Mean dietary iron intake of women (8.9mg/day SD 3.4) was lower than the RDA (18mg). Mean dietary iron intake from plant sources and animal sources were 8.2 (SD 4.2) mg/day and 0.9 (SD 0.4) mg/day, respectively. Dietary intake of energy and other micronutrients related to anaemia was lower than RDA. In conclusion, mean dietary iron intake of non-pregnant women in study area was lower than RDA. The majority of the iron in the present diet of rural women comes from plant sources.

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Keywords: Non-pregnant women, Dietary iron intake, Diet diary

Dietary intake and nutritional status of pregnant women in rural and coastal communities

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A cross sectional study was conducted to assess the dietary intake and nutritional status of pregnant women in second trimester in Pannala (rural) and Mannar (Coastal) DS divisions. Anthropometric measurements; height (cm), weight (kg) and information in maternal records were used to assess the nutritional status according to the standards of Institute of Medicine. Urinary Iodine Excretion level (UIE) was determined by Sandell-Koltoff method[1]. A three-day diet diary was used to determine the nutrient intake. Dietary data was analyzed using Foodbase 2000. The mean age of the sample (n = 133) was 28 (SD 5.3) years. The results showed that the mean dietary intakes of protein, iron, calcium, folate and vitamin A were high, women in coastal area than rural area.

Table: Dietary intake and nutritional status of pregnant women in rural and coastal communities

Dietary nutrient intake		Rural n = 53			Coastal n = 80			
	RDA	mean	SD	% < RDA	mean	SD	% < RDA	P value
Energy (Kcal)	2360	2039	445	73.59	2008.7	469	75	0.529
Protein (g)	59	55.6	23	66.04	59.41	14.4	51.25	0.3
Calcium (mg)	1000	589.7	176	96.23	759.8	218.8	86.25	0.395
Iron (mg)	33	13.2	4	100	13.9	4.1	100	0.471
Folate (μg)	600	218.5	94	100	277.3	85.1	100	0.595
Vitamin C (mg)	55	46.5	34	71.7	43.8	29.2	80	0.371
Vitamin A (μg)	800	434.3	229	87.5	514.3	299.8	85.7	0.262
Nutritional status	**Cut-off**	**Mean**	**SD**	**%**	**mean**	**SD**	**%**	**P value**
Biochemical parameters								
Hb level (g/dl)	> 11	11.64	1.07	77.3	12	1.36	82.5	0.03
UIE level (μg/l)	150-249	223.4	101.7	66	245.3	136.7	71.8	0.02
Based on Pre-pregnancy BMI (kg/m²)								
Underweight	< 18.5	16.5	2.36	32	16.2	1.46	26.3	0.01
Normal	18.5-24.9	22.3	1.88	53	22.7	2.1	53.8	0.799
Overweight	25-29.9	27.8	0.95	9	28.2	1.45	8.8	0.436
Obese	> 30	30.8	1.3	6	30.5	2.5	11.2	0.399
Weight gain (kg)								
2nd trimester	6.8-9	5.32	3.23	32	4.51	2.11	27.5	0.001

Further, results revealed that mean weight gain during 2nd trimester was lower than reference in both communities. Underweight percentage at pre-pregnancy stage was significantly higher in rural communities. The mean levels of Hb and UIE were within the normal range though costal women had higher levels. Nutrition interventions are needed to overcome nutritional problems among pregnant women in both communities.

[1]World Health Organization (2013) Urinary iodine concentrations for determining iodine status deficiency in populations Vitamin and Mineral Nutrition Information System [online] Available from: http://www.who.int/nutrition/vmnis/ indicators/urinary iodine [accessed on 10/06/2017]

Keywords: Dietary intake, Nutrients, Nutritional status, Pregnancy, RDAs

Adherence to complementary feeding guidelines by the care providers of infants

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Establishment of guidelines regarding complementary feeding has been done as a preliminary step to overcome the nutritional problems of infants in Sri Lanka. A cross sectional study was conducted to find out the adherence to complementary feeding guidelines by a group of care providers. Mothers of the infants (n = 100) who attended the Maternal and Child Health (MCH) clinics at Pannala Medical Officer of Health (MOH) area were recruited for the study. A pre-tested interviewer administrated questionnaire, a questionnaire developed incorporating complementary feeding guidelines, child health development record and a 24hours dietary recall were used to obtain socio-demographic data, feeding practices, weight with age and foods from different food groups respectively. Responses were presented as percentages. The results revealed that 61% of mothers had the education up to ordinary level.

Table: The percentage of mothers who adhered to complementary feeding guidelines

Complementary feeding guidelines	Adherence %
1. Introduction of complementary feeding at the age of 6 months	83
2. Continuing breast feeding up to 2 years while giving complementary foods	94
3. Giving demand breast feeding during the first year of the life	88
4. Introducing a new food once in 3-4 days	59
5. Giving complementary feedings in thick form (never in watery form)	69
6. Giving foods according to the correct texture (6-8 months: well mashed, 9-11 months: coarsely chopped, 12 months: family food)	93
7. Giving appropriate frequency of meals per day (6-8 months: 2-3 meals/day, 9-12: 3-4 meals/day)	98
8. Giving adequate amount of food per meal (6-8 months:2-3 spoonful, 9-11 months:3/4 cup, 12 months:1 cup)	63
9. When preparing complementary feeding incorporating a variety of food	69
10. Fruits give in pulped form (not in juice form)	89
11. Not addition of sugar and salt for infant feedings up to age of one year of the child	77
12. Following proper hygienic practices when preparing feeds to infants	98
13. When feeding follow proper hygienic practices for infants	92
14. Avoidance of feeding bottles when feeding to the infant	88
15. Following correct feeding practices during the illness of the child (by increasing the amount)	38
16. Meauring of infant's weight monthly	100

Though 98% of mothers fed their infants in appropriate frequency, 63% provided adequate amount of foods per meal and 38% had correct practices of feedings during illness. These results proved the findings of demographic and health survey, nutritional inadequacy of infants feeding in quality and quantity remain as major problem in Sri Lanka. Results showed a positive correlation between adherence to guidelines with the education level of mother (r = 0.302), father (r = 0.326), monthly total family income (r = 0.306), and monthly expenditure for food (r = 0.326). This study concluded that the necessity of providing awareness programme on complementary feeding guidelines for mothers of infants at MCH clinic levels.

Keywords: Adherence, Care providers, Complementary feeding, Guidelines, Infants

Comparison of nutritional status of infants at complementary feeding stage in rural and urban areas

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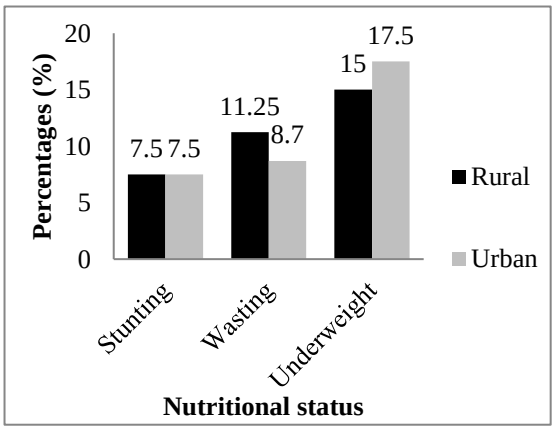
Adequate nutrition is the key to optimum growth, development and survival in infancy. Infants are vulnerable for malnutrition during the period of complementary feeding. The aim of this cross-sectional study was to compare the nutritional status of infants at complementary feeding stage in rural and urban areas. Infants were selected from Maternal and Child Health (MCH) clinics in Pannala (rural) and Kuliyapitiya-West (urban) Medical Officer of Health (MOH) areas and 80 infants were selected from each area (total n = 160). An interviewer administrated questionnaire was used to collect the data on socio-demographic characteristics and infant feeding practices. Standard measuring techniques were used to measure the weight and length of the infants. Dietary data were obtained through a 24 h dietary recall. Nutritional status of the infants was assessed using WHO Anthro Plus software and WHO growth charts. Nutrient intake of the study sample was analyzed by Foodbase 2000 software and compared with Recommended Dietary Allowances (RDA)[1] for infancy. Mean age of the infants in rural and urban areas were 9.18 (SD 2.42) and 10.13 (SD 1.99) months respectively. The results revealed that 86.3% rural and 87.5% urban infants were initiated complementary feeding at 6 months and 81.3% of rural and 77.5% of urban mothers introduced "beri-bath" as the first complementary food. Figure shows that the percentage of wasting was higher in rural infants and underweight was higher in infants in urban area. The mean daily dietary intake (from complementary feedings) of iron, vitamin C and iodine were lower than RDA in both areas. Further, results revealed that the average iron and iodine intake of infants in urban area (7.08 mg, SD 6.07; 55.4μg, SD 33.65) was higher than rural area (4.69mg, SD 6.62; 50.88μg, SD 27.46). Comparatively higher consumption of iron and iodine that are critical for infancy period, of infants in urban area may be due to incorporate animal based foods that are rich in micronutrients when preparing complementary feedings by the mothers of infants. The study concluded that nutritional problems appeared among infants in rural and urban areas without having any significant difference. The findings of the study direct the necessity of giving special attention to mothers of infants regarding preparation of nutritionally balanced feeds.



[1]Dietary Reference Intakes (DRIs): Recommended Dietary Allowances (RDAs) and Adequate Intakes (AIs), Food and Nutrition Board, Institute of Medicine, National Academy of Sciences (NAS), 1998 – 2010

Keywords: Complementary feeding, Infancy, Nutritional status, Rural, Urban

Perception of school teachers, principals and canteen owners on challenges and barriers in implementation of school health and nutrition intervention programs

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It has been shown that, improvement in health and nutrition status contributes to the improvements in learning and achieving learning outcomes[1]. A comprehensive school health and nutrition intervention program can address various issues pertaining to school age children and related communities. A qualitative study was conducted to evaluate the perception of school teachers regarding achieving the objectives and the most significant challenges and barriers of school health and nutrition programs (nutrition assessment in school medical inspection, micronutrient supplementation program, school gardening, school health club, physical activity program, water, sanitation and hygiene (WASH) practices, school canteen and healthy school environment). The views of the canteen owners were also obtained regarding practices at the canteen. Focus group discussions, semi structured interviews and direct observations were conducted in thirteen schools which were selected from Giriulla, Mawanella, Kegalle and Negombo educational zones. All the data were transcribed to English and the transcriptions were analysed according to a coding system using NVivo10.

Challenges, barriers, resources, drawbacks and appreciations were the major themes identified in common for all programs. Lack of parents' participation, operational defects, lack of staff and time, poor attitudes, lack of facilities, maintenance problems were the most significant challenges identified as perceived by the teachers. Consistency, lack of support, enthusiasm, advertency and poor coordination were the barriers emerged from the responses related to all the programs. Poor monitoring and inconsistency of the programs were identified as the drawbacks of the implementation of the health and nutrition programs. There was minimal attention for the nutrition assessment in school medical inspection. Micronutrient supplementation program is implemented inconsistently as perceived by the teachers. School gardening was fairly well-implemented in schools but the expected objectives of the program implementation were not met. School health club was weakly implemented in all the schools. Due to lack of the proper coordination and commitment of relevant stakeholders, the expected objectives were not met. Concerted effort of resource persons required to intensify awareness program on health and nutrition. The implementation of school health and nutrition intervention programs should be strengthened through monitoring and proper coordination at top management level and the implementation level.

[1]Drake, L. J.; Peiris, R.; Dixon. R.; Palfreyman, A.; Ebenezer, R.M; Lokubalasuriya, A.; Kwon, J.H; Medagama, R. S.; Bundy, D.A. P.; Aturupane, H; De Silva, N. (2014) *School health and nutrition in Sri Lanka*. South Asia human development sector series; no. 71. q

Keywords: Barriers and challenges, Nutrition interventions, Qualitative study

Association between lifestyle patterns and metabolic syndrome characteristics of the individuals

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Metabolic syndrome (MS) is a cluster of metabolic disorders associated with increased risk of cardiovascular diseases. Diet and physical activity are the two main lifestyle factors that can alter the risk of MS[1]. However, there are only limited number of studies conducted to assess the association between dietary and physical activity patterns and MS. Therefore, the present study was conducted to assess the association of dietary intake and physical activity patterns with MS. Hundred and nineteen (n = 119) adults (age 25-55 years) were recruited as subjects. They were categorized into two groups as with MS (n = 45) and without MS (n = 74) using International Diabetes Federation (IDF) criteria for MS. Body weight, height, waist and hip circumferences were measured and Body Mass Index and waist to hip ratio were derived. Fasting plasma glucose (FPG), fasting plasma lipids and serum inulin concentrations were assessed. Dietary intake data of the subjects were collect by a five-day diet diary. International Physical Activity Questionnaire was used to determine their physical activity level. Association between lifestyle and MS characteristics was determined by the logistic regression analysis.

Individuals with MS had significantly ($p < 0.05$) higher intake of energy than individuals without MS. However, there was no any significant difference in total energy expenditure and energy balance among the two groups. There was no significant difference observed for the intake of cereal and cereal products, vegetables, fruits, fish, meat, poultry and pulses and milk and milk product groups among individuals with and without MS. Physical activity level of the two groups was also not different. Consumption of fruits (Odds ratio = 11; $p = 0.007$), fish, meat, poultry and pulses (Odds ratio = -0.027; $p = 0.027$) and milk and milk products (Odds ratio = 3.7; $p = 0.027$) was shown to be associated with reduced risk of MS. Cereal and cereal products (Odds ratio = 2.5; $p = 0.03$) consumption was associated with increased risk of MS. Physical activity (Odds ratio = 6.9; $p = 0.006$) was associated with reduced risk of MS. Physical activity was shown to be negatively associated with systolic and diastolic blood pressures, waist circumference, triacylglycerol and FPG.

In conclusion, consumption of fruits, fish, meat, poultry and pulses and milk and milk products and engaged in physical activities have shown to be protective against MS.

Authors would like to acknowledge the National Research Council and Wayamba University Research Grant Scheme for funding

[1]Vega, G. (2011). Obesity, Metabolic syndrome and cardiovascular disease. *American Heart Journal*. 142:1108–16

Keywords: Dietary intake, Metabolic syndrome, Physical activity

Association between lifestyle patterns and antioxidant status of diabetic and non-diabetic individuals

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Persistent hyperglycemia in type 2 diabetes mellitus (T2DM) promotes the free radical formation by non-enzymatic glycation of proteins, glucose oxidation and increased lipid peroxidation leading to oxidative stress. Antioxidants exert the cellular defense and therefore can be considered as biomarkers of oxidative stress. Although diet and physical activity have shown to modify the antioxidant status, studies conducted on assessing the role of diet and physical activity in improving antioxidant status of diabetics are scarce. Therefore, present study was conducted with the objective of determining the association between diet and physical activity with the antioxidant status. A cross-sectional study was conducted using 74 T2DM (males = 37; females = 37) and 44 non-T2DM individuals (males = 26; females = 18). Plasma total antioxidant capacity (TAC), erythrocyte glutathione peroxidase (GPx) and superoxide dismutase (SOD) activities, plasma uric acid, serum albumin, bilirubin and total protein concentrations were measured. Dietary intake was assessed using a five-day diet diary. Physical activity level of the subjects was evaluated using the International Physical Activity Questionnaire (IPAQ) and derived the energy expenditure.

T2DM had significantly ($p < 0.05$) depleted antioxidant status in terms of low plasma TAC, reduced activity of SOD, and low plasma uric acid concentration. However, their GPx activity and total protein levels were significantly ($p < 0.05$) elevated than the non-diabetics. There was no any difference observed between the total energy intake, expenditure and energy balance of diabetics and non-diabetics. Except the cereals and cereal products, consumption of other food groups was similar in both groups. Diabetics had significant positive associations between plasma TAC and intake of n-6 fatty acids ($\beta = 0.422$, $p = 0.021$); GPx activity and intake of n-3 fatty acids ($\beta = 0.273$, $p = 0.048$) and SOD activity and total energy expenditure ($\beta = 1.358$, $p = 0.046$). Moderate physical activity level was positively associated with total protein ($\beta = 0.062$, $p = 0.001$) in diabetics. There were significant positive association between physical activity level and TAC ($\beta = 1.90$, $p = 0.001$), SOD ($\beta = 1.80$, $p = 0.001$), and uric acid ($\beta = 0.080$, $p = 0.001$) of non-diabetics.

It can be concluded that engaging in physical activity has shown to be effective in improving the SOD activity of both groups whereas it tends to increase the total protein concentration among diabetics and plasma TAC and uric acid in non-diabetics. Rise in plasma TAC and GPx activity due to intake of n-3 and n-6 polyunsaturated fatty acid suggests the possible reduction of oxidative stress due to dietary factors.

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Keywords: Antioxidants, Diabetes, Dietary pattern, Free radicals, Physical activity

Physical activity level of diabetic and non-diabetic individuals

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Physical activity is considered as one of the major modifiable lifestyle factors to reduce the risk of type 2 diabetes mellitus (T2DM) and one of the effective methods of improving the glycaemic control of T2DM. However, there are limited studies done on physical activity patterns and levels of T2DM. Therefore, the present study was conducted with the objectives of evaluating the physical activity level of T2DM and determining the relationship between physical activity and glycaemic control of T2DM. A descriptive cross-sectional study was conducted using 98 T2DM and 90 non-T2DM individuals as subjects. Height, weight, waist and hip circumferences were measured and body mass index (BMI) and waist to hip ratio (WHR) were derived. Fasting plasma glucose (FPG), glycated haemoglobin (HbA1c) and fasting insulin concentrations were assessed. Insulin resistance was derived using Homeostatic Model Assessment for Insulin Resistance (HOMA-IR). Their physical activity level was assessed using the long version of International Physical Activity Questionnaire (IPAQ). Using the IPAQ scoring protocol, weekly energy expenditure expressed in Metabolic Equivalent Task- Minutes (MET minutes/ week) was derived. According to the individual score, subjects were categorized as physically inactive, moderately active or highly active.

Majority of T2DM and non-T2DM individuals had high level of physical activity ($>$3000 MET minutes/week). Six percent (6%) of T2DM and non-T2DM individuals were physically inactive ($<$600 MET minutes/week) while nearly 28% of diabetic and 29% of non-T2DM individuals were moderately active (600-3000 MET minutes/week). Both T2DM and non-diabetic individuals were highly active in their domestic and yard activity and occupational activity domains. Eighty four (84%) of T2DM and 98% of non-T2DM were physically inactive in their leisure time. Present study showed that 33% of T2DM and 32% of non-T2DM had sitting hours more than 6 hours per day. BMI ($r=0.30$; $p=0.008$) and FPG ($r=0.31$; $p=0.009$) had positive relationships with sitting hours in T2DM. Domestic and yard activity was negatively correlated with FPG ($r=-0.32$; $p=0.003$) whereas occupational activity was negatively correlated with WHR ($r=-0.24$; $p=0.049$) in T2DM.

In conclusion, physical activity level of diabetic and non-diabetic individuals was not significantly different. Physical activity level of both diabetic and non-diabetic was high. Majority of individuals in study population were physically inactive during their leisure time. Energy expenditure in sitting is relatively very low. Findings of this study suggest that when the sitting hours are higher, diabetics tend to be either overweight or obese where blood sugar control is also affected. Domestic and yard activity where more energy being used, has shown to be effective in controlling central obesity and plasma glucose concentration.

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Keywords: Diabetics, Energy expenditure, Non-diabetic individuals, Physical activity, Sitting hours

Dietary intake pattern of diabetic and non-diabetic individuals

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Glycemic control is the integral part of diabetes management. Diet plays an important role in achieving proper glycemic control of T2DM. Therefore, it is crucial to study the dietary intake and the contribution of dietary intake towards the glycaemic control of T2DM. A cross sectional study was conducted with the objectives of assessing the dietary intake of T2DM and determining the association between dietary pattern and glycaemic control. A five day estimated diet diary was used to collect dietary information from 75 T2DM patients and 75 non-diabetes individuals from Pannala DS Division. Nutrient intake was analyzed using Foodbase 2000 which consists of Sri Lankan food composition data.

Ninety eight percent (98%) of T2DM were on oral hypoglycemic agents (OHA) for glycaemic control. Twenty four percent (24%) T2DM used the diet and physical activities for their glycaemic control along with the OHA. Mean fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c) levels of diabetics were 143 mg/dL and 6.8% respectively. Mean energy intake of diabetics and non-diabetics were 1700 kcal (SD 449), 1748 kcal (SD 967), respectively. Energy intake, expenditure and energy balance of the T2DM was not significantly different from the non-diabetics. However, both T2DM and non-diabetics had positive energy balance. Percentage of energy from carbohydrate, protein and fat were not significantly different among T2DM and non-diabetics. Both the study groups obtained more calories from carbohydrates (62%) than required. T2DM have taken the majority of calories from complex carbohydrates and it was significantly ($p < 0.05$) higher than non-diabetics. Non-diabetics have taken significantly higher level of energy from added sugar than diabetics. Saturated fat was the major type of fat which used in both groups (20%). Monounsaturated and poly unsaturated fatty acid consumption was not sufficient (<5%) in both groups. Among T2DM, only 3% of have consumed a planned diet with regular meals and snacks. Intake of vegetable, fruit and milk/milk product groups were lower in both T2DM and non-diabetic individuals. Fish, pulses, egg, meat and poultry consumption was lower than recommendation among T2DM. T2DM those who consumed higher number of servings of vegetables had significantly ($p < 0.05$) lower FPG and HbA1c levels. Further they were in the healthy BMI range.

Although, the dietary intake of T2DM was better than non-diabetes, both groups have not consumed a balanced diet with the variety and appropriate quantities. Majority of diabetics were not on planned diet which is essential for the proper glycaemic control. Even though, diabetes did not give much attention on dietary management, they had acceptable glycemic control. Therefore, it can be concluded that, contribution of diet in achieving the glycaemic control of T2DM was not significant. Almost all diabetes relied on OHA for their glycaemic control.

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Keywords: Carbohydrates, Diabetes, Dietary intake, Energy, Glycemic control

Perception of consumers, food manufacturers and health professionals on traffic light food labeling in Sri Lanka

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Nutrition food labeling is identified as a potential tool to improve nutrition and health of public[1]. It helps people to make informed healthy food choices quickly and effortlessly. Traffic Light Labeling (TLL) is a simple method of showing a level of a food component using familiar traffic light signals. It was introduced in Sri Lanka in August 2016 to reduce the sugar consumption of general public. The objective of the study was to evaluate the exposure, preference, perception and the familiarity of TLL among consumers and food manufacturers and to evaluate the strengths and weaknesses of implementation of the TLL process. Perceptions of urban and rural consumers (n = 100) were assessed using an interviewer administered questionnaire while they were purchasing food items in retail outlets. Semi structured interviews were conducted to assess perception of six food manufacturers, five dietitians and five public health inspectors. NVivo 10 software was used to analyze the data obtained from semi structured interviews.

Only 46% of consumers were aware about TLL which might be due to the low awareness regarding food labeling. Out of them, only 31% of females and 28% of males reported that they follow the color codes in label while purchasing products. Sixty seven percent of participants who followed the label mentioned that they were able to get the message promptly. Ninety four percent of participants suggested that the government should conduct awareness programs. Representatives of fruit juice and carbonated beverage manufacturers opposed TLL introduced as a mandatory regulation as they face several difficulties as they had to change the labels in a short notice before implementation and limited government support. Nevertheless, majority of beverage manufacturers reformulated their products to reduce sugar amount. Fruit juice manufacturers reported that their sales decreased whereas carbonated beverage manufacturers reported that their sales were not changed after the introduction of TLL. Health professionals indicated that it as a good intervention to reduce the sugar consumption and non-communicable diseases and suggested to extend this to other product categories.

The study concluded that the present level of exposure and familiarity is not sufficient to make a considerable impact on behavioral change to reduce consumer sugar intake although it would be an effective tool to control sugar intake.

[1]Hawkes C. (2004). *Nutrition labels and health claims the global regulatory environment*. Geneva, World Health Organization.

Keywords: Traffic light, Food label, Stakeholders, Perception

Assessment of nutrient intake of infants aged between 6 to 12 months in Pannala and Kuliyapitiya (West) MOH area

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Complementary feeding along with breast milk is important to infants after 6 months for the proper growth, development, and health. Growth faltering and micronutrient deficiencies are highly prevalent due to exceeding of nutritional needs after 6 months[1]. Nutritional inadequacy of infant feeding both in quality and quantity remain as major problem in Sri Lanka[2]. Therefore, this cross-sectional study was conducted to assess the nutrient intake of infants (6-12 months, n = 150) who were attending to Maternal and Child Health clinics in Pannala and Kuliyapitiya (West) Medical Officer of Health (MOH) areas using a 24-hour dietary recall. Socio-demographic status and infant feeding practices were gathered by using a pre-tested interviewer administered questionnaire. Mean daily nutrient intake from complementary food; consumed amount obtained by showing food photos and breast milk; by recording frequency of feeding per day and average time (minutes) of feeding per instance was calculated and compared with WHO/FAO Recommended Nutrient Intake (RNI) value according to the age category.

Table: Mean nutrient intake and RNI of infants aged between 6 to 12 months

Energy and nutrient	6 to 8 months			9 to 11 months			12 months		
	RNI	Mean	SD	RNI	Mean	SD	RNI	Mean	SD
Energy(kcal)	784	763.31	214.78	949	896.16	282.79	1170	889.72	209.59
Carbohydrate (g)	90	93.83	31	95	148.09	137.35	95	118.45	38
Protein (g)	9.1	17.31	7.42	9.6	24.11	9.04	10.9	27.34	10.37
Lipid (g)	30	37.92	10.77	35	46.42	25.55	35	37.56	9.69
Calcium (g)	525	342.02	136.56	525	439.49	204.63	350	424.87	214.58
Sodium (g)	320	564.41	574.51	350	949.47	773.18	500	1062.15	721.15
Potassium (mg)	700	690.66	574.51	700	858.98	313.23	800	854.17	296.01
Iron (mg)	11	3.78	4.06	11	6.88	6.94	6	6.97	7.1
Zinc (mg)	5	3.29	1.07	5	3.82	1.16	6.5	4.06	1.45
Iodine (μg)	60	64.06	24.87	60	74.57	29.98	70	68.72	25.03
Vitamin C (mg)	25	42.68	23.63	25	45.21	16.5	30	41.77	20.65
Vitamin A (μg)	350	725.27	270.05	350	692.92	282.56	400	686.92	520.15
Vitamin D (μg)	7	0.754	0.99	7	1.49	1.79	7	4.98	3.4

Table shows, mean intake of protein, carbohydrate, sodium, potassium, iodine, vitamin C, and vitamin A were higher than the recommendation and energy, calcium, zinc, iron and vitamin D intake were below the WHO/FAO recommendations. It is important to plan nutrition intervention programme on preparation of nutritious feeds including variety of food to provide adequate dietary nutrients to infants at complementary feeding stage.

[1]World Health Organization (WHO)/United Nations children's fund.2003. *Global strategy for infant and young child feeding.* Geneva: WHO.

[2]Department of Census and Statistics(DCS) and Ministry of Healthcare and Nutrition(MOH). 2009. *Sri Lanka Demographic and Health Survey 2006-07.* Colombo, Sri Lanka: DCS and MOH.

Keywords: Breast feeding, Complementary feeding, Infants, Nutrient intake

Impact of a nutrition education brochure on nutritional status of oncology patients receiving chemotherapy

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Malnutrition is a common issue among cancer patients receiving chemotherapy. Effective nutrition interventions are necessary during chemotherapy to achieve positive outcomes of the treatment[1]. The aim of the study was to evaluate the impact of a nutrition education brochure (NEB) on nutritional status, quality of life (QOL), functional capacity and dietary intake of cancer patients receiving chemotherapy. This randomized controlled trial involved 18 individuals recommended for chemotherapy in the age range of 20 to 70 at oncology unit of Kandy Teaching Hospital. They were randomized to receive either NEB ($n = 9$) or usual care ($n = 9$). Patient Generated Subjective Global Assessment (PG SGA)[2], anthropometry and biochemical assessment were used to assess the nutritional status. Quality of life of the individuals was determined by European Organization for Research and Treatment of Cancer Quality of life questionnaire C30 (EORTC QOL C30)[3]. All assessments were conducted at the baseline before the commencement of treatment and again at the next two consecutive chemotherapy cycles at the 3rd and 6th week. Dietary intake was assessed by24 hour recall at the baseline and by three day diet diaries during follow ups. Repeated measures ANOVA was used to analyze the impact of NEB in two groups over the time. The group which received NEB indicated a statistically significant improvement in mean values of PG SGA score, QOL score, physical functioning score, body weight, total lymphocyte count and platelet counts compared to those receiving UC ($p < 0.05$). There was a statistically non-significant but noteworthy improving trend in dietary intake, symptoms management and functional capacity in NEB group compared to UC. NEB has a positive impact on nutritional status, QOL, physical functioning, body weight, total lymphocyte count and platelets count. However, it is recommended to expand the study with increased sample size and longer duration for follow up for more precious results.

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Keywords: Malnutrition, Nutritional status, Quality of life, Functional capacity

Total dietary fiber, total carbohydrates and mineral content of selected underutilized fruits in Sri Lanka

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Nutritional composition data of underutilized fruits grown in Sri Lanka are scarce. Therefore, this study was conducted to analyze total carbohydrates (TCHO), total dietary fiber (TDF), and selected minerals of twenty fruit species grown in Sri Lanka. Fruit samples collected from local market and agricultural lands (Table) were analysed for TCHO, TDF, and minerals (Ca, Mg, Zn and Na) using phenol-sulfuric acid method, enzymatic-gravimetric method and atomic absorption spectrophotometry, respectively.

Table: Nutritional composition of fruits (per 100g of edible portion)

Botanical name	Moisture %	TDF (g)	TCHO (g)	Mineral content (mg)			
				Ca	Mg	Zn	Na
[1]*Acca sellowiana*	85.4	0.10	1.69	22.78	12.52	1.45	3.95
[2]*Cyanometra cauliflora*	87.9	0.22	5.85	10.49	8.12	2.35	7.22
[3]*Muntingia calabura*	86.1	0.22	9.42	20.12	11.05	3.82	16.35
[4]*Carissa macrocarpa*	84.6	0.38	2.03	6.58	1.23	0.25	0.51
[5]*Manilkara zapota*	78.3	0.39	7.93	25.86	9.05	1.74	2.48
[6]*Pouteria campechiana*	64.4	0.40	25.86	8.70	25.64	4.06	33.50
[7]*Averrhoa carambola*	92.5	0.41	6.71	2.53	4.06	0.68	1.64
[8]*Syzygium caryophyllatum*	83.9	0.41	2.70	11.62	4.95	1.01	2.41
[9]*Spondias dulcis*	61.1	0.46	20.33	10.54	5.79	5.19	1.12
[10]*Aegle marmelos*	65.8	0.53	21.59	19.51	20.46	3.41	6.33
[11]*Phyllanthus acidus*	93.1	0.69	4.98	10.85	3.04	0.53	3.21
[12]*Anacardium occidentale*	89.5	0.75	5.46	7.93	6.80	8.84	3.03
[13]*Annona muricata*	79.2	0.87	18.57	1.65	3.94	0.91	1.17
[14]*Flacourtia indica*	78.7	1.06	6.91	15.83	4.01	19.50	2.78
[15]*Flacourtia inermis*	65.9	1.10	10.39	54.48	18.91	11.20	50.59
[16]*Psidium guajava*	89.3	1.21	4.82	11.67	7.06	1.45	2.89
[17]*Diospyros blancoi*	78.5	1.35	6.30	35.14	5.14	7.69	7.21
[18]*Annona reticulate*	80.0	1.90	17.00	12.93	10.97	11.42	5.55
[19]*Psidium guineense*	93.8	2.22	0.92	8.56	7.08	1.74	4.22
[20]*Psidium cattleyanum*	82.6	7.81	9.45	3.05	5.17	0.15	2.79

Common names of fruits; [1]Ambilla, [2]Naminag, [3]Jameic cherry, [4]Jamson, [5]Sapodilla, [6]Lavulu, [7]Star fruit, [8]Local berry, [9]Jew plum, [10]Bael, [11]Star gooseberry, [12]Cashew apple, [13]Soursop, [14]Governer's plum, [15]Lovi, [16]Pink flesh guava, [17]Velvet apple, [18]Custard apple, [19]Sour guava, [20]Jam guava

The highest TDF was found in Jam guava and the lowest was found in Ambilla (Table). Sour guava and Custard apple showed the second and third highest TDF values, respectively. Lavulu had the highest TCHO followed by Bael, Jew plum and Soursop.

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Keywords: Atomic absorption spectrophotometry (AAS), Minerals, Total carbohydrate content, Total dietary fiber, Underutilized fruits

Determination of patients' preferences and opinions on hospital diets in Sri Lanka

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Although all government hospitals in Sri Lanka provide diets for hospitalized patients, malnutrition among hospitalized patients can be observed. Hospital malnutrition increases the length of hospital stay and delays the recovery period of disease conditions. Since no research has been conducted to find patients' preferences and opinions on hospital diets in Sri Lanka this study was conducted to fill this research gap. Information on factors affecting hospital malnutrition, diets available in hospitals and reasons for not consuming diets provided by the hospitals were gathered by reviewing the literature and conducting a preliminary survey among selected government hospitals in Sri Lanka. Using gathered information two questionnaires were developed to collect information on available diets/menus, a way of preparing and food delivering process in government hospitals and patients' preferences and opinions on hospital diets. Information on menu planning and food delivering process were gathered from hospital staff and interviewer's direct observation. A pre-tested interviewer administrated questionnaire was used to gather data from 300 hospitalized patients who were in selected seven hospitals according to their willingness after briefing the study. Hospitals were selected representing main five types of hospitals in Sri Lanka health care sector namely national hospitals, teaching hospitals, district general hospitals, base hospitals and divisional hospitals. Collected data were sorted and then analyzed by SPSS. Out of the total, 71.7% patients (n = 215) admitted that they did not eat hospital diets/foods. The majority (57%) of the patients responded that they did not like to consume hospital provided diets since they were not tasty. Other responses of the patients for not consuming diets provided by the hospitals were not including their favorite foods (5%), not including the variety of foods in the diets (15%), the low salty taste of the foods (14%) and poor hygienic condition of providing foods (4%). Out of the hospital diets consumers, 75% said that they eat hospital diets as the diets are prepared according to their disease condition. The results showed that not only the taste but also the appearance of food, the smell of food, food delivering temperature and the way of delivering affected for not consuming hospital diets by the patients. Further, a positive correlation was detected between hospital food acceptability by the patients and taste of food. The findings of this study indicated the necessity to change the food preparation and serving system in hospital setups according to patients' preferences to minimize the hospital malnutrition by increasing consumption of diets provided by the hospitals.

Keywords: Hospital malnutrition, Patient, Preferences, Opinions, Hospital diets

Trends of refraining illegal border crossing and catch statistics after implementation of vessel monitoring systems in multiday-boats operated from Kalutara, Sri Lanka

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Illegal, unreported and unregulated (IUU) fishing is one of the key issues in world fisheries. On-board logbooks in high-seas fishing vessels and Vessel Monitoring System (VMS) became obligatory requirements in combatting with IUU fishing. Thus, VMS made compulsory by Sri Lankan authorities for the multi-day vessels operated in the country since late 2015. Therefore, this study aimed to identify the numbers and trends of illegal border crossing during 2015 to 2016 period by the multi-day vessels operated from Kalutara, in western Sri Lanka, and also to identify temporal and geographical species-wise production, during the same period, with respect to different fishing gear operated. Log-books and respective VMS information of 20 randomly selected multi-day boats were analyzed for each year. The vessel positions, which reported in every 4hr time intervals, were retrieved from MySQL data base in the Ministry of Fisheries in stimulating root maps for each vessel. According to the speed of the vessel, fishing activities were predicted: if a vessel slows down in Exclusive Economic Zone (EEZ) of an another country, it was counted as potential illegal fishing while crossing an EEZ without slowing down was considered as an innocent passage. Moreover, destruction of the vessels' root and fishing in the EEZ boarders were also counted as illegal fishing. In 2015, only two vessels had VMS and both the vessels found to conduct illegal fishing. But in 2016 the percentage of illegal fishing had dropped to 13%. Total fishery production, which comprised of tuna; billfish, sharks and other fishes, showed more or less similar production trends in 2015 and 2016. Gear-wise monthly productions and monthly Catch per Unit Efforts (CPUE) of gillnets and long line catches shows differences in respective months of the two years but production was observed throughout the year in the fishing grounds in northeast (NE); northwest (NW); southeast (SE) and southwest (SW) to the country. Purse seine, which operates for schooling fish in pelagic water, showed fishery productions only from SW fishing grounds in 2015 but in 2016 additional fishery production has been reported from NE and SE in addition to the SW fishing ground. High skipjack tuna catches observed from NE and SW fishing grounds in 2016 need to be monitored closely for a longer period with respective oceanographic information. Although some potential fishing grounds of different species at different seasons of the year were revealed in this study, a long-term study need to be initiated with geo-location information to establish a reliable fishing ground forecasting system.

Keywords: IUU Fishing, VMS, Logbook, EEZ, Indian ocean

Association between juvenile Carangid fish with the jellyfish *Phyllorhiza punctate*

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The association behaviour of fish and biotic-abiotic floating items has been widely recognized and used for managing, protecting and safeguarding of early developmental stages. The fish-jellyfish association is one of the important ecosystem-relationships, which regarded as a temporary symbiosis. But inadequate knowledge on these important behaviour of jellyfish, mainly due to lack of studies, had led to uncontrolled harvesting of jellyfish for export market in every occasion when jellyfish blooms appeared in Sri Lankan waters. Therefore, this study tried to identify what type of behavior these jellyfishes have with fish species off the western coastal waters of Sri Lanka. Underwater Visual Cense (UVC) technique was used at three selected locations in the Puttalam lagoon: Mampuri; Pallivasalthurai; and Kalpitiya from March to May in 2017. In each location three sites were selected and 50m line-transects were laid. Underwater photographs were taken in every 5m distance along the transects. Further, 30 min. videos were recorded following randomly selected jellyfish. Video footages and photographs, which were taken two times per day at 06:00-09:00 and 15:00-18:00, were analyzed. The highest number of fish seen in the video-frame within the 30min. was recorded. The present or absence of association of jellyfish with the other fish species and their respective numbers were recorded in every 5min. intervals of the video footage frame and the photographs were subjected to a cluster analysis. Scoop nets and randomly operated cast-net catches of jellyfish and associated fish were preserved in 5% formalin and taken to the laboratory for identification of jellyfish species and fish species to the lowest possible taxa using identification keys and guides. Further, gut contents of fishes and jellyfish were analyzed to find out whether the association was due to pray-predator interaction or any other symbiotic relationship. Jellyfish, *Phyllorhiza puncata* were found to be with three fish species: *Carangoides praeustus*, *Terapon jarbua*, *Leiognathus equulus* in the same habitat. Anyhow, a significant association was found only between the jellyfish and *C. praeustus* ($p < 0.05$). The absence of body parts of the both species in the gut contents of each other confirmed that the association was not a predatory relationship. Further, lengths of associated fish species confirmed that only *C. praeustus* juveniles only showed the association behavior with the jellyfish. When jellyfish abundance reduces during the latter months of the study period, due to their seasonal abundance, high numbers of *C. praeustus* juveniles were associated with individual jellyfish. Probably the observed fish-jellyfish association seems to be a symbiosis to get protection from predators by juvenile fish as they can find refuge within their umbrella and tentacles of large jellyfish.

Keywords: Association, Refuge, Medusa, Underwater Visual Cense (UVC)

Consumer willingness-to-pay for eco-labelled and quality certified canned-fish products: a choice experiment with real economic incentives

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Eco-labeling is becoming an important tool used in fishing industry in promoting sustainable fishery products. Such labels are expected to ensure that the product have been produced according to the sustainable ecological principles. Similarly, quality and safety certifications play a significant role in assuring the health concerns of consumers. Eco-labeling concerns the production process rather than the product while the quality certification concerns the end-product. From the consumer perspectives these type of product attributes, called credence attributes, involve a high level of uncertainty because such attributes cannot be evaluated prior to and after consumption unlike in search attributes (price, colour) and experience attributes (taste, durability). Although quality certification is common, Eco-labelled products are a new experience for Sri Lankan consumers. Hence, it is important to know willingness-to-pay (WTP) of Sri Lankan consumers' for eco-labelled products, which showcases whether these certifications can be implemented in Sri Lankan market. Therefore, this study attempted to find the WTP by consumers for food and environmental safety attributes when consuming canned fish by using a choice experiment taking a sample of 25 consumers from the Central Province in Sri Lanka using a pretested questionnaire. A sample of 285 consumers who are responsible for purchasing food for their household and those who do purchase or consume canned fish products were interviewed at 9 supermarkets located in 5 cities covering the central province from March to June, 2017. A multinomial logistic regression model was used to elicit WTP by consumers for preserving the five selected attributes of canned fish: availability of Eco-label; availability of quality certification; country of origin; type of brand; and type of species. Around 80% of consumers stated that the presence of Eco-labels will not always influence their decision to buy a canned fish product. Nevertheless, on the WTP values estimated, consumers in the sample place emphasis on established brand names followed by quality certification and the Eco-labels respectively. Interestingly, country of origin and type of species were not significant for consumers' decision. The WTP for quality certification was 159.91LKR and therefore, consumers will choose products with a quality certification over ones without it, even if the price difference between the two is 159.91LKR. Similarly, the estimated price premium for Eco labels was 140.95LKR revealing that consumers in Sri Lanka concerned with sustainability of the fisheries and are willing to pay to preserve it. Therefore, producers can be driven towards obtaining sustainability certification as consumers will pay an additional amount to buy such products. Thus, this is an important marketing tool that can ensure supply of fisheries products to the future generations.

Keywords: Choice experiment, Eco labels, Quality certification, Willingness-to-pay

Measuring the total economic value of restoring ecosystem services in Negombo estuary: results from a contingent valuation survey

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Understanding the economic value of the nature and the services it provides to humanity has become increasingly important for local, national and global policy decision making. Market and non-market valuation of the estuary account for all of the values that individuals place on the goods and services provided by the estuary such as flood control, water purification and aesthetic value etc. Obtaining such values for Negombo estuary, which has an extended area of 62.3 km^2 and supports for ~25,000 people directly or indirectly for their livelihood, is useful for making investment decisions as estuary has been subjected to multiple pressures due to anthropogenic activities and recent development plans. Therefore, this study attempted to value Negombo estuary in terms of willingness-to-pay (WTP), to identify the current value of the ecosystem services. The WTP by the users of the Negombo estuary was estimated using Contingent Valuation Method (CVM), which is a flexible nonmarket valuation method that widely used in cost–benefit analysis and environmental impact assessment. Households who are directly and indirectly related to Negombo estuary were asked WTP in avoiding environmental pollution around the Negombo estuary. A pre-tested questionnaire collected data on age of respondent, monthly income, educational status, number of family members, marital status, fishing equipment, fish production data and WTP. Data were collected from March to July 2017 covering 5 different areas surrounding the Negombo estuary, namely, Pitipana South, Lellama, Thalduwa, Wella Weediya, and Rejina road area. The total sample size was 150 households. The average WTP in the sample was LKR417 per month. Because the WTP measure obtained from a CVM said to represent the consumer surplus, the average WTP can be used to calculate the total value of the environment by multiplying by the total population in the area: 509,551. Therefore, lower bound of the value of ecosystem services provided by the Negombo estuary is 212.4million per month. However, regression analysis shows that WTP values vary by level of monthly income (coefficient = 1.09) and educational status (coefficient: grade 6-11 = 0.28; A/L = 0.22; graduate = 0.46). Outcomes of this analysis provide lower bound value of the ecosystem services of Negombo estuary to be considered in future development procedures.

Keywords: Contingent valuation, Negombo estuary, Willingness-to-pay

Fish wars: northern Sri Lankan fishers' struggle due to trans-boundary incursions in the Palk Bay

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Maritime border crossing during fishing creates increasing conflicts between countries, leading to fish wars. The two neighboring states in Indian Ocean, Sri Lanka and India, are also struggling with a trans-boundary incursion issue at the shallow and narrow stripe of sea called the 'Palk Bay' and the 'Gulf of Mannar' which separates the two countries. In the past, when fishing technologies were more equitable, fishermen shared the Palk Bay as common fishing grounds. But when Sri Lanka had a civil war during 1979 to 2009, Indian bottom trawl moved to vacated fishing grounds. After the war ended in 2009, artisanal fishers in northern Sri Lanka began competing with large Indian trawlers. Hence, this study attempted to find the perception of different stakeholders on the present maritime border crossing issues in the Palk Bay. This study was conducted in ten selected villages in Jaffna: Delft west; Nainathivu; Karainagar; Mathagal; Munai; Manatkadu; Myliddy; Nagarkovil; Kayts and Uduthurai from March to July in 2017. A pre-tested questionnaire was used to conduct an opinion and information survey by contacting fishers ($n = 360$); navy officers ($n = 2$); fishery leaders ($n = 18$); and fishery scientists ($n = 7$). Secondary data were collected from fisheries department and fisheries cooperative society representatives. Indian trawler intrusion ($p = 0.00$) and banned nets ($p = 0.03$) were significant issues to the fishers in Jaffna than the low income ($p = 0.92$) and lack of own fishing devices ($p = 0.99$). All fishers have seen foreign vessels fishing in their territories, while 13% of fishers have observed these vessels even within 5km from their coast and ~70% of fishers believed those vessels were belonged to Indian fishers. Loss of fishing days due to damages to their gear by trawlers; refrain from fishing due to fear of foreign vessels were the major losses faced by fishers in Jaffna. Fish harvest of Jaffna fishers showed a significant drop in the days where Indian trawlers were operated ($p < 0.05$) and significant differences in economic losses among villags ($p < 0.05$). Despite to the economic losses, special "friendly attitude" of Sri Lankan fishers towards Indian fishers need to be considered in implementing management plans. All stakeholders emphasised that the corporation between fishers and government in rules formulation and implementing management approaches. Relationship of catch statistics of Tamilnadu and Jaffna, from 1990 to 2015, shows that the both parties do sustain from the same resources. In resolving the conflict, strong bilateral agreements between both countries; improvement of the International Maritime Boarder Line (IMBL) detection technology; reviewing legislation and enforcing new laws; ban bottom trawling all around the world and to provide alternatives for trawl fishers by Tamilnadu government were proposed. Further, it was proposed to the Sri Lanka government to enhance the fishing effort in the Palk Bay to discourage trans-boundary crossing fishers. All stakeholders agreed that the issue can only be solved with the good will and support of both countries hence conducting a similar survey in south India is proposed.

Keywords: Bottom trawling, Conflicts, International Maritime Boarder line, Palk Bay

Sex and body segment-wise proximate composition of commercially important four crab species in Sri Lanka

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Crabs are a commercially and nutritionally importance species. Anyhow, crabs vary widely in their nutrient content with respect to different environmental and body conditions. Therefore, present study aimed to document the sex and body segment-wise proximate composition of commercially important four crab species: *Scylla serrata, Portunus pelagicus, Portunus sanguinolentus* and *Charybdis notator* found in Sri Lanka. The samples were collected from the Negombo and Jaffna lagoon from March to June, 2017. From the samples taken to the laboratory the moisture, ash, total lipids and protein were determined: moisture percentages were determined by calculating the weight differences of samples before and after oven drying at 105 °C until it reach to a constant weight; total lipid percentages were determined by using the modified Bligh and Dyer method[1], ash percentages were determined by igniting the sample at 550 °C for 5-6 hours until sample was completely free from carbon particles in a muffle furnace; the protein percentages was determined by Kjeldahl method. The highest moisture percentage was in the *S. serrata* (80.96, SD 3.00) while the lowest was reported in the *P. pelagicus* (78.35, SD 5.29). Total lipid percentage and the ash percentages were highest in the *C. notator* (respectively 0.76, SD 0.23 and 0.21, SD 0.11) while the lowest total lipid percentage and ash percentages were in the *S. serrata* (respectively 0.52, SD 0.31 and 0.14, SD 0.10). *Scylla serrata* had a significantly high protein percentage (38.84, SD 10.65, $p < 0.05$) while the lowest was in the *P. pelagicus* (18.43, SD 9.42). *Portunus pelagicus* had the highest carbohydrate values. The crabs collected from Negombo lagoon had the highest total lipid percentages and the crabs from Jaffna had the highest protein percentages. The total lipid percentages and the protein percentages were higher in the female animals while the ash percentages were highest in the males than females. Further, total lipid and ash percentages were significantly higher in claw meat than body meat of males ($p < 0.05$). Both male and females body meat showed a significantly highest protein value ($p < 0.05$). The results revealed the possibilities for both farmers as well as processors to carefully select the species, gender and the meat source based on their compositions to cater specific market requirements and also for biologists to investigate more on the biological changes happen in these crabs.

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Keywords: *Scylla serrata, Portunus pelagicus, Portunus sanguinolentus, Charybdis notator*

Use of Truss Network analysis to separate different color varieties of *Pterygoplichthys* spp.

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Pterygoplichthys spp. are native to South America and introduced to Sri Lanka through the ornamental fish trade. Two species; *Pterygoplichthys pardalis* and *Pterygoplichthys disjunctivus* have been reported from Sri Lanka. *Pterygoplichthys pardalis* consists dotted color pattern while *P. disjunctivus* consists varmiculated color pattern on the ventral sides. However, there were three groups of fish, which have mixture of color patterns of the *P. pardalis* and *P. disjunctivus*. This could be due to hybridization of two main species or introduction of hybrid varieties. Present study attempted to check the availability of different groups of *Pterygoplichthys* spp., in Victoria and Daduru Oya reservoirs according to their morphometric characteristics. A Truss network analysis was performed by measuring 31 Truss lengths over the identified landmarks of the two species and three color verieties. Prior to multivariate analysis, all the morphometric measurements in identified five color patterns were standardized for fish size as follows.

$$Standardized\ truss\ length = Log_{10}LT_{(i)}\left[\frac{Log_{10}TL_{(m)}}{Log_{10}TL_{(i)}}\right]^{b}$$

Where, $LT_{(i)}$ - Truss length of i^{th} fish, $TL_{(i)}$ – Total length of i^{th} fish, $TL_{(m)}$ – mean value of total lengths, b is the slope. Standardized data of two reservoirs were subjected to Principal Components Analysis (PCA) to identify potential fish populations. Then discriminant analysis was conducted for standardized truss lengths to check whether the divided five groups according to color patterns can be separated according to morphometric characteristics. Growth pattern and condition factor were calculated only for the mixed color patterns of *P. disjunctivus* found in two reservoirs. PCA separated the two populations in to two distinct groups indicating the existence of two different stocks in two reservoirs. Discriminant analysis gave a close to 1 proportionate values for each five groups of fish in two populations indicating the availability of five distinct groups according to truss measurments. Result concluded that Victoria and Daduru Oya reservoirs have two populations and availability of three morphometric groups in each reservoir, which possibly be three hybrid varieties. A genetic study is required to confirm the level of hybridization in both fish stocks. *Pterigoplychthys* spp. have allometric growth and the two reservoirs have suitable environment condition for their growth.

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Keywords: Invasive fish, Truss network, *Pterygoplichthys* spp., Hybridization

Value addition to sail fin catfish through nutrients enrichment of cookies

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The sailfin catfish (*Pterygoplichthys* spp.), in family Loricariidae is an exotic fish groups, which are highly invasive and invaded in reservoirs of Sri Lanka. Sailfin catfish become a threat to inland fishery as it reduces the target catch by disturbing gear due to its entangling nature. Unpleasant appearance and processing difficulties of this fish make underutilize although sizeable populations are available for exploitation. An alternative method of utilizing this sailfin catfish could be possible through product development by value addition. This research was designed to use sailfin catfish to produce nutrient enhanced cookie, which can be used as therapeutic food with increased protein. Fish sample were collected from Daduru Oya reservoir in Kurunagala district and preserved in ice before transporting to the university laboratory. Total plate count (TPC) and coliform test were conducted for flesh of *P. pardalis*, *P. disjunctivus* and hybrid verities immediately after transporting to the laboratory. Dressing percentage of fish and proximate composition for mixed flesh of two species and hybrid verities was also examined. Experimental cookies were produced with addition of 17%, 22% and 27% fish by replacing the 54% wheat flour used for the control cookie. A testing panel of 30 panelists was used to evaluate the quality of appearance, odder, taste, texture, flavor and overall acceptance. The highest performed fish added cookie was selected for further development. Proximate analysis, TPC and coliform test was done for the selected product. Results for the TPC for raw flesh was $5.7x10^5$CFU/g and negative result for coliform test was obtained. The average dressing percentage of fish was reported as 23.19%. The proximate composition of sailfin catfish was reported as moisture 74.73%, ash 1.1%, protein 10.70%, crude fat 3.70%, and crude fiber 1.02%. The cookie developed with 17% fish was obtained the second preference and the control received the first preference. Appearance, color and texture of the developed product was significantly different from the control ($p<0.05$), Wilcoxson sign ranked test followed, Mann-Whitney test). Negative results for the coliform test and total plate count was reported as 1800m CFU/g in selected cookie. The protein percentage of control cookie and developed product were 7.17% and 10.44% respectively and significantly higher in new product ($p<0.05$, T-test). Proximate composition of the new product was reported as follows; Moisture 2.28%, Ash 2.42%, Fat 28.08%, and Carbohydrate 56.78%. The production cost for one biscuit was Rs.1.76. Further improvement to appearance, color and texture should be done for fish incorporated cookie.

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Keywords: Cookie, Sail fin cat fish, Therapeutic food, Value addition

Marketing channels of inland fish of selected reservoirs in Sri Lanka

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Marketing and distribution channels are important components in the process of getting produce from source to consumers. In all market commodities, marketing channels have a greater influence on the final price. Marketing channels in culture-based fisheries production inland reservoirs have not been much studied in the recent past. This study was conducted during March to May 2017 to analyze marketing channels of fish produced at three reservoirs; Deduru Oya reservoir (North Western province), Jayanthi Wewa (Eastern province) and Senanayaka Samudraya (Uva province) in Sri Lanka. Data were collected from fishermen, buyers, fishing societies and district extension officers of each reservoir using a pre-tested, semi-structured questionnaire. Randomly selected 104 fishermen were individually interviewed at the landing sites. Buyers (fish vendors, retailers, distributers, wholesalers and collectors) were selected using purposive sampling technique. Descriptive statistic, linear regression and market margin were used to analyze the data. Deduru Oya reservoir and Jayanthi Wewa have a decentralized marketing network where as Senanayake Samudraya has both centralized and decentralized marketing network. Mean market gate wholesale price for fish species is different in reservoirs were different during the study period. *Oreochromis* spp. received the highest value among all fish and reported as Rs. 250, 210 and 185 in Daduru Oya, Jayanthi Wewa and Senanayake Samudra respectively. Loyalties were taken from each kilo of the landings by the society and it ranged from Rs. 20 to 40. Market gate wholesale price for introduced carp species were ranged from Rs. 100 to 180. Length of the market channels are varied from 1 to 400km within the country and main mode of transportation was motorcycles and was represented 80% in short distance fish delivery. Fish landings of Daduru oya reservoir distributed within shorter distances compared to other two and maximum distance reached was 85km. Fish landings of Jayanthi Wewa and Senanayake Samudraya transported up to 400km and reached to the markets of western coast Chilaw, Negombo and Colombo. Local people living around the Jayanthi Wewa and Senanayake Samudraya transported fish into coastal markets and wholesalers from above coastal areas and the country side markets; Kurunegala, Mathale and Udawalawa visited to the landing sites at Jayanthi Wewa and Senanayake Samudra for purchasing fish. Post-harvest practices in the marketing channel were poor and no ice was used at the farm gate except splashing water or use of wet gunny bags to prevent desiccation. Only wholesalers and distributors use ice during storage and transportation. Market margin per one kilogram varied from 9.09% to 64.00% in short distance and market margin of long distance market channels ranged from 18.04% to 41.21%. People in middle and low income category were the main buyers according to fish vendors. According to the present study awareness about post-harvest preservation should be improved through the market channels.

Keywords: Fish marketing, Inland fisheries, Marketing channel, Culture-based fisheries

Parasitic digenean cercariae and their indefinitive gastropod hosts in two fish farms of Sri Lanka with special reference to *Centrocestus formosanus*

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Parasitic Digenean trematodes are a common problem in fish farms as it causes heavy mortality in fish juveniles. Identification of definitive hosts species available in fish farms and parasitic digenean species hosted by them are important to implement control measures. Present study was conducted to identify existing definitive snail host species and fish parasitic cercariae harbored by them in two fish farms in Northwestern and Central Provinces of Sri Lanka. A special attention was paid to the growth of metacercaria stage of most prevailing fluke species. Snails collected from two fish farms were analyzed to identify the cercariae up to possible lowest taxonomic level using identification keys and other published information. Identified cercariae were preserved in 10% buffered formalin and single staining (Borax-Carmine) was done for further confirmation. Fry stage of *Catla catla* (2.5–3.5cm) was placed in an aquarium with the host snail species of cercariae to study the metacercaria stage of the most prevailing parasite. The number, size and the development of cysts were recorded in 10-days time intervals. Double staining (Haematoxylin and Eosin) was done for histological observation of infected gills. *Thiara scabra, Paludomous sphearica* and *Melanoides tuberculata* snail species were recorded from two fish farms. Cercariae of fish parasitic flukes were reported only from *M. tuberculate and* the infectious rate was reported as 16% and 8% in two fish farms. Cercariae of four parasitic flukes species; *Centrocestus Formosans*, *Transversotrema* sp., *Haplorchis sp.* and *Renicola* sp. were recorded and *C. formosanus* was the most prevailing parasitic species in host snails and mean number of cecariae recovered from one snail was ranged from 3435 to 5000 from the two farms. The redia of *C. formosanus* was found with 600μm total length and 90-130μm body width. The mean sizes of cercaria was recorded as 500μm head length and 600 μm tail length. Oval shaped *C. formosanus* metacercariae were identified by 32 circumoral spines around the oral sucker, X-shaped execratory vesicle, well developed testis and penetration glands. Thickness of the cyst wall developed by the host tissues had been increased from 0μm up to 35μm and became constant within 6 days of time after infection. Ranges of the total length and width of the cyst were recorded as 120-260μm and 50-160μm range respectively. Irrespective to the location of the gills had no relationship with the intensity parasitic infection.

Keywords: *Catla catla*, *Centrocestus formosanus*, Cercariae, *Melanoides tuberculata*

Evaluating the heterogeneity in soil characteristics of different mangroves stands in Kala Oya estuary, Sri Lanka

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Mangrove forest and associated water bodies are the two components in a mangrove ecosystem. Geographical latitude, wave action, rainfall, freshwater runoff, sedimentation rates, aridity, salinity, nutrient inputs and soil quality influence on the growth of mangroves. Tidal inundation influences the soil characteristics that control species zonation of mangroves as well as other physical and chemical properties of water. According to above ground flora, the soil carbon composition can vary. Such information is vital for scientific management of mangrove ecosystems. Present study was therefore, carried out with the objective of determining primary soil characteristics including carbon content in soil supporting *Rhizophora mucronate* (RM), *Avicenia marina* (AM) and *Lumnitzera racemosa* (LR) stands and pH, salinity, conductivity, temperature, dissolved oxygen in water, in three locations at different distances [river mouth (0m), mid estuary (691m), river fall (1880m)] in Kala Oya estuary. Data were collected from March to June 2017. The total organic content (TOC) of the soil indicated that *R. mucronata* stands had the highest TOC ($p < 0.05$) in terms of vegetation stand whilst the lowest overall TOC was at river mouth (Figure1).

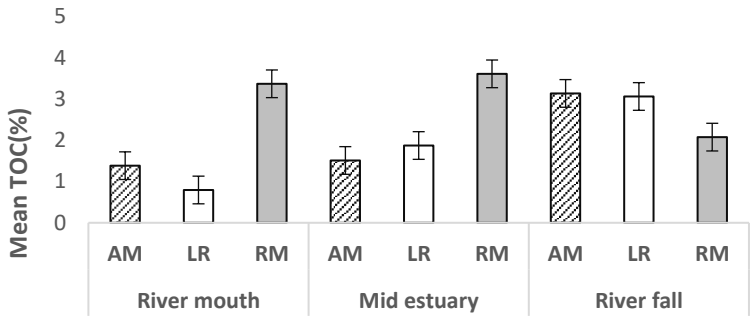

Figure 1. Mean Total Organic Carbon values for different vegetation stands river mouth, mid estuary and river fall.

Both bulk density and soil pH indicated that *L. racemosa* stands had the highest values in terms of vegetation stand ($p < 0.05$) whilst the lowest overall bulk density and pH were at mid estuary. With regard to water the three sites differed markedly and the highest salinity was found in *A. marina* whilst the highest conductivity was at *L. racemosa*. Results confirm that depending on the above ground flora, TOC in soil can vary and such information is required in planned restorations and conservation. Detailed hydrological studies and physicochemical investigations of soil and water in different seasons could assist in detailed carbon mapping of Kala Oya estuary.

Key words: Zonation, Heterogeneity, Soil parameters, Carbon content

An empirical analysis on the sustainability of livelihood of fishing communities adjacent to the Giant Tank in Mannar District

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This study assesses the sustainable livelihood strategies of the fishing communities adjacent to the Giant Tank in Mannar district in order to identify the key issues faced by these communities, both at the level of household and community as a whole, and in turn, to come up with possible recommendations to improve their livelihood. The concept of 'Sustainable Livelihoods Approach', which uses five specific types of assets to characterize the state of poverty and livelihood of a household/community, including the: (1) human; (2) social; (3) physical; (4) natural, and (5) financial, was used essentially to develop the theoretical model. Stratified random sampling techniques were applied to select a sample of households (n = 100) representing the seven fishery societies of tank, and each household was contacted by way of an in-depth personal interviews supported by a pre-tested structured questionnaire to collect data from June to July 2017. Most of the fishers contacted (44%) were within the 41 to 50 age category and educated formally up to secondary level (i.e. grade 6 to 11) (59%). The average annual income of 54% of fishing households was range between LKR 300,000 to 450,000, and more than 70% of which population has earned exclusively by fishing related activities. It was brought to light that the 'Livelihood Pentagons' derived for seven fishery societies were not "symmetrical". In fact, these communities were "very rich" with regard to the Social Capital (97%) highlighting strong and sustainable relationships amongst the households and within the community. Natural Capital was also positioned relatively "high" (85%), because of the facts that high soil fertility, access to forest resources and less impacts from the natural disasters. The state of Human Capital has, however, been on "average" (67%) due to limited access to quality education and health facilities locally. Conversely, the state of Physical Capital was "relatively low" (62%), which was an indication of inadequate land availability for agriculture and livestock, poor transport facilities and lack of access to quality of drinking water. The Financial Capital was rated the "lowest" (47%), because these households, in general, do not possess capacity and/or facility to generate, and/or an access to alternative sources of income, within and nearby areas, through sustainably engage in full or part-time employment, including commercial agricultural and livestock production and retail/service marketing. The outcome of analysis suggests that the livelihoods of these communities are not sustainable enough to cope up with any internal and/or external risks and negative externalities that they would face appropriately, since the households depend largely on fishing in the Giant tank. The outcome of analysis, from policy point of view, provide strong justification to further strengthen the good fisheries management strategies, including culture-based fisheries to augment and diversified the economic potentials of households while safeguard the social relationships.

Keywords: Culture-based fisheries, Fishing communities, Giant tank, Sustainable livelihoods

Two product developments using seaweed *Kappaphycus alvarezii*: new herbal porridge and value addition for traditional herbal gruel "Kola-Kenda"

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There has been a tradition of consuming seaweeds, as sea vegetables around the globe since ancient time because they are of high nutritive value, specially a good source of natural calcium. *Kappaphycus alvarezii* is a red alga, which yields carrageenan, a commercially important polysaccharide. Carrageenan is used in a variety of commercial food applications as in gelling, thickening, and as a stabilizing agent with lot of health benefits. This study intended to develop herbal porridge using *K. alvarezii* and to incorporate *K. alvarezii* with traditional herbal gruel "kola- kenda" (S: Kola-kenda, T: Kanji). Nutritional profiles were analysed and the consumer acceptability were evaluated for the final products. Also buffering capacity of the final product was evaluated using an acid solution. Total fungal count and the total bacterial counts for the final product were tested for the final product. Seaweed herbal porridge was prepared by mixing fresh curry leaves (*Murraya koenigii*) and *K. alvarezii* in following ratios; 0:100, 15:85, 20:80, 25:75. Value addition for "kola kenda" was done by using seaweed powder. Formulation ratios between seaweed and other green leaves (Hathawariya-*Asparagus racemosus*, Gotukola-*Centella asiatica* and curry leaves) used to prepare kola kenda as follows in fresh weight; 0:100, 55:45, 65:35, and 75:25. For sensory test a 5-point hedonic scale for taste, colour, appearance, texture and flavour were used. Sensory data were analysed using Wilcoxn Rank Sums and Kruskal-Wallis test. Herbal porridge with 20% curry leaves had the highest consumer acceptance ($p < 0.05$). Value added kola kenda with 65% seaweeds has the highest consumer acceptance than the normal kola kenda ($p < 0.05$). Seaweeds incorporated products were rich in calcium, fibre (1.0-1.5%), and protein (0.10-0.20%) but were low in fat (0.04-0.05%). ($p < 0.05$) After cooling, the value added Kola kenda it has the highest ability to change the pH from acidic level to basic level. For these two products, the total bacterial counts and total fungal counts were at the acceptable levels for consumption according to the Microbiological Guidelines for Foods, (2014) respectively. These two formulated products can be introduced to the commercial market as a calcium supplement and an alternative medicinal heath food.

Keywords: Seaweed, *Kappaphycus alvarezii*, Carrageenan, Value addition

Antimicrobial effect of seaweed, *Kappahycus alvarezii*

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Much attention is paid on the naturally available antimicrobial compounds due to adverse effects of synthetic antimicrobials. Seaweeds are considered as a source of several active compounds including antimicrobials. These compounds have been extracted to several organic solvents while methanol had been more effective in extracting. Number of studies conducted to evaluate antimicrobial effect of seaweeds, but less attention has been paid for evaluating antimicrobial effect of *Kappaphycus alvarezii*, especially in Sri Lanka. In this study, the antimicrobial effect of *K. alvarezii* was evaluated. The antimicrobial effect was evaluated against two types of bacteria: *Escherichia coli*, and *Staphylococcus aureus* and a fungi *Aspergillus niger*. Minimum inhibitory concentration of seaweed extract was determined for the bacteria species. Antifungal activity of the seaweed was compared with a commercially utilized fungicide. The antibacterial activities of the seaweed extract were tested by using agar disc diffusion method and zone of inhibition were measured to the nearest millimeter for each bacteria, after 24hours of incubation. Poisoned food technique was used to evaluate antifungal activity and the percentage of inhibition was calculated. Methanol was used for preparation of seaweed extract from seaweed powder. The zone of inhibition for the tested three concentrations of the extract ranged between 10-21mm for Staphylococcus aureus and 9-18mm for E. coli. The maximum activity (21mm) was recorded from 30% of the extract of *K. alvarezii* against *S. aureus* and minimum (9mm) was recorded by *E. coli*. The Minimum inhibitory concentrations of the Methanolic extract of *K. alvarezii* was established as 5% for *S. aureus* and 2.5% for *E. coli*. A significant inhibition of the mycelial growth of *A. niger* was observed with respect to the seaweed extract. The 20% and 30% of extract were shown better inhibition compared to the control and those two concentrations effectively inhibited the mycelial growth than commercially utilized fungicide. Even after five days, there was no any considerable mycelial growth of Aspergillus niger observed under 30% seaweed extract. The present study confirmed that the *K. alvarezii* has strong antibacterial and antifungal effects against all tested micro-organisms. The results indicate significant capacity and future scope for the use of seaweed against a wide range of microbial populations in food industry and agriculture. A detailed study should be done by using advanced separation techniques to find out the principal compound in the seaweeds which is responsible for antimicrobial activity.

Key words: Anti-microbial, *Kappaphycus alvarezii*, Methanol, Extract

Low salted dry fish production using herbal salt extracted from *Halosarcia indica* (willd.) Paul G. Wilson

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Halosarcia indica (willd.) Paul G. Wilson is an underutilized, freely available, medicinal herb widely distributed in coastal areas of different parts of the world. The plant is rich with sodium and other phytochemicals or secondary metabolites which can be easily extracted for human consumption. Even though, this plant has been reported by many authors, information on phytochemical contents and their sustainable utilization is lacking. On the other hand, high salt content of dry fish has been identified as one of the leading causes for cardiovascular diseases. Therefore, in the present study attempts were made to investigate the possibilities of extraction and utilization of sodium and phytochemical rich extract of *Halosarcia indica*, for low salted dry fish production as a value addition to dry fish industry. Herbal salt was extracted from *H. indica* and freeze dried. Low salted dry fish production was carried out using Oreochromis niloticus at four different salt concentrations (0%, 10%, and 15%) of normal and herbal salt. Treated Fish was oven dried at 60-70 oC for 14 hours. Dried fish were screened for physical, chemical and biological parameters including moisture content, salinity, pH, water activity (aW), sodium content, Total Volatile Nitrogen (TVN), microbial counts, yeast and mold count, crude protein content, crude fiber content, crude fat content, ash content, Total Phenolic Content (TPC), Total Flavonoid acid Content (TFC) and Total Antioxidant Capacity (TAC) and sensory attributes by using standard protocols. Results revealed that dried fish prepared with herbal salt exhibited the significantly higher TPC (3.44, SD 0.19) and TAC (2.77, SD 0.097) compared to the normal and the control. Moreover, herbal salt demonstrated the presence of significantly low sodium content, low microbial count and low water activity. In addition, herbal salt treated fish received high preference for color, taste, texture, appearance and overall attributes for consumer preference. According to the above results, it is clear that herbal salt extracted from *H. indica* demonstrate favorable physical, chemical, biological and sensory attributes of dry fish prepared using *Oreochromis niloticus* fish. Therefore *H. indica* can be effectively used for the production of value added, low salted high-quality fish as a cottage industry in *H. indica* growing areas of Sri Lanka.

Keywords: *Halosarcia indica,* Herbal salt, Total antioxidant capacity, *Oreochromis niloticus* dried fish

Feasibility of house hold level biogas generating system by utilizing fish and kitchen waste

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Poor waste management is one of the biggest environmental and social problems in the world as well as in Sri Lanka. Land filling is the usual method practiced to dispose waste. Waste generated in fishery industry is usually dumped to sea. Waste can be used for energy production by producing biogas. When fishery waste is used for biogas production, it is impossible to obtain maximum performance due to the presence of high proportion of nitrogen in fish waste. Fish waste should be incorporated with other waste rich in carbohydrate such as kitchen waste to reduce the proportion of nitrogen. The best ratio of fish waste to other carbohydrates rich waste is 1:1 in a batch type biogas production system. However, the effectiveness of biogas production by using fish waste as raw matter in continuous plug flow method is still unknown. This study was carried out to evaluate the effectiveness of biogas production by using fish waste as raw material in a continuous plug flow type biogas generating system. Four continuous type biogas generating systems were produced by using used chemical barrels with similar dimensions. Two of them were fed by 100% cow dung, as the control. Remaining two digesters were fed by 40% fish waste, 40% kitchen waste and 20% cow dung combination, as the treatment. All biogas production systems were provided the same conditions. The biogas production of each plant was measured daily for two months by using a manometer. Mean biogas production of control and treatment were calculated and the temporal variations were plotted. Maximum biogas production in treatment digesters and control were reached within 24 days and 11 days respectively. After reaching to the maximum biogas production limit, the biogas production of both was almost same. There was no significant difference in biogas production of the digester which was fed by 100% cow dung and the combination of fish waste (40%), kitchen waste (40%) and cow dung (20%).

Key words: Biogas, Fish waste, Kitchen waste, Bio-energy, Plug flow

Analysis of polycyclic aromatic hydrocarbons of firewood smoke used by indigenous communities

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Smoking is one of the oldest methods used to preserve and process fish and meat. Wood smoke is mainly used for fish smoking. Most of the wood smoke contains Polycyclic Aromatic Hydrocarbons (PAHs). The PAHs refer to a ubiquitous group of several hundred chemically-related, environmentally persistent organic compounds having various structures and varied toxicity. Various types of firewood are being used to generate smoke, which contains at least 100 PAHs and their alkylated derivatives. Smoked fish contain higher amounts of PAHs than raw fish. The aim of this study is to select the best firewood used by indigenous people for food smoking. Four commonly used wood species such as Mora (*Mora excels*), Kooratti (*Phyllanthu pollyphyllus*), Dikanda (*Pytaranthe verrucosa*) and Seru (*Premna tomentosa*) from Mahiyangana area were selected for the study. Moisture contents of the selected wood were determined by oven dry method. Solvent extraction method developed by Industrial Technology Institute was used to separate PAHs from smoke. For this purpose, solvent mixture of acetonitrile, acetone and toluene at a ratio of 6:3:1 was used to trap PAHs within one hour time duration in replicates. The PAHs in the samples were analyzed using Agilent 1260 Infinity High-performance liquid chromatography (HPLC) equipped with a quaternary gradient pump, diode array and fluorescence detectors and thermo stated column compartment. The moisture content of Dikanda wood was ranged from 9.60 (SD 0.002) and the moisture content of Seru wood ranged from 10.00 (SD 0.001). Napththalene, fluorene, pyrene, phenanthrene, anthracene, fluoranthene, chrysene, benzo (a)anthracene, benzo (a) pyrene, benzo (b) fluoranthene, and benzo (k) fluoranthene was identified in the smoke of the wood tested. Among them, fluoranthene was most abundant PAH in the smoke of all selected woods. Respective quantities of fluoranthene in Dikanda, Mora, Seru, and Kooratti smokes were 160.48ppm, 69.87ppm, 44.56ppm and 42.95ppm respectively. Fluoranthene is less carcinogenic of PAHs.Considering the types and respective amount of PAHs in selected wood smoke. Cooratti has the lowest level of PAHs based on PAHs levels in smoke.

Key words: Fish smoking, Polycyclic aromatic hydrocarbons, Smoked food

Toxin extraction from freshwater catfishes; *Heteropneustus fossilis* and *Mystus keletius* and its effect on nauplius larvae and fish fry

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Sri Lanka is rich in freshwater fish fauna with 115 species, which includes 50 endemic, 41 native and 24 exotic species. Some freshwater fish species like freshwater catfish have sharp spines on their dorsal and pectoral fins, which have glands that secrete toxic venom. Only a little information is known about toxins of local catfishes and as such, there is a lack of studies on toxin extraction. The purpose of this study was to extract toxin from some toxic freshwater catfishes (*Heteropneustus fossilis* and *Mystus keletius*) and to evaluate the toxic effect on Nauplius larvae of *Artemia* and fry stage of guppy, and swordtail fish. Fish samples were collected from Pavatkulam reservoir located in Vavuniya District. Collected fish samples were frozen (-20 ºC) until use. The head, organs, and fin parts were separated from frozen samples and separated parts were individually chopped and then were homogenized with acetic acid and distilled water separately. Homogenized samples were centrifuged and their respective supernatants were collected. Collected supernatants were warmed up-to 95 ºC and then filtered using filter paper. The filtrate was labeled as the toxin extract. Different concentrations (0%, 25%, 50%, 75%, and 100%) of toxic extracts were made and fish larvae (*Xiphophorus hellerii* and *Poecilia reticulate*) and Artemia larvae were put into these solutions separately. Their reactions and time periods for mortality were noted. Data entering and analysis was done using Microsoft Excel and SPSS software. In the case of Artemia nauplii, the organ extract of *Mystus keletius* had a greater effect when compared to its head and fin extracts. On the other hand, the head extract of *Heteropneustus fossilis* was more toxic than the other two extracts. With guppy (3-4 days old) and swordtail fish (4-5 days old) larvae, head extract of both *Mystus keletius* and *Heteropneustus fossilis* had the greater toxicity. Results indicate that the toxicity of *Mystus keletius* extracts was higher than that of *Heteropneustus fossilis* extracts.

Keywords: Freshwater, Catfish, *Heteropneustus fossilis*, *Mystus keletius*, Toxin, Artemia, Fish larvae

Dynamics of water quality and vegetation in Maila Wewa reservoir of Wilpattu national park, Sri Lanka

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The irrigation works in ancient Sri Lanka, the earliest dating from about 300 BCE, in the reign of King Pandukhabaya and under continuous development for the next thousand years, were some of the most complex irrigation systems of the ancient world. Reservoirs are influenced by a set of hydrologic conditions such as watershed, the shape of the reservoir basin, the reservoir water and the bottom sediments. These physical and chemical components, in turn support a community of organisms that is unique to reservoir environment. The biota enriches the complexity of reservoir[2]. Wilpattu National Park consist many such tanks but getting dry at drought creating more tough situations for animals in the national park. As many such tanks have a limited water capacity, cannot be expand more. Anyhow, Maila Wewa Reservoir (08° 24′ 090′′ N, 080° 00′ 660′′ E) which is located in Wilpattu National Park, has found to be possible to excavate to uphold the water holding capacity. But reservoir restoration could deal with the eutrophication process, restoration and management need to be done with minimal disturbance. Therefore, any restoration process requires baseline data to understand pre and post restoration changes. Hence, this study attempted to establishe baseline data for Maila Wewa Reservoir. Three representative areas of reservoir (open water area, total Salvinia cover and mixed vegetation area) were selected to lay transects over the reservoir and 0.5m*0.5 m quadrates were laid systematically in entire reservoir along the line transects for vegetation analysis. Surface and bottom (50cm) water samples were taken with two replicates. Bottom characteristics of the reservoir were recorded. Soil pH, moisture content, bulk density and organic content of the soil samples were measured by using soil pH meter, standard dry weight volume method, standard oven dry method and Walkly Black method respectively. Samples were drawn to measure water and soil parameters with three replicates. Percentage cover of vegetation was estimated.
Collected data were measured with the 0.05 significant levels in SPSS 16.0 software. Only Salvinia and an aquatic grass was found along the transects. However, most of the salvinia were dead. The percentage cover of vegetation along the three representative areas of the reservoir was not significantly different. When consider soil analysis 0.157, 0.855, 0.051 and 0.181 were the respective p values for moisture content, organic content, bulk density and soil pH. None of the values are less than 0.05 So, there is no significant difference between analyzed soil samples in different quadrates.

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[2]Olem. H, Flock. G, (1990), Eds. Lake and Reservoir Restoration Guidance Manual.02nd Edition. EPA 440/4-90-006.Lake Management Society for United States Environment Protection Agency, Washington, DC.

Keywords: Live salvinia, Dead salvinia, Unidentified grass, Water

Ginger (*Zingiber officinale,* Roscoe) oleoresin for carbonated beverage by ethanolic extraction

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Ginger is a well-known spice used as a flavoring agent in various foods and beverages. As the chemical composition responsible for the characteristic pungency of ginger varies with the agronomical factors, extraction methods and processing factors, to ensure the uniformity within the products in terms of flavor, ginger oleoresins are widely used. Studies revealed various extraction methods of oleoresin. But some of these methods are limited in the industrial process because of their high technology. Therefore, it is important to find a simple technology for oleoresin extraction and determine its applicability to food and beverages. Solvent extraction is considered as a cheap and safe way for oleoresin extraction. Thus, this study focuses on evaluating the suitability of local ginger (Siddha ginger) oleoresin obtained by ethanolic extraction for carbonated beverages.

The study consisted of determination of most suitable conditions for oleoresin extraction, analysis of oleoresin for physiochemical and functional properties, preparation of ginger beer, determination of the optimum formula for ginger beer, physicochemical, functional and microbiological properties and shelf life of optimum formula. Extraction was carried out with three different ethanol concentrations (70, 80 and 95%) at three different temperatures (31, 45 and 55°C). Extraction with water served as the control. Oleoresins were subjected to examining their functional properties; total phenolic content (TPC)quantified by Folin-Ciocaltue Assay, total flavonoid content (TFC) quantified by the aluminum chloride colorimetric method, and antioxidant activity (% inhibition of DPPH radicals). A sensory analysis was conducted to identify the acceptable proportion of oleoresin to be incorporated in the formulation.

Oleoresin extracted with 80% ethanol at 45°C showed the highest functional properties (TPC 20.04 GAEmg/g of oleoresin (SD 7.33), TFC 6.90 Rutin equivalents mg/g oleoresin (SD 0.40) and percentage inhibition of DPPH radicals 68.68% (SD 0.09). Oleoresin that was incorporated to the formula had13.21 mg/g of oil content. The sensory analysis showed that 0.6% (v/v) oleoresin incorporated formulation attained the desired sensory attributes and it had the minimum of one month of shelf life at refrigerated conditions. Further, the developed formula had total plate count of 2CFU/mL and zero yeast and mold count.

Thus, it is concluded that there is a possibility to develop a ginger beer with desired sensory attributes using natural ginger through ethanolic extraction with 80% ethanol at 45°C. Further studies are needed to increase the yield of oleoresin while preserving its functional properties.

Gunathilake. K.D.P.P and Rupasinghe. H.P.V. (2014). Optimization water based-extraction methods for the preparation of bioactive-rich ginger extract using response surface methodology. *European journal of medicinal plants,* 4(8), pp. 893-908.

Keywords: Ginger, Oleoresin, Ethanolic extraction

Effect of postharvest application of silicon on 'Embul' banana

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'Embul' (AAB) banana is one of the most popular fruits in Sri Lanka and the predominant cultivar grown for the domestic market. It causes severe postharvest losses during different phases of the postharvest handling chain[1]. Anthracnose is a major postharvest disease in banana caused by the fungus *Colletotrichum musae*. The control of anthracnose diseases in banana fruits relies mainly on the use of synthetic fungicides. Therefore, there is an urgent need for an alternative control strategy (Khleekorn *et al.* 2015). Silicon (Si) has proven to enhance disease resistance in a wide range of tropical fruits and vegetables while extending the shelf life. Therefore, this study was carried out to investigate the effect of the postharvest application of silicon on, post-harvest quality traits (pH, TSS, %TA and firmness) anthracnose disease development and shelf life of the banana.

Mature green bananas were washed with 0.5% chlorox solution for one minute and followed by distilled water. The bananas were separately dipped in different concentrations (0, 1000, 2000, 3000, 4000, 5000 and 6000 mg/L) of sodium silicate (Na_2SiO_3) solutions for 20 minutes and allowed to air dry. A suspension of (105–106 conidia per mL) *C. musae* was prepared by using 5-6 days old pure cultures. Each banana was inoculated by placing drops of (25µl) conidia suspension at three different places along the longitudinal axis of each banana. Inoculated fruits were maintained in moist chambers (95-100% relative humidity at 28°C, SD 2). The average lesion diameter (cm) was measured for each banana.

There was no significant difference in pH, TSS and titratable acidity and firmness of the fruits treated with silicon compared to untreated control fruits. The mean lesion diameter was lowest in fruits treated with 5000mg/L sodium silicate and the highest mean lesion diameter was attained by untreated control fruits. However, there was no significant difference ($p < 0.05$) in disease development in silicon treated fruits compared to untreated control fruits. The shelf life was increased by 2-3 days in fruits treated with 5000mg/L sodium silicate solution compared to control. Postharvest dip treatment at 5000mg/L sodium silicate has reduced the anthracnose disease development and increased the shelf life of the fruits.

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Keywords: Anthracnose, Banana, Shelf life, Sodium silicate

Incorporation of pineapple bagasse for value addition to bakery product

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Pineapple (*Ananas comosus* L.) is a popular and fifth major cultivated fruit in Sri Lanka. During the industrial fruit processing, 70-80% of waste generated from the pineapple fruit including peel (40%), bagasse (23%), stem and crown (14%). The purpose of this study was to incorporate pineapple bagasse powder (PBP) as an ingredient to bakery product to enhance the functional value.

The pineapple bagasse was collected from fruit processing company, dehydrated at 55-60°C for overnight and powdered to obtained PBP (425μm). The water holding capacity (WHC) and oil holding capacity (OHC) of prepared flour were 5.14mL/g and 6.48g/g respectively and the water activity was 0.38. The dry PBP has higher total dietary fiber content as 33.70g/100g. Muffin was prepared in different PBP and cake flour ratios (0:100, 5:95, 10:90, 15:85 and 20:80) in commercial scale. The prepared muffin samples were subjected to physicochemical, sensory and functional property analysis. The proximate composition was not significant in muffin samples, except dietary fiber content was increased from 0.76 to 4.96g/100g in dry basis with the level of PBP addition. The 5% substituted muffin got the highest mean score for flavor (2.22) and overall preference (2.24) over 80 untrained panelists. In texture profile analysis, gumminess and cohesiveness were gradually reduced with the high level of PBP addition. However, crumb and crust color got more darken with the level of PBP addition based on chromo meter data. The lowest pH and height was obtained in 20% PBP added muffin but the total phenolic content was maximum (67.14mgGAE g^{-1} FW).

In conclusion, the preparation of bagasse powder using industrial fruit waste can be composite with soft wheat flour up to 5% in bakery industry through the enrichment of 2.02g/100g dietary fiber. Since value addition of bakery product simultaneously give economically viable solution for the industrial fruit waste.

Keywords: Bagasse, Bakery industry, Dietary fiber, Muffin, Pineapple processing

Value added food product development using *Pterygoplichthys* spp. fish

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Sailfin catfish (*Pterygoplichthys* spp.) is a popular ornamental fish which has been intentionally introduced to the freshwater bodies due to the negligence of aquarium industry. Since there is no natural predator, the population has increased immensely making it an alien invader in Sri Lankan fresh water bodies. Sailfin catfish accounts in significant number in daily gill net catch in freshwaters; but due to the appearance, difficulty in processing and low flesh yield this fish has no market value. With this background, the study was conducted to produce a fish loaf as a value-added product which can easily be processed and consumed by local consumers while indirectly establishing a market value for sailfin catfish.

The fish samples were collected from the Daduru Oya reservoir, North Western Province, Sri Lanka during March to June 2017. Initially, selected morphometric measurements of the fish were measured. Then the initial microbial count (SLSI 516, 2013) and proximate composition (AOAC, 2000) were measured in the fresh fish fillets. The product development using the fillets was carried out in two stages. During the first stage, the suitability of different flour types using chick pea flour, soy flour and wheat flour was tested while the best fish: flour ratio, by adding 10%, 15% and 20% flour was tested during the second stage of the product development. The final product, the fish loaf was developed combining the above results and the best formula was determined by a sensory test. Microbiological quality and proximate composition of the final product were reassessed. The shelf life of the final product was determined by packing it in a vacuum bag and storing it at -18^{o}C for a period of 4 weeks.

The average dressing percentage of this fish was 23.15% (SD 1.13). The flesh weight was highly correlated with the total weight of the fish in which the Pearson correlation coefficient was 0.91000. The microbiological quality of the fresh fillets was in the acceptable range for human consumption while the significant nutrients were crude fat 3.36% (SD 0.17) and crude proteins contained 10.36% (SD 0.28). According to the sensory results, the best formulation for the final product was developed by incorporating 20% soy flour and 80% fish. The product contained 3.21% (SD 1.14) of crude fat 6.77% (SD 0.01) of crude protein, 2.15% (SD 0.13) of crude fiber, 7.46% (SD 0.66) of carbohydrate. Per 100g of fish loaf production, total ingredient cost was Rs.38.21. In conclusion, the organoleptically acceptable fish loaf can be developed from locally available tank cleaner fish with minimum 4 weeks shelf life without adding any synthetic preservatives.

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Keywords: Freshwater fish, Morphometric measurements, Proximate composition, Tank cleaner fish, Value addition

Physicochemical evaluation in the development of palmyrah and pineapple mixed fruit toffee

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Palmyrah fruits have excellent chemical and physical properties for the development of food and beverages. Unfortunately, palmyrah fruit pulp contains slightly bitter taste. Pineapple contains slightly acidic pH and emits a sweet aroma which has the ability to mask the bitterness of palmyrah fruit pulp. The toffees are highly acceptable confectionery products preferred by almost all the age groups as a snack for quick energy. Therefore, the main objective of the investigation was to develop a method to produce a consumer acceptable palmyrah and pineapple mixed fruit toffee. Five different compositions of toffee were developed by using palmyrah and pineapple pulp at 100:0, 80:20, 60:40, 40:60, and 20:80 ratio respectively. Two different types of toffee (hard toffee and soft toffee) were developed by adjusting the ingredients and Brix value. The final formulations were evaluated by using 20 untrained sensory panelists using 5 points hedonic scale. The hard toffee and soft toffee which contained 60% Palmyrah fruit pulp and 40% pineapple pulp were selected. Controls for both toffee types were developed by using only pineapple pulp and all the toffee types were evaluated for proximate composition, physicochemical, functional properties and microbial count. Nutritional composition of soft toffee and hard toffee were compared with the pineapple toffees without palmyrah fruit pulp (controls).

Table: Proximate composition of developed fruit toffees

Composition (%)	Hard toffee	SD	Hard toffee control	SD	Soft toffee	SD	Soft toffee control	SD	P value
Total sugar	63.51	2.64	67.46	1.99	42.45	1.01	11.70	0.21	0.000
Reducing sugar	6.49	0.05	6.83	0.82	5.21	0.19	5.12	0.13	0.002
Moisture	6.26	0.09	7.31	0.10	9.35	0.19	11.70	0.21	0.000
Protein	4.40	0.03	4.35	0.07	1.77	0.02	3.23	0.07	0.000
Fiber	1.53	0.23	0.92	0.10	1.94	0.23	1.01	0.12	0.001
Fat	8.61	0.25	7.99	0.10	14.43	0.06	14.60	0.26	0.001
Potassium	0.29	0.00	0.33	0.00	0.28	0.00	0.18	0.00	0.000
Sodium	0.21	0.00	0.32	0.01	0.35	0.01	0.17	0.00	0.000

Total phenolic content of hard toffee and soft toffee and their controls were 589.19 (SD 6.79), 621.15 (SD 8.29), 318.49 (SD 1.75), 331.16 (SD 7.56) µg Gallic acid equivalent/g respectively. DPPH radical scavenging capacity of prepared hard toffee and soft toffee and their controls were1.28 (SD 0.07), 2.57 (SD 0.19), 1.48 (SD 0.34), 2.59 (SD 0.07) µmol of Trolox equivalent/g respectively. The microbiological evaluation showed that the prepared fruit toffees were safe for consumption until six weeks from the week when the product was developed because they did not show any growth of bacteria, yeast and mold. The developed hard toffee and soft toffee were showed better quality in the analyzed properties than the pineapple toffees without palmyrah fruit pulp.

Keywords: Hard toffee, Mixed fruit toffee, Palmyrah, Preserved pulp, Soft toffee

Alpha amylase and alpha glucosidase inhibition activity and heavy metal accumulation of selected seaweed species in Sri Lanka

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Diabetes Mellitus is a metabolic disorder characterized by high blood glucose level caused due to deficiency of insulin secretion or insulin action[1]. The inhibition of carbohydrate hydrolyzing enzymes such as α-amylase and αglucosidase can be an important strategy in the postprandial blood glucose level in patients with type II diabetes. Seaweeds contain different chemical constituents with potential for inhibition of α-amylase and α-glucosidase and hence may be used as therapeutic. Eleven species of red, green and brown algae of seaweed groups were tested for α-amylase and α-glucosidase enzymes inhibitory effects. Different concentrations (5, 10, 50, 100, 500, 1000, 2000 ppm) of methanol extracts were incubated with enzyme substrate solution and the activity of the enzyme inhibitions was measured whilst Acarbose was used as the standard inhibitor. In order to evaluate the suitability of those seaweeds for consumption, all the samples were analyzed for the heavy metals (Al, As, Cd, Co Cr, Cu, Mn, Ni, Pb and Zn) using ICP-OES (Inductive Coupled Plasma - Optical Emission Spectrometer). All the seaweed species tested, did not show any response to inhibition of αglucosidase. The highest αamylase inhibitory activity was demonstrated by *Gracilaria corticata* (IC_{50} value 265.525mg/L), while *Caulerpa racemosa* (285.612) > *Cladophora herpestica* (353.792) > *Turbinaria ornata* (354.981) > *Sargassum cinereum* (360.859) > *Pterocladiella caerulescens* (1253.514) > *Padina antillarum* (1299.464) > *Ulva rigida* (1902.207) > *Gelidiopsis variabilis* (2687.222) > *Codium tomentosum* (3778.065) respectively, when compared with Acarbose (IC_{50} value 0.004mg/L). Hence, all the eleven-seaweed species tested exhibit a significantly ($p < 0.05$) low αamylase inhibitory activity than Acarbose. In heavy metal testing, Co concentration was significantly ($p < 0.05$) higher in *Caulerpa racemosa, Sargassum cinereum* and *Turbinaria ornata* species whilst concentration of Cu and Pb concentrations were significantly higher in *Ulva rigida, Caulerpa racemosa, Gracilaria corticata, Sargassum cinereum* and *Turbinaria ornata*. Average concentrations of Al, As, Cd, Cr, Mn, Ni and Zn were significantly higher in all the tested seaweed species than the World Health Organization standard levels of those elements.

[1]WHO, 2006. Global Strategy on Diet, Physical some Activity and Health, Annual Report, Geneva, Switzerland. pp: 1-2

Keywords: α-amylase, α-glucosidase, Enzyme, Heavy metals, Seaweeds

Assessment of Amino acid profiles and proximate compositions of commercially available local dried fish in Negombo, Sri Lanka

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This investigation was carried out to assess the amino acid profiles and proximate composition of two selected commercially available local dried fish species; skipjack tuna (*Katsuwonus pelamis*) and Indian scad (*Decapterus russelli*). Samples were purchased from different local dried fish producers at fish processing and marketing land Negombo, Sri Lanka. Sixteen, essential and non-essential amino acid were identified from both dried fish species. The essential amino acids were Isoleucine, Leucine, Methionine, Phenylalanine, Tyrosine, Threonine, Tryptophan, Valine, and Histidine. The non-essential amino acids were Aspartic acid, Glutamic acid, Serine, Arginine, Alanine and proline.

Glutamic amino acid was the most predominant amino acid in both species; skipjack tuna (1.88%, SD 0.028) and Indian scad (1.907%, SD 0.07). The least available amino acid in skipjack tuna and Indian scad were arginine (0.107%, SD 0.013) and threonine (0.067%, SD 0.003) respectively. Amino acid compositions of both dried fish species were not significantly different ($p < 0.05$). Amino acid compositions dried fish of both species, were significantly different ($p < 0.05$) from that of fresh fish. Essential amino acid (EAA) concentrations of both dried fish were scored compare to FAO/WHO standards of EAA concentrations. All EAA scores were below 15%. Phenylalanine had the highest EAA score (15.41%) while lysine (1.05%) having the lowest in skipjack tuna. In the proximate analysis, moisture, crude protein, salt and TVB-N contents were analyzed and they were not significantly different in both dried fish. The crude protein contents of skipjack Tuna and Indian scad were 42.83% (SD 2.04) and 43.04% (SD 5.16) respectively. While, the TVB-N contents of skipjack tuna and Indian scad were 85.00mgN/100g (SD 2.06) and 43.04mgN/100g (SD 5.16) respectively. The salt content of Skipjack Tuna was 16.12% (SD 2.53) and it was 17.22% (SD 3.00) in Indian scad. The moisture content of skipjack Tuna and Indian scad were 44.17% (SD 4.07) and 44.193% (SD 1.57) respectively.

Keywords: Amino acid composition, Dried fish, Fish salting, Protein quality

Validating Torrymeter by chemical, microbiological and organoleptic methods using *Katsuwonus pelamis*, *Decapterus russelli* and *Lethrinus nebulosus*

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Fish is a major protein source consumed by Sri Lankans. Best keeping quality or freshness retains the nutritional quality of fish and it is essential as a marketing tool. Freshness destroys mainly due to poor handling practices, inappropriate storage conditions, and physiological changes like rigor-mortis. The freshness of fish can be determined by microbiological, chemical, organoleptic and rapid sensing instruments. Traditional methods were improved with the knowledge leading to chemical and microbial analysis and technological innovations initiated sensor instruments. The present study was carried out for validation of Torrymeter as a quick, easy and non-destructive method of fish freshness determination in Sri Lankan context. Although Torrymeter is a sensor tool that can measure fish freshness quickly no studies have been carried out in Sri Lanka about its confirmation. Torrymeter readings were compared with chemical, microbiological and organoleptic fish freshness evaluation methods. Skipjack tuna (*Katsuwonus pelamis*), Indian Scad (*Decapterus russelli*) and Spangled emperor (*Lethrinus nebulosus*) were obtained from local fish markets and kept in chill condition for seven days in ice. Obtained Torrymeter measurements (Model 14-10949) for the fish samples were compared with Total plate count (TPC), Total Volatile Base Nitrogen content(TVB-N) and Organoleptic Quality Index Method (OQIM) values of the same.

Torrymeter, TPC, TVB-N, and OQIM indicate accurate freshness for all species separately. Chi-square test of Analysis of variance for *Lethrinus nebulosus* showed a correlation coefficient with TPC, TVBN, and OQIM in 0.4576, 0.8129, and 0.8783 that corresponds 85.7%, 85.7% and 85.7% equality with Torrymeter respectively. In *Decapterus russelli* it was obtained as 85.7% (TPC), 96.2% (TVBN) and 85.7% (OQIM). *Katsuwonus pelamis* showed poor correlation 0.1968 (TPC), 0.3557 (TVBN) and 0.3154 (OQIM) that corresponds with 1%, 2.4% and 2.9% respectively for the same with Torrymeter values. The reason would be the fishes obtained from multi-day boats and testing started for fishes which have already spent certain days after catching. The study confirmed that use of Torrymeter as a quick, easy and non-destructive method of fish freshness determination can be done in Sri Lankan context.

Keywords: Fish, Freshness, QIM, Torrymeter, TVBN

Effect of cooking methods on Eicosapentaenoic acid and Decosahexaenoic acid content of three fish species (Yellowfin Tuna, Sword fish, and Spotted Sardinella)

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Fish is a food of high nutrition value. The retention of nutrition value of the fish mainly depends on the way of fish processed for consumption. Cooking (wet heat processing) is the main fish processing method in Sri Lanka. Among important nutrients, fish fatty acids are highly susceptible to change during cooking. In previously published literature, a few researches have investigated the effect on Eicosapentaenoic acid (EPA) and Decosahexaenoic acid (DHA) content in frequently consuming fish species by commonly practicing cooking methods by Sri Lankans. The purpose of this research is to study the effect of three cooking methods (Kirata, Mirisata and Ambulthial) on EPA and DHA content of Yellowfin tuna (*Thunnus albacares*), Sword fish (*Xiphias gladius*) and Spotted Sardinella (*Amblygaster sirm*).

Fish samples were collected from the Negombo Fish Market. Eleven samples were selected for each fish species and half of a sample was kept in raw state and other half was cooked under three cooking methods; Kirata, Mirisata and Ambulthial. Fatty acids were extracted from raw and cooked samples by using Bligh and Dyer method and converted to methyl esters by acid crystallized esterification method. Extracted samples were analyzed by gas chromatography using standards. Samples cooked by Ambulthial method had the highest increase in EPA % and the highest increase in DHA% compared to the samples cooked by Kirata and Mirisata methods.

Table: The EPA % and DHA % of raw and cooked samples for three fish species

Fish species	EPA %			DHA %		
	Kirata	Mirisata	Ambulthial	Kirata	Mirisata	Ambulthial
Spotted Sardinella						
Raw	1.69 ± 0.40	1.11 ± 0.44	1.50 ± 0.12	0.66 ± 0.22	3.64 ± 0.25	0.07 ± 0.01
Cooked	0.88 ± 0.05	1.10 ± 0.16	1.77 ± 0.10	0.00 ± 0.00	3.60 ± 0.40	0.13 ± 0.02
Sword fish						
Raw	5.65 ± 0.78	2.43 ± 0.95	3.65 ± 1.98	0.07 ± 0.01	0.14 ± 0.03	0.30 ± 0.03
Cooked	5.03 ± 1.96	2.26 ± 0.08	3.89 ± 0.29	0.07 ± 0.02	0.06 ± 0.01	0.60 ± 0.21
Yellowfin tuna						
Raw	0.40 ± 0.11	0.17 ± 0.02	1.50 ± 0.13	0.34 ± 0.12	0.01 ± 0.00	0.19 ± 0.02
Cooked	0.48 ± 0.18	0.00 ± 0.00	1.85 ± 0.05	0.35 ± 0.16	0.00 ± 0.00	0.64 ± 0.21

Keywords: Fatty acid, Gas chromatographic analysis, Spotted sardinella, Sword fish, Yellow fin tuna

Functional and physicochemical properties of hibiscus incorporated black tea

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The flower of *Hibiscus rosa sinensis* plant, well known as "Pokuruwada mal" is an indigenous edible flower in Sri Lanka. Clinical studies have revealed its therapeutic effects on selected diseases such as "raktapradara"; a disease co-related with menorrhagia in modern medicine[1]. A key improvement in the food industry is increasing sustainability and add value to the foods which are claiming health benefits. In this study, dried hibiscus flower powder was incorporated with selected two Ceylon black tea brands (X and Y) to increase the popularity among people. A sensory evaluation was conducted for both brands using 18 semi-trained panelists. From 25%, 37.5%, 50% and control, 25% hibiscus incorporated black tea was selected as the best combination. Physiochemical and functional properties were determined to the best consumer acceptable ratio. Radical scavenging activity of sample extracts was determined based on the percent inhibition of DPPH. Total Phenolic Gontent (TPC) were estimated based on the Folin–Ciocalteu method, while the pH differential method and aluminum chloride methods were employed to estimate Total Anthocyanin Content (TAC) and Total Favonoids Content (TFC)in the sample extracts, respectively. Color analysis was performed using Image J software. Moisture content, ash content and pH were determined by physicochemical properties.

Results showed TAC (mg/100g of fresh matter) for infusion of 25% hibiscus incorporated X black tea/Y black tea and X/Y black tea alone were 461.18 (SD 9.53), 329.30 (SD 4.00), 41.41 (SD 1.33) and 115.33 (SD 3.21) respectively. Red color index (%r) for infusion of 25% hibiscus incorporated X black tea/Y black tea and X/Y black tea alone were 57.17 (SD 0.82), 4626 (SD 0.26), 68.77 (SD 0.75) and 62.36 (SD 136) respectively. TAC and TFC were significantly different between 25% hibiscus incorporated black tea and black tea alone for both brands separately. No extract was significantly different for TPC, DPPH radical scavenging assay, TAC, ash and moisture with controls respectively. As a conclusion, TAC was increased in hibiscus incorporated black tea than black tea alone and red color index (%r) of 25% hibiscus incorporated X/Y black tea was lower than X/Y black tea alone. These results indicate the potential of exploiting this flowers as a source to develop novel functional beverage while using as a natural colorant.

[1]Kumara GUA, Thisera MHA and Wakkumbura HP, (2014), Clinical study on the efficacy of *Hibiscus rosasinensis Linn* (Ratupokuruwada mal) for Asrugdhara 1st international symposium on traditional medicine, Gampaha Wickramaarachchi Ayurveda Institute, University of Kelaniya, Sri Lanka.

Keywords: Antioxidant, Black tea, Hibiscus incorporation, Pokuruwada mal

Effect of thermal treatments and packing materials on the quality of Sri Lankan bee honey

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Honey is a sweet and viscous fluid produced by honey bees (*Apis cerana*) This natural complex food product is produced from the nectar of flowers and secretion of living parts of plants or excretion of plant sucking insects. High moisture level (>21%) increases the yeast count in honey and deteriorate the quality by fermentation. Therefore, many local bee honey producers practice uncontrolled heating to increase the shelf life. Uncontrolled heating results hydroxy methyl furfural which is having potential health hazards including cytotoxicity and genotoxicity. The best heat treatments and packing materials required to process Sri Lankan bee honey are not adequately studied. Therefore, the research was conducted to determine the effective thermal treatments and packing materials on the quality of Sri Lankan bee honey.

Red gum honey, rubber honey and wild honey samples belonging to the June-August honey harvesting period, 2016 were used for the research. Three different heat treatments (water bath heating, steaming, micro wave heating) and three different packaging materials (glass bottles, spout pouches, plastic bottles) were evaluated during the study. In water bath and steaming treatments, heating was done to 55°C for 15 minutes (treatment 1) and 65°C for 10 minutes (treatment 2). In a microwave, honey was heated to 180 power level for 30 seconds (treatment 1) and 180 power level for 60 seconds (treatment2). The moisture content, pH, free acidity, yeast count were determined according to methods given by International Honey Commission 2009, while the HMF content was measured using HPLC according to Jayasinghe *et al.*, (2012). The samples from all honey types were heat treated, cooled and stored in different packaging materials and the above quality parameters were measured in every two weeks interval up to two months.

The results revealed that the highest percentage moisture reduction in red gum honey was recorded by microwave heat treatment 2 reaching 19.22% (SD 0.22). In rubber honey, it was 19.55% (SD1.15) by microwave heat treatment 2 and of wild honey, the highest reduction was given by microwave heat treatment 2 reaching 16.2% (SD 0.9). In all three types of honey, the yeast count was significantly reduced by 95% ($p<0.05$) by microwave heat treatment 2. The lowest HMF content was recorded as 14.5ppm (SD 0.71) in red gum honey with 33.37ppm (SD 0.66) in rubber honey and 39.43ppm (SD 1.13) in wild honey by microwave heat treatment 2. Acidity, pH and r% of the colour were not significantly different ($p>0.05$) between heated and unheated honey samples. There were no significant differences ($p>0.05$) of moisture content, HMF, pH, acidity and colour of the honey with the packaging materials. When considering about results lowest moisture content (<21%) and HMF content (<80ppm) and highest yeast reduction (<500cfu/ml) were given by the microwave heat treatment 2. In conclusion, the suitable heat treatment is microwave heat treatment (180 power level for 60 seconds) for the three types of bee honey.

Keywords: Bee honey, Hydroxy methyl furfural, Fermentation, Heating

Extraction and characterization of chitosan from *Portunus pelagicus* crab species and evaluation as an additive for crackers

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Chitosan is a poly aminosaccharide obtained by the deacetylation of chitin[1]. Since the biodegradability of chitin is very low, accumulation of shell fish discards has become a major concern in the seafood processing industry[2]. Also, chitosan has been of interest in the past few decades due to their potential broad range of food industry applications as edible films, antimicrobial agents, preservative agents, acidification and clarification agents. However, only limited attention has been paid to bakery industry applications of these versatile biopolymers. So utilization of chitosan as an additive for crackers is important due to its health benefits. The study was carried out to investigate the extraction and characterization of chitosan from crab species *Portunus pelagicus* using the conventional methods consists of deproteinization, demineralization, decolorization, and deacetylation. The extracted chitosan was evaluated for its physicochemical and functional properties compared to commercial chitosan. Crackers were prepared with incorporation levels of chitosan 5%, 10%,15% and 20%. Sensory evaluation was conducted using 30 untrained sensory panelists to select the best proportion that could be incorporated. The extracted chitosan contained moisture 0.91% (SD 0.02), protein 9.88% (SD 0.07), ash 1.72% (SD 0.29) and fat 0.08% (SD0.001). Physicochemical and functional properties of chitosan include degree of deacetylation 65%, bulk density (untapped) 0.17gmL^{-1}, water binding capacity 617.33% (SD 46.52), fat binding capacity 367.73% (SD 29), viscosity 148Cp (SD 4), viscosity average molecular weight 180kDa and solubility 76.93% (SD 8.79). Ferric reducing power and total antioxidant capacity of chitosan were 0.84mg ascorbic acid equivalent (AAE)/g of dry weight and 0.21mgAAE/g of dry weight respectively. IC50 of DPPH radical scavenging ability of extracted chitosan was 638.14mg/L. Cracker with 10% chitosan incorporated obtained the highest mean rank for overall acceptability from the sensory test. Results revealed that chitosan can be extracted from crab shells about 15% yield using the chemical method and extracted chitosan has properties in the range values in the literature although it has some deviations from the commercial chitosan. In conclusion, 10% of crab chitosan can be incorporated to crackers to have a tastier snack.

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[2]Shahidi F., Arachchi J.K.V., Jeon Y.J. (1999). Food applications of chitin and chitosan. *Trends in Food Science and Technology*,10, PP 37 -51

Keywords: Chitosan, Crab shells, Crackers

Optimization of palmyrah fruit pulp jam

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Palmyrah fruits comprised of excellent chemical and physical properties which are beneficial for human health. As it is seasonal, it cannot be utilized throughout the year due to lack of post-harvest processing and preservation practices. Consumer demand for existing Palmyrah jam is low due to the facts that the characteristic palmyrah taste is totally absent in the jam as a result of the effort to mask the characteristic bitterness of palmyrah and no information about the nutrient profile is available. Hence an urgent need has risen to optimize the palmyrah pulp jam. So, this study was designed to find a new formulation and to improve the quality of palmyrah jam in the points of nutrient content and SLS requirements through optimization. Freezing and heating techniques were used to reduce the bitterness of pulp. Orange, tomato, tamarind, and pumpkin were selected as the bitterness masking substances at the level of 20% and 30%. Sugar percentage was optimized at two levels (55% and 75% in pulp weight). Sensory evaluation was carried out using a five-point hedonic scale. The jam optimized with 20% orange and 55% sugar in pulp weight was recorded as the best formulation. The finalized product was stored at the refrigerated and non-refrigerated condition. Functional properties (total phenolic content and DPPH radical scavenging capacity), proximate, physicochemical and microbial analysis were conducted for finalized products. Optimized jam at refrigerated condition contained 35.01% moisture, 44.69% total sugar, 32.63% reducing sugar, 0.80% protein, 0.89% ash, 1.35% fiber, 139.87mg/100g sodium and 124.03mg/100g potassium. Optimized jam at non-refrigerated condition contained 34.45% moisture, 42.63% total sugar, 32.53% reducing sugar, 0.71% protein, 0.81% ash, 1.31% fiber, 135.41mg/100g sodium and 118.71mg/100g potassium. The titratable acidity of optimized jam at refrigerated and non-refrigerated condition was 0.93% and 0.96% respectively in terms of citric acid. Total soluble solid of optimized jam at refrigerated and non-refrigerated condition was 65.52^{0}Brix and 65.94^{0}Brix respectively. The optimized jam at both refrigerated and non-refrigerated conditions did not show any growth of yeast and mold and bacteria throughout the shelf life study of 8 weeks. In conclusion, the optimized palmyrah fruit pulp jam showed better quality in the analyzed properties and it was accepted more than the commercially available jam in the sensory evaluation.

Keywords: Bitterness, Freezing, Palmyrah jam, Preserved pulp

Postharvest shelf life extension of coated giant guava using an appropriated dosage of gamma irradiation

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Giant guava (*Psidium guajava* L.) has higher demand in both local and international market and has a limited shelf life of 4 days under normal room conditions. The research was aimed to extend the shelf life by edible coating followed by irradiation at 0Gy, 100Gy, 200Gy, 300Gy, and 400Gy doses. A water emulsion with 1% bee wax, 5.5% sunflower oil, 0.5% Tween 80, and 0.05% of tamarind (*Tamarindus indica*) seed powder was used as a coating. Tamarind seed powder contained 132.06ppm (SD 0.95) total polyphenol content, 1% (SD 0.00) saponin and 3.37% (SD 0.00) alkaloid content produced good antioxidative and antimicrobial properties. Shelf life was determined by measuring weight loss, color (E value based on L*, a*, b* in Hunter color scale), breaking point, titratable acidity (TA), pH, total soluble solids (TSS), moisture content and evaluation for sensory properties of treated and not treated guava samples. Among the treatments, 100Gy and 200Gy treated in both coated and non-coated samples remained acceptable for 16days. 100Gy treated coated guava sample was shown 15.66% (SD 0.58) weight loss, 197.4 (SD 28.95) breaking point, 57.20 (SD 3.10) E value, 4.96 (SD 0.04) pH and, 0.31% (SD 0) TA by 16th day were significantly better ($p < 0.05$) compared with other treatments. Coating of guava decreased the moisture loss and shriveling effect while irradiation treatment reduced respiration process as green color of samples existed for 16 days in normal room temperature (31°C, SD 0.2). Results conclude that coated 100Gy gamma irradiated giant guava can be kept for more than two weeks with the acceptable freshness.

Keywords: Giant guava, Edible coating, Gamma irradiation, Postharvest shelf life extension, Room temperature

Effect of different precooking methods on bitterness and storage stability of palmyrah tuber flour

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Palmyrah (*Borassus flabellifer*) tuber is widely grown in northern and -eastern parts of Sri Lanka. People consume tuber after boiling or as products made from dried tuber flour at household level. The bitterness of palmyrah tuber flour (PTF) is a hindrance for its consumption. The bitterness in PTF is due to the presence of a steroidal saponin, flabelliferin. Different pre-cooking techniques have known to possess positive effects on removal of bitter compounds and have the impact on nutrition content positively and negatively. With this background, the study was designed to select an appropriate pre-cooking method to remove the bitterness in un-boiled PTF and to determine the most suitable combination of pre-cooking method and packaging material for safe storage and flour stability. Three months old palmyrah tubers belonging to the black skin fruit variety were obtained from local farmers in Jaffna. After peeling the outer cover, the tubers were washed, drained and were subjected to primary treatments (soaking in water and soaking in 12%NaCl for 3hrs). Tubers were subjected to secondary treatment (boiling, steaming, pressure cooking for 30min and fermentation for 24hrs). After the secondary treatment, the tubers were cut into uniform pieces (3mm) and dried in an oven at 85°C for 4.5 hrs. Dried tuber slices were ground, sieved and packed in high-density polyethylene bags and the traditionally used brown paper bags and stored at room temperature. Flour types were analyzed for saponin content, total phenolic content (TPC), DPPH radical scavenging assay, proximate composition and sensory evaluation. The result indicated that precooking techniques reduces the bitterness of PTF significantly ($p < 0.05$). The flour obtained by soaking in water and fermentation had the lowest saponin content (0.15mg SE 0.01) and significantly lower ($p < 0.05$) sensory scores for bitterness during sensory evaluation. The flour subjected to soaking in 12% NaCl, steaming and water soaking and pressure cooking in the respective order had the highest TPC (2.30, SE 0.03) content and reducing power (13.6, SE 0.24). The flour soaking in 12% salt and steaming had the highest ash (2.47, SE 0.11), crude fiber (1.74, SE 0.04) and crude protein (3.20, SE 0.07) contents. Polyethylene packaging material was significantly recorded as suitable packaging material compared with paper packaging material. The study confirmed that bitterness in PTF can be removed successfully by providing suitable pre-treatments. Soaking in water followed by fermentation reduces the bitterness to the highest extent and use of a new packaging material, polyethylene can increase the storage stability of PTF.

Keywords: Bitterness, Precooking method, Palmyrah tuber flour, Saponin

Survivability of lactic acid bacteria in synbiotic set yogurt enriched with underutilized local yam carbohydrate extracts

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There has been a growing interest in using probiotic microorganisms as dietary adjuncts in the dairy industry for the purpose of enhancing bowel health. In this regard, bifidogenic and lactic acid bacteria (LAB) are the most commonly used types of probiotic cultures. According to World Health Organization recommendation, more than 10^7CFU/g of probiotic bacteria in yogurt at the time of consumption is necessary. But due to high acidic content, the presence of bacteriocins and fermentation conditions, the survivability of probiotic bacteria decreases before consumption[1]. Incorporation of prebiotics to stimulate the survival ability of probiotics is a commonly used method which is finally called a synbiotic product. Sri Lankan lands are rich sources of nutritious yams and tuber crops yet underutilized.

The aim of this study was to evaluate the prebiotic effect of selected underutilized yams (water soluble carbohydrate extracts) of Sri Lanka (Kiriala, Innala, Rajala) on the survivability of lactic acid bacteria in low fat set yogurt. Yam carbohydrate extractions were prepared by using wet milling process. These extracts were separately incorporated (3%) in yogurt samples inoculated with freeze dried direct vat strain of lactic culture and a control sample free of yam extracts was prepared. Yam carbohydrate extractions were tested for their proximate composition, plate count, titratable acidity, and pH throughout the storage period at 0, 7, 14, 21, 28 days.

The yogurts with prebiotics and the control showed a significant decrement in the colony forming units ($p < 0.05$) throughout the storage period. The survival ability of LAB in terms of CFU in all three treatments was significantly high ($p < 0.05$) when compared to the control while yogurt with Rajala and Innala showed the highest survival ability with 8.38 (SD 0.13) and 8.17 (SD 0.04) $\log_{10}$/ g at the end of 28days of storage respectively. The control showed the highest acidity at the end of storage (pH 4.20/ TA 0.862) while yogurt with Rajala showed the lowest acidity (pH 4.35/ TA 0.805). The survival of Lactic acid bacteria was enhanced by all the potential prebiotics but Rajala and Innala showed the most effective in the preparation of synbiotic yogurt.

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[1]Ferdousi, R., Rouhi, M., Mohammadi, R., Mortazavian, A. M., KhosraviDarani, K., andHomayouni Rad, A. (2013). Evaluation of probiotic survivability in Yogurt exposed to cold chain interruption. Iranian Journal of Pharmaceutical Research 12, 139–144.

Keywords: Probiotic, Prebiotic, Yam carbohydrates, Synbiotic yoghurt

Contamination of *Alternanthera sessilis* and *Centella asiatica* with Profenofos, Fipronil and Tebuconazole in Kandy, Kalutara and Puttalam districts

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Alternanthera sessilis (Mukunuwenna) and *Centella asiatica* (Gotukola) are the most consumed leafy vegetables in Sri Lanka. These vegetables are rich in fibers and micro nutrients and people prefer to consume them either in raw form or after low-temperature cooking or after a low cooking period to retain its nutritive value. The majority of large scale leafy vegetable farmers use various kinds of pesticides for their fields. There is a higher possibility of pesticide residues ingestion through the leafy vegetable matrix. The aim of the research was to determine the levels of selected pesticides in Mukunuwenna and Gotukola and also compare with Maximum Residue Limit (MRL). Based on a farmer survey, three mostly used pesticides (Profenofos, Fipronil, Tebuconazole) were selected for the study. Samples were collected from the fields of leafy vegetables in districts of Kandy, Puttalam, and Kalutara and in each district three different area were selected. Of total samples, 33% of the leafy vegetable samples were collected from the fields where synthetic pesticides were not applied. Sample collection was done by the standard composite sampling technique. The extraction process was done by QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) technique. After the extraction and clean-up steps, samples were analyzed by Gas Chromatography Mass Spectrometry (GC-MS). The limit of detection for all three pesticides was 40ppb. Fifty percent of the samples were detected as contaminated with at least one of the three pesticides. Among the detected samples, profenofos, tebuconazole and fipronil were detected at 43.3%, 13.3% and 13.3% respectively. Of natural pesticides used field samples, 30% were detected for pesticides. Of the analyzed samples, 60% of Gotukola and 40% of Mukunuwanna were detected as containing at least one of the three pesticides. Sixty percent of the samples obtained from Kalutara, 60% of the Puttalam sample and 30% of the Kandy sample were detected as containing at least one of the three pesticides. According to the European Union (EU) standards, MRL for Profenofos and Tebuconazole are 10ppb and MRL for Fipronil is 5ppb. But Profenofos and Tebuconazole Pesticide residues have detected up to 7.5ppm level. So, there is a huge gap in between the MRL value and detected values. The result of the study concludes that all detected samples containing pesticide residues above the MRL.

Keywords: Fipronil, GC-MS, Profenofos, QuEChERS, Tebuconazole

Cereal based, high energy product for children under five years with moderate acute malnutrition

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Malnutrition is a major problem among children in Sri Lanka. Improper feeding practices and inadequate food intake increase the degree of moderate acute malnutrition (MAM). The dietary management of MAM is very important to prevent them from severe acute malnutrition. The annually considerable amount of foreign exchange is being utilized to import complementary foods. It is difficult to purchase such foods for people with limited income. Therefore, the aim of this study was to produce economical, cereal based, high caloric product for children under five years suffering from MAM considering acceptability, nutritional value, availability, feasibility and organoleptic properties of ingredients. Accordingly, the final formula complied with the WHO recommendation[1] for treatment of MAM and complementary foods. After selecting three formulas, further analysis was done for sensory attributes, particle size, proximate composition, dietary fiber level (DFL), protein digestibility (PD) through in vitro protein digestibility assay and amino acid composition of digested samples. According to sensory analysis, formulas were not significantly different ($p > 0.05$) and mean ranks of formulas varied around 7 from 9 hedonic scales. 100%particles were passed through 1000μm sieves and 65% were passed through 600μm sieves. The caloric value, protein, fat, DFL, carbohydrate, moisture and ash (per 100g) were, in formula A 433.88kcal, 20.5g (SD 0), 15.5g (SD 0.1), 4.7g (SD 0.7), 52.45g, 4.3g (SD 0.4) and 2.6g (SD 0) respectively. In formula B 440.2kcal, 21.8g (SD 0.2), 15.3g (SD 0.1), 3.6g (SD 0.1),3.9 (SD 0.1) and 2.4g (SD 0.1) respectively. In formula C 424.53kcal, 20.9g (SD 0.3), 14.6g (SD 0.7), 5.3g (SD 0.2), 53.09g, 3.5 (SD 0.4) and 2.5g (SD 0) respectively. PD of formula A, B and C were given 75.6%, 73.1% and 68.53% respectively. DFL and PD of formula C do not comply with the recommendations. Further pretreatment may require to reduce DFL and to increase PD in formula C. Formula A gave the highest number and highest concentration of amino acid due to its high PD. All formulas were economically feasible than commercially available products. It is concluded that formula A and B are superior therapeutic foods for treatment of MAM as it contains more than 400kcal/100g with recommended nutrients.

[1]WHO codex alimentarius guidelines (1991), guidelines on formulated complementary food for older infants and young children. Online available from: www.codexalimentarius.org/input/download/.../298/CXG_008e.pdf

Keywords: Complementary foods, In vitro protein digestibility, Moderately acute malnutrition, Severely acute malnutrition

Extraction and evaluation of physiochemical properties of arabinoxylan gum from leaves of *Neolitsea cassia*

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Water soluble arabinoxylan is classified under dietary fiber group which mainly consist of cereals. Typically, it shows the highest water holding capacity due to the presence of hydroxyl groups. However, in industrial applications, it is used as a good thickening agent, molecular binding agent and stabilizing agent. Among the native plants in Sri Lanka, *Neolitsea cassia* is most famous due to the presence of a gummy substance in the leaves. The aim of the study was to isolate arabinoxylan gum from leaves of *Neolitsea cassia*, characterize and use as a thickening agent in food models (tomato sauce). Water extractable method was used to isolate the gum from leaves and its physicochemical and functional properties were evaluated. The extractable arabinoxylan content of leaves was 1.02% on dry matter basis. The proximate analysis of the freeze dried powdered gum sample revealed that moisture content, ash content, protein content and fiber content were 4.56% (SD 0.085), 4.64% (SD 0.182), 2.74% (SD 0.758) and 5.94% (SD 0.372) respectively. The 3% concentrated gum sample showed the highest viscosity at 45^{o}C. Water holding capacity and oil holding capacity of the arabinoxylan gum were 88.82% (SD 0.667) and 66.67% (SD 1.792) respectively. It also showed 80.25% (SD 1.025) solubility in water at 45^{o}C temperature with shearing force. Diluted arabinoxylan gum was used to evaluate the emulsion stability index and it showed higher value was obtained up to seven days. Further the chemical analysis showed that total antioxidant activity, DPPH inhibition activity and the Ferric reducing power assay were 156.21μg/g (SD 0.998), 9.87% (SD 0.386) and 1.97mg/g (SD 0.386) respectively. The total phenolic content (400.76mgGAE/100g SD 0.987) and reducing sugar content (20.35mg/g, SD 0.564) were estimated using glucose standards. Total flavonoid content of the gum sample was 156.21mgRE/g (SD 0.998). To evaluate the suitability of the gum as a thickening agent, it was incorporated into tomato sauce in varying levels (0.5% to 4%). Its viscosity and spreadability were compared with commercially available sauce. There is no any significant difference ($p < 0.05$) in viscosity, titratable acidity and the water activity between commercially available sauce and 2% arabinoxylan incorporated sauce. It can be concluded the the arabinoxylan gum sample also has higher viscosity, water holding capacity and oil holding capacity comparable to the commercially available gums. 2% of arabinoxylan gum can be incorporated into tomato sauce as a thickening agent, without interfering the behavior of the food system.

Keywords: Arabinoxylan, Arabinose, Emulsion stability, Viscosity, Xylose

Impact of gamma irradiation on physical parameters, microbial safety, and the total poly phenolic content of commercially available Ceylon black tea *Camellia sinensis* L.

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The study was carried out to evaluate the impact of gamma irradiation on physical parameters, microbial quality and total polyphenol content (TPC) of Ceylon black tea (*Camellia sinensis* L.).120 BOPF black tea samples of 5 different brands were collected from an open market. The samples were irradiated at doses of 0kGy, 1kGy, 2kGy, 5kGy, 10kGy and 30kGy by Co-60 gamma irradiator. Water activity (a_w), moisture content, color of powder and infusion (Hunter scale), total plate count, yeast and mold count and coliform count were measured for each of the treatment. All tea samples had an average moisture content and water activity of 5.29% (SD 0.98) and 0.49 (SD 0.06) respectively. No significant difference was observed between irradiated and non-irradiated samples. However, the mean value of L, a, b and E hunter parameters in the infusion with tested irradiation doses were significantly different ($p<0.05$) with the control sample but there was no significant difference observed among tea brands. The average TPC in the control samples was $1.89x10^3$ cfu/g (SD $2.02x10^3$) while 5kGy irradiated samples had 3.03cfu/g (SD 11.73) for the same. The average Yeast and Mould count in the control samples was $2.87x10^2$cfu/g (SD 209.47) while 5kGy irradiated samples had low TPC value 3.03cfu/g (SD 11.73). The 10kGy and 30kGy irradiated tea samples showed sterilized conditions. All irradiated samples showed a significant reduction ($p<0.05$) of TPC and yeast and mold counts. Total coliform was not detected in any samples. Non-irradiated samples showed the lowest TPC (15.72, SD 3.44) where irradiated samples showed higher values. 10kGy (27.16, SD 0.06) and 30kGy (27.22, SD 4.75) irradiated samples showed significantly higher ($p<0.05$) TPC due to the formation of the arubigin compounds. When comparing with the control sample, their radiated 5 kGy (15.512, SD 2.358) samples were not significantly different. It is concluded that the 5KGy is the better dose for the effective microbial reduction while preserving the physical parameters and TPC of Ceylon black Tea.

Keywords: Black tea, Irradiation, Physical parameters, Microbial safety, TPPC

Development of low-fat synbiotic yoghurt from purple yam (*Dioscorea alata*)

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*Dioscorea alata (*purple yam*)* is an underutilized yam variety known to contain several bioactive compounds mainly dioscorin, diosgenin and water-soluble polysaccharides, and it is a good source of mineral, anthocyanin, and prebiotics. The purpose of this research was to develop a low-fat synbiotic yoghurt using purple yam as a source of prebiotic to enhance the survival of probiotics in the product. For the sensory test, different levels of yam powder were incorporated at levels of 3, 5, and 7% (w/w) in the yoghurts prepared with lactic acid bacteria at a level of 9.43 (SD 0.06). The sensory test was done for selecting the best level of yam incorporated yoghurt. The yoghurt with 5% yam powder showed the highest average ranking score for all sensory attributes and yoghurt with 7% yam powder showed least average ranking score for all sensory attributes except color and aroma. Then 5% yam incorporated yoghurt was tested for physicochemical, organoleptic and microbial properties. Total lactic acid bacteria, pH, and titrable acidity of the 5% yam incorporated yoghurt were 9.38logcfu/g (SD 0.06), 4.55 (SD 0.01), and 0.908 (SD 0.11) respectively. And Survival of probiotic in the 5% yam added yoghurt was enhanced by 2.5%. Nutrient component of yam powder and 5% yam incorporated yoghurt were determined. Crude protein content of yam powder was 10.28 (SD 0.06). Carbohydrate (66.14, SD 0.21) was the predominant fraction of yam powder. Crude fiber and fat content of yam powder were 8.17 (SD 0.88) and 0.98 (SD 0.01) respectively. Moisture content, crude protein content, crude fiber content, fat, and carbohydrate content of 5% yam incorporated yoghurt were 75.56 (SD 0.94), 4.55 (SD 0.38), 1.24 (SD 0.02), 2.22 (SD 0.03) and 16.22 (SD 0.09) respectively.

Keywords: Purple yam, Synbiotic, Yoghurt

Improving the shelf life and sensory properties of traditional oil cakes (kevum) for export market

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Oil cakes are deep fried, sweet and tasty confection unique to Sri Lanka. Short shelf life of 2-3 weeks, limits this product reaching export markets. This study was directed to improve shelf life and sensory properties (reduce sweetness and retain soft texture) of oil cakes by the application of selected food additives. Potassium sorbate (E 202) at 0ppm, 500ppm and 1000ppm and Ascorbyl palmitate (E 304), at 0ppm and 250ppm was used to control mold growth and as an antioxidant, respectively. Isomalt (E 953) in combination with kithul treacle was applied at ratios of 0:100, 25:75, 50:50, and 75:25, to reduce sweetness and retain structure of the oil cakes. Distilled mono glyceride (DMG 5611, Palsgaard) (0ppm, 2500ppm) was used to reduce anti-staling effects and maintain softness in the oil cakes, during storage. The oil cakes with ratio of kithul treacle: isomalt of 75: 25, selected as highly acceptable by sensory attributes by 25 untrained panelists. Samples were sealed in polypropylene packages and stored at ambient conditions (32^{o}C; RH 75%) for a period of four weeks. The moisture content, water activity, yeast and mold count, total plate count, color, and texture of oil cake samples were evaluated during storage.

Moisture content reduced significantly with increased levels of isomalt in oil cakes ($p < 0.0001$). The texture was also retained with increased levels of isomalt ($p < 0.0051$). Mean value of L, a and b on color determination had a significant (loss of color) effect ($p < 0.0001$) with addition of isomalt to oil cake. Oil content was significantly reduced when increased the level of isomalt of the oil cake samples. The water activity of oil cake was significantly reduced with the addition of both potassium sorbate ($p < 0.0$) and DMG 5611 ($p < 0.0$) probably due to water binding effect of above additives. The shelf life of the oil cake had an interactive effect with water activity from Potassium sorbate*Ascorbyl palmitate*DMG 5611 ($p < 0.0001$). The firm texture of the oil cake was significantly reduced with the addition of DMG 5611($p > 0.32$). The texture of oil cake had an interactive effect from Potassium sorbate*Ascorbyl palmitate*DMG 5611 ($p < 0.006$).

In the aspects of sensory preferences, oil cakes added with maximum levels of potassium sorbate (1000 ppm) and distilled mono glyceride DMG 5611(2500 ppm) were preferred by the panelists. DMG 5611 added oil cakes retained the expected soft texture of the oil cakes. A combination of selected food additives, improved the sensory properties and extended the shelf life of oil cake, thus suitable for export market.

Keywords: Extended shelf life, Food additives, Oil cake

Value addition to American sailfin catfish (*Pterygoplichthys* spp.) through fish cake development

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Inland fishery industry plays a major role in human nutrition and livelihoods in rural communities. *Pterygoplichthys* spp. an invasive species which colonized fresh water bodies of many regions and it has become a problematic fish. Although it can be used as a food fish, the direct introduction to local consumers is difficult because of its appearance, handling difficulties and since it is popular as an aquarium fish. This study assessed the feasibility of increasing the market value of the sailfin catfish by determining the flesh quality, to develop a fish cake using sailfin catfish and assess the level of consumer acceptability of the product. Samples of scavenger fish were collected from Deduru Oya in Kurunegala. Estimation of dressing %, microbial analysis, and proximate analysis was performed to check the flesh quality. For the product development initiatives, four formulations of fish cake were prepared by changing the flesh amount; 65%, 70%, 75%, and 80%. In the second stage, another three fish cake formulations were prepared by using selected flesh amount and changing the flour type as sweet potato flour, cassava flour and palmyrah tuber flour. Sensory evaluation was carried out using five-point hedonic scale followed by the simple ranking test. Microbial and proximate analyses were performed up to four weeks to check the product quality and shelf life. Sensory evaluation revealed that there was a significant difference ($p < 0.05$) among each fish cake formulations. Based on that 75% flesh and cassava flour were selected as most suitable. Mean dressing % of *Pterygoplichthys* spp. was 23.15% (SD 0.96). The most acceptable composition of the fish cake was with 74.63% mince flesh, 7.46% flour, 4.48% vegetable oil, 4.48% onion, 2.99% salt, 2.99% sugar, 1.49% garlic, 0.75% pepper and 0.75% spices. Coliforms were not detected and total plate count was below the maximum allowable limits for flesh. Total plate count, yeast and mold counts of the product were below the maximum allowable limits within four weeks.

Proximate composition	Flesh	SD	Fish cake(cassava)	SD
Moisture (%)	82.45	0.40	79.59	0.90
Crude protein (%)	10.70	0.51	6.38	0.22
Crude fat (%)	3.81	0.35	4.05	0.09
Crude fiber (%)	1.03	0.05	5.67	0.52
Carbohydrate (%)	1.02	0.04	2.40	0.43
Ash (%)	1.00	0.08	1.91	0.11

This result showed that fish cake from *Pterygoplichthys* spp. with natural preservatives had minimum four weeks of shelf life and fish cake can be prepared successfully using cassava flour and 75% of sailfin catfish flesh.

Acknowledge the financial Assistance received by Wayamba University Research Grant (Research grant no. SRHDC/RP/04/16-08)

Keywords: Cassava flour, Fish cake, Sailfin catfish, Sensory evaluation

Shelf life evaluation of coconut milk substituted synbiotic ice cream

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Ice cream is a very delicious and highly nutritious product popular among all age groups due to its cool and sensation property[1]. The latest trend in the world is towards therapeutic products. The incorporation of probiotics into ice cream make therapeutic ice cream. But frozen storage can reduce the viability of probiotics in ice creams. Prebiotics provide the substrate for probiotic to stimulate their growth in the ice cream matrix[2]. Incorporation of prebiotics into the ice cream can enhance the survivability of probiotics. The purpose of this research is to evaluate the shelf life of a synbiotic ice cream developed using coconut milk (40% v/v), arrowroot tuber (*Maranta arundinacea)* starch (7%) as a source of prebiotic and *Lactobacillus acidophilus* as a probiotic microorganism (10^7CFU/g). An ice cream produced without prebiotics was used as a reference. Products were stored under -18°C until further use. Chemical (moisture content, protein content, fat content, titratable acidity, mineral), physical (pH, total soluble solids, overrun) microbiological (probiotic viability, yeast and mold counts, total aerobic count, coliform count) and sensory properties (taste, odor, color, texture and overall acceptability) were determined. Survival of probiotic *L. acidophilus* was higher in the synbiotic ice cream showing values of $2.47*10^6$ while it was $1.43*10^5$ in the reference sample by the 10th week. Results revealed that moisture (0.432), protein (0.232), fat (0.206), micronutrient (0.214), overrun, taste and color in the synbiotic ice cream had no significant difference ($p>0.05$) compared to the reference sample throughout the storage period. Prebiotic arrowroot had shown to increase the survival rates of probiotic *L. acidophilus* in ice creams up to 10 weeks of storage period under acceptable probiotic properties. The synbiotic ice cream had shown the good acceptability of sensory properties of texture, odor and overall acceptability up to the 6th week.

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Keywords: Ice cream, Synbiotic, Probiotic survivability, Shelf life

Characterization of physicochemical and functional properties of flour and starch extracted from *Amorphophallus paeoniifolius* (elephant foot yam)

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Amorphophallus paeoniifolius is commonly known as elephant foot yam, is an edible aroid belongs to the Araceae family. This highly potential tropical tuber crop is widely grown and consumed in south east Asian countries. The aim of this study was to investigate the physicochemical and functional properties of flour and starch extracted from elephant foot yam. Physicochemical properties including granular morphology, proximate composition, amylose content, mineral composition, total phenolic content, oxalate content, β-carotene and lycopene content and functional properties including swelling and solubility, water binding capacity, pasting behavior, gelatinization temperature, paste clarity and least gelation concentration were determined for extracted flour and starch. The flour was extracted by dry processing method followed by wind sifting whereas starch extraction was done using wet milling method. The starch and flour yield from the yam was 6.77% and 15.92% respectively. The granular morphology revealed that the starch granules were round and polygonal shape. The proximate composition showed high fiber content (2.65%) and low-fat content (0.62%) in the flour. This attribute of the flour is desirable in the preparation of low caloric food. The extracted flour showed high peak viscosity (1702BU) compared to the starch (615BU), indicates that the flour is more resistant toward shear thinning. This attribute is useful in complementary foods in which long term thermal processing is desired. Gelatinization temperature of the flour was in the range of 70-72°C while for starch it was 68-72°C.The starch exhibited resistance to swelling and solubility. The swelling power was 13.34 and 9.64 at 90°C for starch and flour respectively. The least gelation concentration for starch and flour was 8%(w/v) and 14%(w/v) respectively revealing the ability of the starch to form firm gels at least concentration. Hence it can be used as gelling agent, stabilizers, and thickeners. The paste clarity of the starch and flour decreased with storage at refrigerated temperature(4°C) revealed the tendency of the flour for retrogradation which is not suitable for products in which clarity is desired. Both starch and flour of elephant foot yam show broad application within the food industry.

Keywords: Elephant foot yam, Flour, Functional, Physicochemical, Starch

Evaluation of Gahala (*Colocasia esculenta*), Innala (*Plectranthus rotundifolius*), and Kiriala (*Xanthosoma sagittifolium*) in bread making

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Due to the expensiveness, high demand, and geographical scarcity of wheat flour, there have been attempts on a suitable replacement, especially in tropical areas including Sri Lanka. Sole replacement by foreign flours has not shown positive results. The application of composite flour has given more remunerative results. Gahala, Innala, and Kiriala which have found it comfortable growing in Sri Lanka are potential flour and bread making sources. However, there have not been enough studies performed locally in this regard. Thus, the focus of this study was to check out the suitability of these yam flour incorporation with wheat flour, in terms of bread making. The study consisted of flour preparation, proximate analysis, analysis of rheological properties, preparation of bread, evaluation of bread with the relevance of yam flours sensory characteristics and bread scoring. Blend levels from yam flours used for composite flour were 10%, 20%, and 30%. 100% wheat flour was used as a control. Flour prepared by drying and grinding the yams. AOAC approved methods were used for determining the proximate composition. Rheological properties for each blend levels were evaluated by farinogram and extensogram analysis. Bread was prepared as for AACCI 10-10.03 method and were evaluated for sensory properties and bread score. According to the results obtained, carbohydrate amounts were 82.36% (SD 2.82), 81.94% (SD 2.59), and 81.29% (SD 2.68) for Gahala, Innala and Kiriala flour respectively. Protein levels were 1.80% (SD 0.03), 1.44% (SD 0.04), and 1.27% (SD 0.03); fat levels were 1.92% (SD 0.07), 2.04% (SD 0.01) and 2.32% (SD 0.02); moisture levels were 10.42% (SD 0.16), 11.02% (SD 0.18), and 11.43% (SD 0.15); ash levels were 1.75% (SD 0.09), 2.03% (SD 0.06), and 1.89% (SD 0.06); crude fiber 1.75% (SD 0.20), 1.56% (SD 0.20), and 1.79% (SD 0.17) for Gahala, Innala, and Kiriala respectively. Farinogram analysis revealed that 10% incorporation of Gahala flour results in 67% of water absorption, 6minutes of dough development time, 2minutes of arrival time and 23.5minutes of stability. As for Innala, the respected values were 60%, 7.5minutes, 1minute, and 20minutes. Extensogram revealed 121.7mm of Extensibility, 518BU of resistance to extension, 617.7BU of maximum ration, and 4.3 of ration number for 10% Gahala dough whereas the values were 112.7, 514.6, 620, and 4.6 for 10% Innala dough. Developed bread showed that with the incorporation of yam flour there was a decline in the rise of bread. Each bread type had characteristic odors respective of their yam. According to the sensory analysis, the bread the blend level of 10% was insignificant in overall acceptability with normal wheat bread. Both 20% and 30% blend levels have resulted in significantly different bread compared to the control. These sensory results are true for both Gahala flour and Innala flour incorporated bread. Thus, it was concluded that 10% Gahala and Innala flour incorporation was the most suitable blend level for bread making based on sensory evaluation and bread scoring. Further studies are suggested to gain improved bread.

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Keywords: Bread, Composite flour, Gahala, Innala, Kiriala, Rheological properties

Air frying as a way of producing snacks with desired quality attributes

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Frying is a prevalent and traditional cooking method which makes the food more palatable and desirable. Therefore, the consumption of fried food products has increased in Sri Lanka due to lifestyle changes and increased outside eating a wide variety of delicacies from world-over. Consumption of fried snacks is popular among people regardless of age groups. Studies revealed that the consumption of fried products leads to the development of cardiovascular diseases, obesity and type II diabetes. These issues have encouraged the fried product industry to search new ways and produce products with low oil intake and without changing desirable sensory attributes. Air frying is a novel technique which allows frying foods, without or minimum use of oil. Despite, air fryers being available in Sri Lankan markets, comparison of the quality and sensory characteristics of locally available snacks produced by air frying vs. deep frying is not available.

This study compared: (1) the process dynamics of air frying with conventional deep frying and (2) the products formed by the two processes in terms of color, texture, and sensory characteristics. Initially, a locally available snack (Bites) was prepared and then analyses were done according to the objectives.

According to the results of the temperature profile, initially, the temperature at the center of the product increased almost linearly with frying time until it reaches to approximately 100°C.The deep-fried sample took 4 min to reach the boiling point of water, whereas the air fried sample took nearly 16 min. In the case of oil uptake, the values varied between 1.17 and 2.42 g/100 g defatted dry matter for samples processed by air frying, and between 1.83 and 26.56 g/100 g defatted dry matter for deep fat fried samples. There was a significant difference between air frying and deep frying over fat content in the final product ($p < 0.05$). Sensory analysis showed that the proper frying time for that snack on deep frying was 10 min and it was 12 min for air frying. Comparison of these accepted two samples showed the different sensory characteristics ($p < 0.05$). As the conclusion, air frying process permits the manufacture of lower fat content products, though these products have different sensory characteristics.

Keywords: Air frying, Deep fat frying, Oil content, Sensory analysis

Evaluation of antioxidant properties of selected vegetables varieties

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Vegetables in the diet have been found in epidemiology studies to be protective against several chronic diseases. Vegetables contain a unique complex of naturally occurring antioxidant compounds. This study was carried out using the fresh vegetable (FV) to evaluate antioxidant properties (AP) in three different coloured (green, yellow, and red) sweet bell peppers (*Capsicum annuum* L.), green lettuce (*Lactuca sativa*) and tomato (*Solanum lycopersicum*). The AP was evaluated using 50% methanol extractions of FV for total phenolic content (TPC), 1,1-diphenyl-2-picryl-hydrazyl (DPPH) radical scavenging and ferric reducing antioxidant power (FRAP) in vitro antioxidant assays. The mean TPC of selected vegetable varieties (VV) were ranged from 16.14 (SD 5.05) to 109.15 (SD 7.69) mgGAE/100g. TPC of green, yellow, red pepper, tomato and green lettuce determined by the Folin-Ciocalteau method were 64.56 (SD 1.83), 81.91 (SD 5.24), 109.15 (SD 7.69), 16.14 (SD 5.05) and 39.80 (SD 5.00) mgGAE/100g fresh weight, respectively. The bell pepper had higher TPC than the tomato and green lettuce. The red pepper had higher TPC than the green pepper. Vegetables with seeds have higher TPC than vegetables without seeds.

In DPPH radical scavenging method, lowest IC_{50} values were observed in Lettuce (15.35mg/ml, SD 0.20). The highest IC_{50} value was observed in the Green bell pepper (236.36mg/ml, SD 0.03). The FRAP values of tested vegetable varieties ranged from 0.06 (SD 0.01) to 0.16 (SD 0.02) mMFe(II)/100g. Among the VV, Yellow bell pepper (0.16mMFe(II)/100g, SD 0.02) and Red bell pepper (0.15mMFe(II)/100g, SD 0.01) were the highest in total antioxidant capacity while Green bell pepper (0.06mMFe(II)/100g, SD 0.01) was the lowest.

Keywords: Antioxidant properties, Pepper, Lettuce, Tomato, Total phenolic content, DPPH, FRAP

Levels of selected heavy metals in Mahaweli river water, Sri Lanka

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In 2015, United Nations has recognized access to safe drinking water as a human right. In fact, 748 million people from world's total population do not have access to safe drinking water source[1]. In the Sri Lankan scenario, 14.3% of the total population does not have a way to access safe drinking water source[2], though Sri Lanka is having 103 rivers. Among those, Mahaweli is the longest river and it provides sustenance to people in seven districts. Countrymen live in Polonnaruwa, Anuradhapura and Trincomalee districts used to drink raw water from Mahaweli River without any treatment. As such, use of raw water could be a possible reason for emerging health risk of Chronic Kidney Disease of Uncertain Etiology (CKDu)[3] in those districts because, chemical hazards especially heavy metals at considerable levels are added into the water by unsafe discharging of pesticides and fertilizers, and by water pollution through industrial effluents. In this study, 15 locations (Hatton, Watawala, Ginigathhena, Nawalapitiya, Ualapane, Gampola, Gelioya, Kandy, Manampitiya, Sungawila, Somawathiya, MawilaruAnicut, SeruNuwara, Upparu Ferry and Ralkuli Ferry) were selected along the Mahaweli River and water samples collected from the locations were analyzed for heavy metals (Arsenic- As, Boron- B, Chromium- Cr, Copper- Cu, Lead- Pb, Manganese- Mn, Mercury- Hg, Nickel- Ni, and Selenium- Se) by using Inductively Coupled Plasma- Mass Spectrometry and the results were compared with WHO standards. The average Mn concentration was significantly higher in samples collected from SeruNuwara (0.7815ppm, SD 0.3099), Ralkuli Ferry (1.9465ppm, SD 1.1760), and Upparu Ferry (1.3134ppm, SD 0.7270); average Ni concentration was significantly higher in the samples collected from Ralkuli Ferry (0.1030ppm, SD 0.0219). In the samples collected from both Upparu Ferry and Ralkuli Ferry, average concentration of B (25.0120ppm, SD 3.4500 and 19.8673ppm, SD 4.9900), Cu (10.2110ppm, SD 01.0790 and 8.2519ppm, SD 3.8600), As (0.2335ppm, SD 0.0267 and 0.2986ppm, SD 0.0447) and Se (1.3611ppm, SD 0.1443 and 1.5582ppm, SD 0.2180) were significantly higher in river water. The elevated levels of the heavy metals in river water in Upparu Ferry and Ralkuli Ferry could be due to contamination of river water with sea water because of the high tide.

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Keywords: CKDu, Heavy metals, ICP – MS, Mahaweli River, Potable water

Functional properties of flour obtained from Gahala *(Colocasia esculenta)*, Kiriala (*Xanthosoma sagittifolium*) and Innala (*Plectranthus rotundifolius)*

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Colocasia esculenta (Gahala), *Xanthosoma sagittifolium* (Kiriala) and *Plectranthus rotundifolius* (Innala) are underutilized yam varieties in Sri Lanka, which can be exploited for various aspects in the food industry. Therefore, the research was conducted to evaluate the functional properties of three yam flour types in order to manifest their potentials in utilization for the food industry. Flour (0.250mm) samples were prepared from Gahala, Kiriala and Innala. The Swelling Power (SP), Solubility Index (SI), Least Gelation Concentration (LGC), Water (WHC) and Oil Holding Capacities (OHC), Emulsifying Capacity and emulsion Stability (ES), Foaming Capacity and Foam Stability (FS) were determined for all three flour types. The viscosity of 3%(w/v) flour suspensions were obtained using Brookfield Viscometer. Gelatinization characteristics were determined using Brabender Viscoamylograph. There was a significant difference ($p < 0.05$) among SP of flours at 70°C, 80°C and 90°C. Gahala flour had the highest SP (13.174%) at 80°C. Kiriala flour had the highest SP (13.447%) at 90°C. Highest SI ranged between 16.848%-22.207% and were observed at 80°C. LGC of these flours ranged from 5-7%(w/v) indicating that they can be utilized as additives to other gel forming materials in food products. The best WHC (1.789mL/g) and OHC (0.991mL/g) were observed for Innala flour. The highest viscosity was recorded for Innala flour (280 cP). Even though Kiriala and Gahala flour had lower viscosities, all the three flours may have a good potential as thickening agents. As calculated from Viscoamylographs obtained for Gahala, Kiriala and Innala flour the gelatinization temperatures (GT) ranged between 65°C -84°C, 75°C -94.5°C, 72°C -86.25°C respectively. Gahala flour had the lowest GT, which is more preferred as it may consume less energy for pasting. Highest peak gelatinization viscosity was recorded for Kiriala flour (2510BU). From the three flour types, Gahala exhibited the least time to reach peak viscosity. Innala flour had the highest ES (112.651%) and FS (83.929%). Hence it is perceptible that flour types obtained from above yam species have a potential in utilization as thickening agents, gelling agents, ingredients in baking, formulation of products like noodles and numerous other processes in the food industry.

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Keywords: Tuber flour, Functional, Underutilized, Viscosity, Yam

Evaluation of minimum inhibitory concentration of Sri Lankan bee honey against *Staphylococcus aureus* and *Escherichia coli*

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Bee honey is the natural sweet substance produced by honey bees from the nectar of blossoms or from secretions on living plants. It has been identified as a potential alternative to the widespread use of antibiotics, which are of significant concern considering the emergence of resistant bacteria. In this context, this study aimed to evaluate the Minimum Inhibitory Concentration (MIC) of different bee honey types found in Sri Lanka and to evaluate the bactericidal/bacteriostatic activities against *Escherichia coli* and *Staphylococcus aureus.*

Honey samples were collected belonging to the August-October harvesting period of 2016. Samples from three main honey types available in Sri Lanka (Rubber honey, Red gum honey and Wild honey) were evaluated during the study. Two different assays were performed according to the method described by Aween*, et al,* 2014 to evaluate the antibacterial activity of honey. Colony counts were taken by growing the selected bacterial species in nutrient agar with different honey concentrations (2.5%,5%,10%, 20%, 30% and 50%). The bactericidal/bacteriostatic effect was determined by inoculating a known concentration of bacteria to nutrient broth with 50% honey, followed by re-growing in 100% nutrient agar incubated at 37°C for 24hours.

According to the results, all the three types of bee honey used for the assay demonstrated complete inhibition of *Staphylococcus aureus* and *E. coli* with 20% incorporated bee honey. Furthermore, the three honey types possessed bactericidal effects against the selected pathogens. The research concludes that minimum inhibitory concentration of Sri Lankan rubber honey, red gum honey and wild honey is around 20% against *Staphylococcus aureus* and *E. coli* and the effects are bactericidal. The research needs to be continued in future to determine the exact bee honey concentration/s required to completely inhibit the selected pathogens.

Keywords: Bee honey, Antibacterial activity, Minimum Inhibitory concentration, Bactericidal / bacteriostatic effect

Determination of prebiotic potential of local yams (*Colocasia esculenta, Xanthosoma sagittifolium and Plectranthus rotundifolius)*

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Locally available yam varieties in Sri Lanka are known to possess high nutritional and medicinal values. Moreover, these yams contain considerable amounts of dietary fiber, which may have a potential to act as prebiotics. Since the prebiotic potential of commonly consumed, local yam varieties are not adequately studied, the research was conducted to evaluate the prebiotic potential of three locally available yams, Gahala (*Colocasia esculenta*), Kiriala (*Xanthosoma sagittifolium*), and Innala (*Plectranthus rotundifolius*). Yams were obtained from local markets in Sri Lanka during the period of March-June 2017. The ethanol extracts of fresh ground samples were subjected to the procedure described by Wichienchot *et al.* (2011)[1] to quantify indigestible polysaccharide content. The resistant starch content was quantified using the resistant starch assay kit (Megazyme) according to AOAC official method 2002.02. Pectin content present was quantified following the extraction procedures described by Liew et al. (2014). Moreover, gastric and intestinal digestion with dialysis followed by in-vitro colonic fermentation was conducted and crude fiber content, resistant starch content, and total sugar contents were measured before and after the digestions/fermentation to evaluate the effect on yams by digestion and colonic fermentation.

Results revealed that the indigestible polysaccharide contents present, per gram of dry extract for Gahala, Kiriala and Innala were 623.69mg (SD 8.8), 400.9mg (SD 15.8), and 448.71mg (SD 17.0) respectively. Resistant starch content present in Gahala, Kiriala, Innala were obtained as a percentage of total starch content and the yams contained 65.73% (SD 2.67), 54.49% (SD 3.51), and 37.82% (SD 9.14) respectively. Pectin content present in Gahala, Kiriala, Innala were 2.3741g (SD 0.60), 5.2160g (SD 0.41) and 2.5753g (SD 0.09) per 100g of flour respectively. The crude fiber and resistant starch contents were relatively similar before and after the gastric and intestinal digestion proving that they moved to colon for the fermentation. After colonic fermentation, the total sugar content was reduced suggesting that some compounds were fermented in the colon which is the main characteristic of a prebiotic. The series of experiments revealed that the local yams Gahala (*Colocasia esculenta*), Kiriala (*Xanthosoma sagittifolium*), and Innala (*Plectranthus rotundifolius*) were having considerable quantities of prebiotic compounds and are having prebiotic potential.

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[1]Wichienchot, S. et al., 2011. Extraction and analysis of prebiotics from selected plants from southern Thailand. Songklanakarin Journal of Science and Technology, 33(5), pp.517–522

Keywords: Gahala, Kiriala, Innala, Prebiotic potential, Colonic fermentation

Applicability of cold chain transportation for vegetables in Sri Lanka

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The vegetable sector is one of the sub sectors of agriculture in Sri Lanka contributing 0.6-0.8% to the total Gross Domestic Production (GDP) of the country. It is estimated that about 16-41% vegetable loss in this method of transportation (APO, 2006) and it impacts for the food security and the energy security of the country. In Sri Lanka, most fruits and vegetables are transported in lorries, open trucks, three wheelers, containers, tractors, canters, and motor bikes with no any definite temperature and humidity. Reduction of postharvest losses of vegetables is vital for the country's economic development. Internationally it has been investigated that cold chain transportation, a temperature controlled supply chain which ensures the desired low-temperature can reduce respiration and transpiration of vegetables and it reduces perishability, water loss, shriveling and ethylene production and ripening of the vegetables. In Sri Lanka, applicability of transportation of vegetables in cold chain transportation was not investigated. Thus, the study has been designed with the objective to assess the postharvest losses of vegetables in normal transport method and cold chain transport method, maintained at 12-15^{0}C in Sri Lanka. Five types of vegetables with the highest extent of production in Sri Lanka were selected for the study. They were carrot, leeks, cabbage, tomato and brinjal. The selected value chains for the study were Nuwara Eliya to Pannala, Dambulla to Pannala and Nuwara Eliya to Wattala. Quality changes of vegetables in normal transport method and cold chain transportation at loading and unloading of vegetables were measured by means of mechanical damage percentage, weight loss, and Visual Quality Rating. Results indicate that mechanical damage percentage was significantly reduced for cabbage, carrot and brinjal in cold chain transportation method than normal transportation method by 9%, 9%, and 5% while for leeks and tomato it was reduced by 3% and 2% respectively. Physiological weight loss was significantly reduced for cabbage, carrot, tomato, leeks, and brinjal by 0.81%, 0.58%, 1.26%, 0.44%, and 0.70% respectively in cold chain transportation than normal transportation method. The visual quality change was significantly reduced for cabbage, carrot, brinjal and leeks in cold chain transportation than normal transportation method. Therefore, it can be concluded that the post-harvest losses of vegetables are significantly reduced in cold chain transportation and there is a potential to use this in Sri Lanka for the transportation of vegetables.

Keywords: Cold-chain transport, Mechanical damage, Postharvest loss, Vegetables, Visual quality

Physicochemical, antioxidant and sensory properties of selected fruits dehydrated by combination of pretreatments and drying methods

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Consumers are health conscious and seeking for healthier natural foodstuffs in order to have a nutritious diet and this lead to the increase of dietary intake of fruit. Demand is also increased for fruits that keep more of its original characteristics. Fruits undergo physical, chemical and nutritional changes during drying. It affects the quality attributes like colour, flavour, odour and its nutritional value. The objective of this study was to improve the product quality of dehydrated fruits (papaya, banana, pineapple) by combining pretreatments and drying techniques. This study involved investigation of bioactivity, physicochemical properties and the sensory assessment on organoleptic qualities. Three drying methods, namely, sun drying (SD) at 40- 45°C, hot air drying (HA) at 55°C and vacuum-microwave drying (VM)at 45°C,1000w were used for drying untreated, citric acid treated, sodium metabisulphite treated and osmotically treated fruit samples. Each treatment was applied separately for three different fruits. Drying time was changed according to the fruit variety and pretreatment. The results showed that the highest retention of ascorbic acid content was found in osmotically treated VM dried fruit samples. It was found that citric acid treated, vacuum dried samples had the highest retention of total phenolic content and DPPH radical scavenging activity. Citric acid treated vacuum dried Papaya, pineapple and banana showed 165.46mg/GAE, 146.74mg/GAE and107.87 mg/GAE total phenolic content respectively. There was a significant reduction ($p < 0.05$) in the total phenolic content of dried fruits after applying osmotic treatment. The combination of high temperature, osmotic treatment and long drying time may influence on total phenolic content and DPPH activity. The results indicated that osmotically pretreated dried fruits have the highest Brix values. Sensory evaluation revealed that the osmotically treated dried fruits had the highest overall acceptance than other pretreated dried fruits. The studied parameters (moisture, total phenolics, antioxidant capacity, ascorbic acid content and Brix value) were significantly ($p < 0.05$) affected by different drying processes, with the minimal effects on pH value. This study has demonstrated that pretreated vacuum-microwave drying can produce high-quality dried fruits, with the additional advantage of reduced processing times and low temperature.

Keywords: Fruits, Drying methods, Pretreatments, Bioactivity, Sensory assessment

Extraction and evaluation of anthocyanin from *Dioscorea alata* and its application as a natural food color in food product development

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The color of the foods plays a vital role in the food industry. Anthocyanin is a natural colorant and present in nature mainly in six different types (Jing, 2010). *Dioscorea alata* is an underutilized tuberous vegetable in Asia. In Sri Lanka, the crop is freely available. Use of artificial colorants results in many negative impacts on consumers like neurotoxic-effect and carcinogenic diseases. Therefore, natural food colorants have an expanding market demand. Studies have been conducted on natural colorant extraction from *Dioscorea alata* tuber, but no sufficient emphasis given to the effect of preheat-treatment on Anthocyanin yield. Steaming pretreatment of fresh yam is beneficial to the color stability (Xiu-li *et al.*,2015). Therefore, the research was conducted to optimize the Anthocyanin yield by giving emphasis to preheat-treatment and check the storage conditions and its sensory suitability as a natural colorant.

In order to optimize the yield freshly harvested purple yam tuber was subjected to a preheat-treatment and extraction was conducted using the ethanol-water solution as a solvent. pH differential method (AOAC, 2005) was used to determine the Anthocyanin content. During extraction the effect of different preheating treatments (32°C, 40°C, 50°C, 60°C and 70°C), solvent ratio (ethanol: water- (0:10), (1:9), (2:8), (3:7), (4:6) and (5:5)) and extraction time (30, 45, 60, 75, 90, 105 and 120 minutes) on yield was evaluated. Then the stability of extracted Anthocyanin under different temperatures (32°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C and 100°C), pH levels (2, 4, 6, 8 and 10) and storage time (0, 10, 20 and 30 days) were evaluated. Finally, the sensory suitability of Anthocyanin as a natural colorant was tested by incorporating to cake and the acceptability was tested with fifteen semi-trained panelists using five points hedonic-scale method.

Results revealed that the maximum anthocyanin yield of 66.90mg/kg was obtained at 60°C of preheat temperature, 90 minutes of extraction time, 4:6 of ethanol (purity 96%): water ratio. Extracted anthocyanin had the highest stability at 2.0-6.0pH range and 30 days of storage at chill condition (0-4°C) in dark. There is no considerable effect of processing temperature on stability. 66.67% of the sensory panelists prefer the cake produced using Anthocyanin as a natural colorant. Therefore, It can be concluded that there is a positive effect of preheating treatment on the yield of anthocyanin extracted from *Dioscorea alata* and it can be used as a natural food colorant in the bakery industry.

Keywords: Anthocyanin, *Dioscorea alata*, Extraction, Evaluation

Radioactivity in selected foodstuff and annual committed effective dosage from gamma-emitting radionuclides to an adult in Pulmoddai, Sri Lanka

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The largest mineral sand deposit occurs in Pulmoddai, Sri Lanka. The mineral sand mining area in Pulmoddai has identified as high natural background radiation area by Sri Lanka Atomic Energy Board. Long term accumulation of radionuclides in the human diet is due to absorption of radionuclides in the soil by roots of plants. Due to high radionuclides concentration in soil, the foodstuff grown in this area can be contaminated with ^{226}Ra, ^{232}Th and ^{40}K which are responsible for radioactivity in the human diet. Long term consumption of high radioactive foodstuff can cause health defects such as cancers, leukemia, and death. Seasonably available foodstuff including cereals, vegetables, nuts, fruits and yams were collected from sampling area in Pulmoddai and used to prepare common meal plans consumed by the residents. Samples were analyzed with HPGe gamma spectrometer for activity concentration. Activity concentration of ^{40}K in cooked meal plans were ranged between 129.28 Bqkg^{-1}(dinner) and 163.24 Bqkg^{-1} (lunch) while and raw foodstuff was ranged between 41.51Bqkg^{-1} (rice) and 1183.72Bqkg^{-1} (drumsticks). Trace amounts of ^{137}Cs in lemon, ^{232}Th in ladies fingers, ^{7}Be in long beans were identified. Cooked meal plans and raw foodstuff were contained elevated ^{40}K activity concentration. It may be due to high ^{40}K concentration in the soil, which can be planted transfer factor and fertilizer application. The total committed effective dosage to an adult from gamma emitting radionuclides from cooked meals was 0.1482mSvyr^{-1} and raw foodstuff was 0.0667mSvyr^{-1} which are below the maximum committed effective dosage due to ingestion of foods which is 1mSvyr^{-1}. Therefore it can be concluded that foodstuff and cooked meals in Pulmoddai Sri Lanka are radiologically safe for consumption.

Keywords: Effective dosage, Gamma spectrometer, Radio nuclides, Mineral sand deposit

Application of cleaner production methodology for selected fruits and vegetable value chains in Sri Lanka

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Agriculture plays a vital role in the national economy with a contribution of 7.9% to the GDP while fruit and vegetable sub sector of agriculture have contributed between 0.6-0.8%in the total GDP of the country. Postharvest losses (PHL) of the fruits and vegetables through the value chains impacts on energy security and food security of the country. However, literature data is scarce on PHL of each fruit and vegetable through the value chains. Cleaner Production (CP) methodology is a continuous application of an environmental strategy to increase the productivity of processes, products and services by ensuring less harm on human and environment. In this study CP methodology was used to assess the PHL and identify the CP potential of leeks, beetroot and papaya with the material flow from Nuwara Eliya to Pannala, Puttalam to Pannala and Puttalam to Kandy respectively via Dambulla Economic Centre (DEC). Further, the causes for the PHL and CP potential to reduce or utilize the losses were identified. At each node of each value chains, losses were calculated by analyzing the daily and monthly resource flow. By analyzing the cost of wastes, the CP potential was determined.

Table: Calculated percentage of waste and cleaner production potential (Lanka Rupees/year)

Fruit / Vegetable	Node	Waste (%)	CP Potential (LKR Mn/ year)
Leeks	Farm	10.00	0.04 /acre
	Collection Centre	2.00	37.14
	DEC	1.28	1971.81
	Retail/ Wholesale	10.00	4.30
Beetroot	Collection Centre	4.66	31.92
	DEC	1.72	524.25
	Retail/ Wholesale	1.30	0.87
Papaya	Farm	16.00	0.27/acre
	DEC	12.67	55.52
	Retail/ Wholesale	16.67	0.18

It was identified that PHL is high in retail level in related to sorting and unsold vegetables. The identified root causes for the losses were mechanical damage, poor handling, poor package, and climatic change. At DEC, a surplus of produces caused high wastage of consumable fruits and vegetables due to less/no demand. The CP solutions identified through the study to reduce PHL of leeks, beetroot and papaya are provide technical education to the farmers/handlers and use of good seeds in proper time for cultivation. Moreover, the usage of plastic crates and reduction of unit package weight could reduce much loss and cold storage facility at economic centers could be useful. Instead of discarding, wastage could be used to produce fuel and biogas, synthesized proteins and copolymer substances. The consumable wastages could be used in food or material productions.

Keywords: Cleaner production, Fruits and vegetables, Postharvest loss, Value chain

Bioavailability, bioaccessibility and antioxidant activity of black plum (*Syzygium caryophyllatum*)

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Black plum (*Syzygium caryophyllatum* (L.) Alston) also known as Dan, is native to Sri Lanka. However, it has not been much exploited, although it has high potential to be a rich source of natural antioxidants. Thus, this study aimed to analyse the influence of dried fruit and juice processing and *in vitro* gastrointestinal digestion on contents of bioactive constituents and antioxidant activities of black plum together with the fresh blueberry. The results reported in Table show that fresh blueberry own high amount of tested bioactive compounds and highest antioxidant properties while fresh black plum shows lower levels which consist with findings of other authors. Simultaneously it illustrates that both drying and juice preparation downgrade the contents of bioactive and antioxidant properties in fresh black plum fruits.

Table: Contents of bioactive constituents and antioxidant activities of blueberry, fresh black plum, dried black plum and black plum juice

Bioassay	Blueberry		Fresh black plum		Dried black plum		Black plum juice	
	Value	SD	Value	SD	Value	SD	Value	SD
Bioactives assays								
Total phenolics e	262.86^{a}	4.39	171.68^{b}	3.01	99.54^{c}	1.28	78.70^{d}	1.47
Total flavonoids f	6.84^{a}	0.95	3.82^{b}	0.15	2.63^{c}	0.25	1.08^{d}	0.02
Anthocyanins g	250.48^{a}	3.77	47.12^{b}	0.23	28.58^{c}	1.73	19.53^{d}	3.07
Carotenoids g	183.62^{a}	6.99	112.01^{b}	3.35	86.39^{c}	4.16	70.63^{d}	2.98
Lycopene g	56.88^{a}	1.57	23.45^{b}	1.05	20.04^{c}	0.87	19.05^{c}	0.91
Antioxidant assays								
Antioxidant capacity h	134.88^{a}	9.89	85.25^{b}	5.19	65.09^{c}	0.87	53.76^{d}	7.36
ABTS scavenging h	379.75^{a}	3.41	296.25^{b}	2.54	137.37^{c}	1.46	91.73^{d}	0.85
Lipid peroxidation h	279.14^{a}	2.75	231.14^{b}	1.86	185.74^{c}	1.06	225.47^{b}	5.32
Singlet O_2 inhibition i	202.43^{a}	1.56	164.57^{b}	1.04	103.39^{c}	0.74	155.66^{d}	2.03
Nitric oxide inhibition i	1752.23^{a}	7.93	1660.01^{b}	8.64	1818.45^{c}	3.62	391.98^{d}	1.93

e μmol gallic acid equivalent per 1g dry weight, f μmol rutin equivalent per 1g dry weight, g μg per 1g dry weight, h mg ascorbic acid equivalent per 1g dry weight, i mg gallic acid equivalent per 1g dry weight. Values in each row having the same letter are not significantly ($p > 0.05$) different.

Furthermore, the bioaccessibility and bioavailability of bioactives found in blueberry, fresh black plum, dried black plum and black plum juice show more variations. The current study introduced a detailed understanding of the alterations in contents of bioactive constituents and antioxidant activity of black plum due to drying, juice processing and gastrointestinal digestion, which can serve as a novel source of functional food.

Keywords: Antioxidant activity, Bioaccessibility, Bioavailability, Black plum, *In vitro* digestion

Development of a method for making coconut milk based butter

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Sri Lankan coconut is one of the main commodities around the world and, coconut based products are available in the current market. They are desiccated coconut, coconut milk powder, coconut oil, coconut cream and coconut flour. Nowadays there is a demand for nondairy butter for vegetarians, although there are vegetable fat based margarine developments available. However, those are much concerned about some health issues. Therefore, this study was to develop a method for making coconut milk based butter with good organoleptic properties as coconut is rich in protein, fat and fiber. After the coconut butter was developed, its sensory properties were compared with the commercial dairy butter and the shelf life of the coconut milk butter was evaluated. Coconut cream was a major ingredient for the development of the coconut butter. In the butter production, two main steps were followed; separation of cream from the coconut milk and the production of butter from the separated cream. Some analyses were used to estimate the shelf life of the coconut butter in order to determine the storage period of butter before deterioration. According to that preliminary sensory analysis, soy lecithin 0.3%, pectin 2.5%, salt 1.5% and color are preferable. Meanwhile moisture 48.73%, fat 38. 78% protein 9.12%, ash 2.0473% and carbohydrate 1.314% are preferred for the coconut butter according to the proximal analysis. According to the microbiological test, availability of the microorganism was increased with the time interval. The CFU value of nutrient agar culture media was $2.536*10^4$, $3.136*10^4$ and $3.427*10^4$ and potato dextrose agar culture media was $2.727*10^2$, $3.181*10^2$ and $5.909*10^2$. Gas Chromatography method was followed to determine the fatty acid profile. The available fatty acids were lauric acid (54.129%), miristic acid (15.877%), caprylic acid (11.441%), palmitic acid (5.082%), oleic acid (3.315%) and stearic acid (1.528%). Fat extraction with chloroform was used to determine the Free Fatty Acid value (FFA), which was found to be 0.119.

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Keywords: Coconut milk, Coconut cream, Coconut butter, Shelf life

Functional, chemical and sensory properties of reduced fat mozzarella cheese

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Mozzarella cheese is usually consumed as a pizza topping, normally full fat mozzarella cheese contains not less than 45% of fat in dry basis. Therefore, the amount and type of fat consumed is important for several chronic diseases such as obesity, cardiovascular disease, and cancers. As a result, reduced fat cheese represents a good choice for the current society. In this study reduced fat mozzarella cheese was made from skim milk standardized with whole milk to achieve target fat content in cheese. Three samples of cheese were produced using 1.8%, 1.75% and 2% standardized milk. The 1.8% milk fat containing cheese sample was selected for further studies. Sensory analysis was conducted using simple preference test. Meltability was determined according to modified Schreiber test (Kosikowski and Vikram, 1977). Mean meltability values related to the area was measured within one month time period in two weeks interval. Chemical composition and shelf life evaluation were done by proximate analysis during different storage periods (1day, 14days, and 28days). For improvement of sensory and functional properties suitability of fat replacer also tested. Mean preference values of sensory data for reduced fat cheese were for color 5.36, flavor 5.36, texture 5.06, overall acceptance 5.40. For meltability there is no significant difference was observed related to the area values. ($p > 0.05$). For stretchability there is no significant difference was observed for mean length of stretched cheese of reduced fat cheese compared with full fat cheese strand ($p > 0.05$). For chemical analysis moisture % was ranged 54.164 (SD 0.515), 55.406 (SD 0.266), 53.615 (SD 0.158) ($p > 0.05$) while ash content % ranged 1.666 (SD .250), 2.508 (SD 0.189), 1.576 (SD 0.123) ($p > 0.05$) and for protein % ranged 24.139 (SD 0.196), 23.355 (SD 0.676), 22.785 (SD 0.276) (p value > 0.05) fat% ranged 18.278 (SD 0.189), 17.163 (SD 0.255), 16.291(SD 0.600) ($p > 0.05$) acidity % was ranged 0.523 (SD 0.018), 0.572 (SD 0.022), 0.818 (SD 0.031) ($p > 0.05$) pH was ranged 5.18 (SD 0.03), 5.26(SD 0.05), 5.01(SD 0.05) ($p > 0.05$) calcium mg/L ranged 26.096 (SD 0.053), 23.396 (SD 0.217), 21.630 (SD 0.132), ($p > 0.05$). There was no significant difference observed for chemical properties within one month shel life evaluation period. It can be concluded that mozzarella cheese can be successfully prepared using low-fat milk with acceptable functional properties.

Keywords: Mozzarella, Cardiovascular diseases, Obesity, Stretchability, Meltability

Influences of lipid type and quantity on bioaccessibility of lycopene from tomato paste

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The beneficial effects of intake of lycopene on the risk of certain types of cancers and chronic diseases have been presented in many studies; some recent studies indicated that lipids can positively influence its bioaccessibility and bioavailability. What is less clear, is the type and quantity of dietary fat needed for optimal lycopene bioavailability. This study explains the impact of the type and quantity of lipids, added upon digestion of tomato paste, on the bioaccessibility of lycopene. Lycopene bioaccessibility was studied by measuring the micellization during *in-vitro* digestion. Coconut oil, palm oil, and sunflower oil were selected because of their distinctly different fatty acid composition. Upon adding 2% of lipid to tomato paste, all tested lipids significantly improved the lycopene bioaccessibility. The largest increase in lycopene bioaccessibility was noticed after supplying 10% of palm oil, followed by 5% and 2% of the same oil. Next to the palm oil increase in lycopene bioaccessibility was noticed on sunflower oil and then from coconut oil. Moreover, depending on the amount of added lipid, the type of lipid resulting in the highest lycopene bioaccessibility differed. The results revealed that lycopene bioaccessibility depends on both the type and on the quantity of the lipid present during *in-vitro* digestion of tomato paste.

Keywords: Lycopene, Lipids, Tomato, *In vitro* bioaccessibility

Physicochemical and functional properties of rice bran protein concentrates isolated from At 308, At 362 and BG 300 rice varieties

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Rice (*Oryza stativa*) bran is an underutilized byproduct of the rice milling process and it is commonly used for the production of animal feed. Sri Lankan annual paddy production in 2015 was 4819metric tons and 10% of paddy was removed as the bran. Rice bran is an inexpensive source of protein. The objectives of this research were to extract protein from rice bran and to analyze the physicochemical and functional properties of rice bran protein concentrates (RBPCs). In this research three commonly consumed Sri Lankan rice varieties (At 308, At 362 and BG 300) were used. Protein concentrates were prepared using alkaline extraction and isoelectric point precipitation of defatted rice bran. Properties of RBPCs were analyzed in comparison to casein.

The protein content of RBPCs was ranged between 46.5 to 57%. At 362 exhibited highest DPPH radical scavenging activity, reducing power assay and total antioxidant activity compared to other two varieties. All RBPCs showed nitrogen solubility in the range of 52.94-72.38%. Water binding capacity ranged between 0.87-2.6(g/g) while oil absorption capacity was in the range of 1.24 - 1.68(g/g). RBPCs had a considerable value of water absorption especially for BG 300 and it could be incorporated into beverages and bakery goods. Water absorption is required for keeping the freshness of the bakery goods and it affects for the mouth feel of those products. At 308 had highest oil absorption and it could be used for the production of sausages and batters[1]. At 308 had the highest bulk density (0.91g/ml). Foaming capacity of RBPCs was lower than that of casein except for BG 300 at 5% and 10% sugar conditions. In that condition, it showed comparable foaming capacity to casein. Results showed At 362 had a comparable emulsifying capacity to casein at pH 7.0 and10.0, sugar 10%-15% and salt 0.5%. RBPCs had potential to use as an emulsifier in different pH, sugar and salt conditions. Results further suggest that RBPCs have good functional and physicochemical properties and extracted RBPCs have considerable amount of protein.

[1]Chandi, G.K. and Sogi, D.S. (2007), Functional properties of rice bran protein concentrate, 79 (February 2006), pp.592–597.

Keywords: Protein concentrates, Rice bran, Water absorption

Validation of an alternative method adapted from ISO 4831:2006 standard to detect coliforms in powdered milk

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The knowledge of microbes and their specific growth characteristics are highly imperative to ensure safety and quality of dairy products. Development of simple, easy and low-cost methods to detect the microorganisms act as food safety indicators in milk and milk products is essential. ISO 4831:2006 standard gives the general guidelines to detect coliforms using most probable number technique which takes 72hours to produce negative results. Fonterra brands Lanka uses an alternative test method developed by slightly modifying the existing ISO method which is capable of detecting the Coliforms in 48hours. However, this method is not validated. This study was done to validate the alternative method as per the requirements in ISO17025.

Method comparison study was done to validate the alternative method as per ISO16140:2003 (protocol for validating alternative microbiological methods). Each method consists of presumptive coliform test and confirm coliform test. 60 samples were analyzed in both methods. Approximately 50% of the samples were negative. Positive samples were prepared using microbiology reference material RM 6737-M-1by spiking the samples.

Relationship between two methods was analyzed according to chi-square test of independence. It showed that there was no significant deference between the results obtained by two methods at $\alpha = 0.05$ level. Relative accuracy, relative specificity and relative sensitivity determined according to ISO 16140:2003 were 98.33%, 100% and 96.87% respectively. Relative detection level for the alternative method lied between 1 to 5cfu/g. Discordant results analysis showed that there was no significant difference between the two methods. The alternative method is validated according to the method comparison study for the detection of coliforms and can be used as a validated method for coliform detection by MPN.

ISO 16140:2003 Microbiology of food and animal feeding stuffs - Protocol for the validation of alternative methods.

ISO 4831:2006 Microbiology of food and animal feeding stuffs - Horizontal method for the detection and enumeration of coliforms - Most probable number technique

ISO 17025 General Requirement for Competence of Testing and Calibration Laboratories

Keywords: Food microbiology, Alternative methods, Validation, Coliform

Determination of growth performance and quality parameters of a novel dog food

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Commercial pet foods are designed to provide all needed nutrients in correct proportions in a given product[1]. In recent years, improvements in such foods formulated for dogs have resulted in many types. However, these types of commercial pet foods are popular only in developed countries but not in developing countries like Sri Lanka. Therefore, it will be beneficial to produce a commercial dog food locally to fill that gap. So, in this study, such type of a novel dog food was tested for its growth performances and quality parameters.

The study was done using eight puppies. They were divided into two groups. Three feeding trials were performed including flushing up periods by using novel food and commercially available other dog food type. Two groups were switched between two food types after each feeding trial. Body weight of each puppy was measured daily throughout the experimental period. Water consumption of each puppy per day was also measured. Palatability test was performed by using two - pan free choice test. Proximate analysis was done for both formulated and commercial food samples. One-way ANOVA was used to analyse the growth rate of puppies statistically.

According to the statistical analysis, there was no significant difference between mean growth rates of puppies for two food types, during three feeding cycles and flushing up period. Nutrient composition was higher in the novel food type compared to that of the commercial food. Concerning the label information of commercial food, it was lower than the tested values. In palatability test, more preference was showed by puppies for commercial food. The amount of water consumed by novel food fed group was higher than the commercial food fed group. Moreover, dogs showed comparatively hyperactive condition when provided with the novel food.

[1]Laflamme, D.P., Abood, S.K., Fascetti, A.J., Fleeman, L.M., Freeman, L.M., Michel, K.E., and Willoughby, K. N. (2008). Pet feeding practices of dog and cat owners in the United States and Australia. *Journal of the American Veterinary Medical Association*, *232*(5), 687-694.

Keywords: Dog food, Proximate analysis, Growth rate, Palatability

Effect of cobalt supplementation on dairy cows' dry matter intake digestibility and lactating performance during lactation period

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Minerals are important in dairy nutrition which plays a significant role in milk production. Cobalt is an essential trace element that directly impacts the vitamin B_{12} production, which can increase the lactating performance of dairy cows by promoting gluconeogenesis and protein metabolism. The objective of this study was to determine the effect of an external dietary supplement of Cobalt to the dry matter (DM) digestibility and milk yield. The supplement was provided to 15 pure Jersey cows (283.69, SD 30.97 kg), by dividing them into three homogenous groups, with three different treatments: control, 0.2mg/kg DM and 0.4mg/kg DM. The research was conducted for three months and during each month, first 21 days were taken as the adaptation period, and the final 7 days were considered as the sample collecting period. Both milk and faecal samples were collected during morning (9.00 hrs) and evening (13.00 hrs) in five days of sample collection period. Body weight, feed intake, and daily milk yield was measured daily. Statistical analysis was conducted according to the Latin Square Design (LSD). Results revealed that the milk yield has increased by 1.02% in 0.2mg/kg DM treatment level, and an increase of 5.30% in 0.4mg/kg DM treatment level compared with the control. Milk fat content has shown a reduction by 7.80% in 0.2mg/kg DM, and a slight increase of 1.83% in 0.4mg/kg DM level. Milk protein showed a reduction by 2.21% in 0.2mg/kg DM and an increase by 97% in 0.4mg/kg DM level. SNF content showed a reduction by 1.93% and 0.04% in 0.2mg/kg and 0.4mg/kg levels, respectively. Body weights of the animals has shown an increase by 0.56%, and 0.16% in 0.2mg/kg DM and 0.4mg/kg DM levels, respectively. DM intake showed an increase by 2.60% and 5.30% in the above treatments, respectively. DM digestibility has increased by 3.59% in 0.4mg/kg DM levels. Organic matter digestibility has increased by 3.68% in 0.4mg/kg DM levels. In conclusion, 0.4 mg/kg DM level is effective for milk production, milk fat and milk protein increments. DM digestibility, organic matter digestibility, DM intake and the body weights of the animals were increased. 0.4mg/Kg DM level can be taken as better treatment compared to 0.2mg/kg DM level.

Keywords: Cobalt supplementation, Digestibility, Dry matter intake, Milk yield

Effect of dietary cobalt supplementation on selected blood minerals and glucose status during early lactation in dairy cows under tropical conditions

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Macro and micronutrients are inorganic substances essential to maintain the normal functions and living status in domestic animals. Many of these minerals are dietary essentials for optimal growth, physiological function, and productivity in animals. Cobalt (Co) is known as an essential trace element for ruminants. According to National Research council (2001) the dietary cobalt requirement for dairy cattle is 0.11mg/kg DM. The objective of this study was to determine the effects of dietary cobalt supplementation on selected blood minerals and glucose status during early lactation in dairy cows under tropical conditions. In this study, altogether 15 healthy pure jersey cows (BW 283.68kg, SD 30.97) which were in same parity, same lactation, same average milk yield, and same stage of lactation were selected and allocated into three groups as two treatments (0.2mg/kg and 0.4mg/kg added cobalt in DM) and control. Animals were fed with 75% Guinea grass and 25% CO3 fodder grass diet during the experiment. Treatments were provided to three groups according to 3×3 Latin square design. Blood samples were individually taken into blood collection tube (BD vacutainer) from the jugular vein of each experimental cows after the 21 days of adaptation period. Blood plasma samples were analyzed for macro and micro minerals, and glucose. Plasma macro and micro minerals were analyzed using the flame unit of Atomic Absorption Spectrometer (ThermoiCE 3000 series). Plasma glucose was measured using glucometer (Free style optimum glucose meter). Highest plasma glucose level was observed in treatment 0.4mg/kg DM (4.42mmole/L, SD 0.88) and lowest was observed in control (3.75mmole/L, SD 0.89). Highest selected macro mineral concentration was observed in treatment 0.4mg/kg DM (Ca = 4.44, SD 1.39; Mg = 0.35, SD 0.84 mmole/L) and lowest was observed in control (Ca = 3.84, SD 1.44; Mg = 0.34, SD 0.84 mmole/L). Highest micro mineral concentrations for cobalt, copper, and selenium were observed in treatment 0.4 mg/kg DM (Co = 124.09, SD 2.54; Cu = 135, SD 3.81; Se = 3.65, SD 1.68 μmole/L) and lowest was observed in control (Co = 28.45, SD 2.55; Cu = 103.55, SD 3.88; Se = 2.84, SD 1.64 μmole/L). Highest mean plasma zinc concentration was observed in control (105.94μmole/L, SD 3.87) and lowest was observed in treatment 0.4mg/kg DM (63.19μmole/L, SD 1.65). Highest mean plasma iron concentration was observed in control (112.39μmole/L, SD 5.63) and lowest was observed in treatment 0.2mg/kg DM (97.28μmole/L, SD 5.61). Mean plasma mineral concentrations and glucose were increased with the dietary cobalt intake. Therefore, these results concluded thatdietary cobalt concentration of 0.2mg/kg DM was sufficient to meet the requirements of high yielding dairy cows.

Keywords: Cobalt, Glucose, Minerals, Dairy cows

Conservation of forages in pelleted form and its influences on feeding behaviour, feed intake and nutritional value for dairy cattle

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Benefits of dairy industry primarily depend on natural pasture and fodder. The seasonal availability of forages is one of the major constraints for dairy production. Hay and silage making is limited to a few large-scale farms in Sri Lanka due to various reasons. Sustainable forage conservation method which is simple and economical for local dairy farmers is a current need. This study was conducted to evaluate the feasibility of conserving forages in pelleted form and to study the acceptability, palatability, keeping quality and physical properties of pelleted forages. Hybrid Napier Grass (CO3), *Panicum maximum* (Guinea grass), *Leucaena leucocephala* (Ipil ipil) and *Gliricidia sepium* were harvested and sun dried for 3hrs (Sd), 4hrs (Md), and 5hrs (Ld) to identify the best duration of drying for pelleting. Pelletability of biomass, moisture content, bulk density, unit density, keeping quality and nutrient composition of pellets were analysed. Supplemented pellets were made with each forage variety by mixing 75% dried forages with 25% rice polish (T1) and 75% dried forages with 12.5% rice polish and 12.5% coconut poonac (T2) and tested for keeping quality, acceptability and palatability of dairy cows. Biomass of short dried (Sd) *Leucaena,* medium dried (Md) *Gliricidia*, prolonged dried (Ld) CO3 and guinea grass biomass gave the best pelleting ability, stable pellets and longest shelf life with high bulk density and unit density. Best quality pellets could be stored under room conditions over two months without fungal and mould growth, smutty smell and colour changes. A significant interaction of moisture content, bulk density and unit density of pellets between biomass types and their dryness were observed and significant differences of crude protein and crude fibre content among the pelleted forage varieties ($p < 0.05$) were found. Higher acceptability and palatability were observed in T2 pellets than the T1 in all forage varieties. Palatability of pellets was significantly different between T1 and T2 and also between forage varieties ($p = 0.05$). *Gliricidia sepium* gave the highest palatability. The amount of fresh forage required to produce 1kg of pellet was 5.4kg of grasses and 3.9kg of legumes, respectively. The cost of production for T1 diet was Rs.24.83/kg with grasses and Rs.21.52/kg with legumes while it was Rs.22.77/kg and Rs.26.08/kg for T2 diet with grass and legume, respectively. Forage pelleting is a cost-effective conservation method of grasses and legumes which give pellets with better keeping quality, palatability and acceptability for dairy cattle.

Keywords: Conservation, Palatability, Pelleting ability, Physical properties

Silage preparation with pelleted fresh roughages and evaluation of quality and feeding behaviour with dairy cattle

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Seasonal grass availability is a major drawback for dairy cattle management in the tropics. Forage conservation as silage in silos and pits is not popular among medium and small scale dairy farmers in Sri Lanka. This study was carried out to test convenient method for small and medium scale silage production with fresh grass pellets ensiled in bags. Commonly available forages; Hybrid Napier Grass (CO3), Guniea (*Panicum maximum*), Ipil ipil (*Leucaena leucocephala*) and Gliricidia (*Gliricidia sepium*) were sundried for 3hours to get 70% of dry matter content. Each forage material were pelleted by adding 5% of molasses with CO3 (T1) and Guniea (T2). A forage mixture (T3) with CO3, Guniea, Ipil ipil and Gliricidia in ratio of 9:9:1:1 with 5% molasses were also pellet and ensiled. Pellets were packed in airtight bags and allowed to ferment up to 35 days. Samples were tested after 21st day onwards up to 35 days for pH, organoleptic properties, dry matter and crude protein content. Acceptability and palatability were tested with untrained dairy cows. The crude protein level for T1, T2 and T3 were 3.83%, 3.43%, and 3.68% respectively. Best organoleptic properties were found in T1. Bulk density of T1, T2 and T3 at the beginning were 478kgm^{-3}, 452kgm^{-3}, 538kgm^{-3} and gradually reduced at the end of 35 days to 220kgm^{-3},198kgm^{-3},260kgm^{-3}respectively.The pH value of T1, T2 and T3 after 21 days were 4.20, 4.43, 4.12 and at the 35 days were 4.10, 4.22, and 4.08 respectively. Palatability of T1, T2 and T3 was significantly different ($p < 0.05$) within treatments and best acceptability was observed in T1 and highest palatability was observed in silage made with the T3. Cost of production of pelleted grass silage and legumes were Rs.23.14/kg and Rs.18.70/kg respectively. The overall best pH, organoleptic properties, crude protein and highest acceptability were observed in CO3 grass but the highest bulk density and the highest palatability were found in the mixture. Forage conservation as pelleted silage in selected forages is a cost effective method to produce silage with higher acceptability and palatability for dairy cattle. Pelleting forages before ensiling increases bulk density and helps airtight packing and compressing the material for better ensiling in bags.

Keywords: Fermentation, Forage conservation, Pelleted silage, Silage

Effect of partial substitution of energy supplements with de-oiled rice polish in broiler diet

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De-oiled Rice Polish (DORP) is a byproduct of rice oil extraction. Compared to raw rice polish, DORP is assumed to be more laxative, contain relatively low amount of energy and fat but high in protein and fiber. Availability of DORP in the local market is increasing due to the growth of rice oil industry. This study was conducted to study the impact of different inclusion rates of DORP in diets on broiler performance and economic benefits. Experimental diets were prepared to get equal levels of protein and equal levels of energy in all three diets by incorporation of DORP at 10% (T1), 20% (T2), and 25% (T3). The control diet was prepared with no DORP in formula. Feeding trial was conducted with day-old Cob 500 chicks (n = 100). Birds were assigned to 3 treatment and control groups with 3 replicates in each. Weight gain and FCR (Feed conversion ratio) were measured and final body weight, dressing percentage, Broiler performance index (BPI), Broiler efficiency index (BEI) were calculated at the end.

Table: The effect of DORP on Broiler Performance

Treatment	Feed Intake (g/bird)	Final Body Weight (g)	FCR	BPI (%)	BEI	Dressing Percentage (%)
Control	3530	2158	1.67	52.98	48.74	74.10
T1	3352	2041	1.65	46.62	38.25	73.85
T2	3686	2124	1.84	37.25	27.80	72.20
T3	3530	2011	1.81	30.14	24.13	71.41

Feed intake, weight gain and final body weight in starter and finisher phases were not significantly different ($p > 0.05$) among the treatments. FCR between treatments were not significantly different ($p > 0.05$) though T2 and T3 has shown poor FCR (Table 1). BPI and BEI were higher in control than treatments but all the treatments have shown better BBI and BEI values compared to the standard for better economic performance. Dressing percentage, the yield of major carcass cuts and giblets were not significantly different ($p > 0.05$) between treatments and the survival rate of birds were 99%. The highest feasible rate of inclusion of DORP was 25% to maintain optimum fat and fibre levels in the diet which had not caused abnormal feeding and drinking behaviour or disorders among birds. The best economic return can be expected by incorporation of DORP at 20% in broiler diet and DROP can be incorporated up to 25% in broiler diet without significant effects on the broiler performance and economic returns.

Keywords: De-oiled rice polish, Broiler performance, Broiler diet, Inclusion rate

Nutritional status of wild mega herbivores in Wilpattu National Park, Sri Lanka

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Nutritional status of animals reveals the quality of the ecosystem that they live in. Hence, estimates on nutritional status can be a good indicator that can be used for pre and post monitoring of any ecosystem, after a management intervention. Restoration of degraded aquatic systems is currently considered for Wilpattu National Park, Sri Lanka, where both natural villus and human-made reservoirs are key water sources. We studied the nutritional status of selected wild mega herbivores in Wilpattu National Park from March to June 2017 when the park was undergoing drought conditions. Sri Lankan elephant (*Elephas maximus maximus)*, spotted deer (*Axis axis*), barking deer (*Muntiacus muntjak*), sambar deer (*Rusa unicolor unicolor*) and wild buffalo (*Bubalus arnee*) were studied. We investigated both adult male and female animals, while excluding pregnant. A total of 263 *A. axis, 20 R. unicolor unicolor,* 17 *E. maximus maximus*, 31 *B. arnee,* were sampled. Nutritional status of *E. maximus maximus* and *B. arnee* were analyzed using an already existing body condition scoring system. For deer, a new scoring system was developed based upon the evaluation of the degree of fattiness where the main emphasis was given to the prominence of bones, such as the spine, rib cage, hip bone, etc. After synthesizing the scoring system, animals were visually observed with the aid of a binocular and photographs were taken wherever possible. In parallel to the body status assessment, we did a qualitative assessment of their diet. Most preferred eight pasture species consumed by these animals were identified around Mailawewa, a seasonal reservoir and its vicinity and they were chemically analysed according to the AOAC (1996) method to obtain their moisture, ether extract, crude fibre, crude protein and ash content. Six species were sedges and two of them were grasses. Nitrogen Free Extract and thereby the metabolizable energy were estimated using calculations. Results suggest that 77% of the sampled deer and sambar population had an average, or above average body condition and 28% of them were in good or excellent body condition. Also, 47.9% of the elephants and 74.19% of the wild buffaloes had a good body condition while 16.31% of buffaloes were in an obese condition. Proximate analysis revealed that *Eleocharis dulcis cypracea* (S: Boru pan) had the highest protein content (17.75%), while, young *Cyperus compressus* (S: Thunassa) had the highest energy content (2987.76kcal/kg). It can be concluded that despite the ongoing drought megaherbivores appeared to be in good condition and pasture growing near reservoir were selectively consumed. The new body condition score can be used by park management for nutritional status evaluation throughout their range and thus to propose management interventions.

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Keywords: Body condition score, Herbivores, Wild animal nutrition, Wilpattu national park

Behaviors of mega herbivores and nutritional composition of fodder in Mailawewa reservoir of Wilpattu National Park, Sri Lanka

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Animal behaviours reveal the use of a given habitat. Amongst different animal groups, mega herbivores are a good indicator group that can provide information on the status of producers and predators, as they are affected by both. In dry zone forests, aquatic systems create several habitats and mega herbivores tend to associate them. As most aquatic systems are degraded, park management plans to restore them. Pre and post comparisons of impacts of such interventions can be understood with behaviour data. Therefore, a study was conducted at Mailawewa, Wilpattu National Park, Sri Lanka. Behaviours of selected mega herbivores were recorded using a standard Ethogram. Groups of *Axis axis* (Spotted Deer) *Sus scrofa* (Wild Boar), *Rusa unicolor unicolor* (Samba Deer), *Bubalus arnee* (Wild Buffalo) and *Muntiacus muntjak* (Barking Deer) were observed and video recorded for 15 minutes, using scan sampling between 5.30a.m. to 6.30p.m. from March to July 2017. Proximate analysis was used to determine the moisture content, crude protein, crude fibre, crude fat and ash in fodder with evidence of consumption.
A. axis displayed prominent behaviours such as grazing (70%), walking (15%) and vigilance (9%). Whereas *S. scrofa* displayed 61% of grazing, 18% of walking and 12% of resting behaviour. *R. unicolor* showed comparatively less grazing behaviour (37%) and spent more time for walking (25%), and vigilance (23%), drinking (12%). *B. arnee* spent 57% of its time on grazing, 20% of time for walking and 12% for vigilance While *M. muntjac* was grazing (40%), drinking (22%) walking (17%), showing vigilance (13%) and running (8%) near reservoirs and villus. Grazing was identified as the key behaviour which was very significant in all the tested species.
Seven browse species (*Merdeniya, Mikania micrantha, Zizyphus oenoplia, Indigofera tictoria, Centialla asiatica, Maytenus emarginata, Syzygium cumini*) were identified as their most common browsing plants. Among seven varieties *Syzygium cumini* (Madan) has the highest protein content (16.39%) and the highest energy content (866.19 kcal/kg). Results revealed that reservoirs and villus provide key habitats for mega herbivores to perform key behaviours. Additionally, the presence of browse was identified by this study. Hence it is concluded that conservation of key browse species during any restoration attempt is a necessity. High level of vigilance could be an indicator of the presence of predators, hence the healthy relationships between species.

Keywords: Mega herbivore, Behaviours, Ethogram, Proximate analysis, Vigilance

The green synthesis, characterization and evaluation of the antibacterial activity of silver nanoparticles synthesized from *Plectranthus zatarhendi* (Iriweriya) leaf extracts

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The silver nanoparticles (AgNPs) have gained much interest from chemists, physicists, biologists and engineers who wish to use them for the development of new generation nano-devices. Development of AgNPs using plant extracts has evolved into a critical area of nanotechnology due to the eco-friendly aspect. Aqueous extract of plants can reduce silver ions in aqueous solutions to generate extremely stable silver nanoparticles[1]. The objectives of this study were to synthesise AgNPs using *Plectranthus zatarhendi* leave extracts (PZLE) and evaluate characteristics of the synthesised AgNPs. The AgNPs were prepared by the reaction of silver nitrate and PZLE under different processing conditions including various concentration of PZLE, various concentration of silver nitrate, pH and light condition. Biosynthesis of the AgNPs in the mixture was monitored by measuring the UV–vis spectroscopy. The morphology, size and composition of the NPs were determined using Scanning Electron Microscopy (SEM), Particle size analyser and Fourier Transform Infrared Spectroscopy (FTIR) respectively. The synthesised AgNPs were initially identified with the colour change and further confirmed by the absorbance peak around 480nm characteristic for AgNPs. The 2% PZLE exhibited the best results for AgNPs synthesis with maximum absorbance after 24-hours. The synthesised AgNPs showed 90nm average particle size. The FTIR showed nanoparticles were combined with plant compounds. Biosynthesized silver nanoparticles showed antibacterial activity against Gram-negative (*Klebsiella spp*, *Acinetobacter* and *Pseudomonas aeruginosa*) and Gram-positive (*Staphylococcus aureus*, *Streptococcus spp* and MRSA (Methicillin resistant *Staphylococcus aureus)* bacteria. In summary, the PZLE is an excellent eco-friendly, non-toxic source which is a simple biological method for the synthesis of AgNPs. Rapid biological synthesis of AgNPs was observed using *P. zatarhendi* leaf extract.

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Keywords: *Plectranthus zatarhendi,* Green synthesis, Silver nanoparticles, Characterization

Effect of bacterial contamination on the hatchability of broiler breeder hatching eggs

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The poultry industry is one of the well-established animal husbandry sector in Sri Lanka. The chick production from a poultry breeder flock mainly depends on both fertility and hatchability. There are several factors which affect the incubation process and hatchability. The hygienic level at the hatchery is considered as one of the most important factors for production of healthy chicks[1]. One of the medium scale broiler breeder hatchery in the North-Western Province experienced a reduction of the hatchability in spite of correcting other associated factors. Therefore, the present study investigated bacterial species associated with contamination leading to reduce hatchability. Information on total eggs laid, fertile eggs and number of chicks hatched were collected to calculate the performance level of the hatchery using standard equations. Using sterile swabs, samples were collected from meconium, unhatched, infertile and floor eggs. After collection, all samples were immediately transported to the laboratory in an ice box. The samples were plated onto sterile blood and nutrient agar plates and then incubated at 37°C. Bacterial pathogens were identified by plating on selective media including; MacConkey agar (Mac), Xylose Lysine Deoxycholate Agar (XLD), Salmonella-Shigella Agar (SS), Brilliant Green Agar (BG) and followed by biochemical tests. According to the calculations the performance of the hatchery ranged as follow, 67.9-80.2% fertility, 35-60% hatchability, 52.7-75.3% hatch of fertile and 24.6-47.2% Dead in Shell (DIS). Out of the collected samples; 16.67% of infertile eggs, 25% of floor eggs, 33.33% of unhatched eggs and 37.5% of meconium (n=9; 37.5%) harbored bacterial contamination. Identification of positive culture samples revealed the following proportions of bacterial agents; *Pseudomonas* (80.0%) and *E. coli*, (20.0%). However, *Salmonella* (0.0%) was not isolated from any of the samples. The 0.528 regression coefficient between the DIS% and the contamination% indicative of the effect of bacterial contamination on the reduced hatchery performances. Isolation of microbial pathogens in this study indicates a serious issue associated with inadequate hygiene practices, improvement in hatchery operations particularly with regards to hygiene and sanitation. Adequate training of hatchery operators is needed to raise awareness of the crucial role of hygiene and biosecurity play in ensuring high hatchability and fertility rates.

[1]Desha, N. H., Islam, F., Ibrahim, M. N. M., Okeyo, M., and Bhuiyan, H. J. A. (2015). Fertility and hatchability of eggs and growth performance of mini-incubator hatched indigenous chicken in rural areas of Bangladesh. *Tropical Agricultural Research*, *26*(3), 528-536.

Keywords: Hatchery, Hatchability, Bacterial contamination, Poultry

Evaluation of possible sources of raw milk contamination and hygienic practices of small scale dairy farmers in Makandura area

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In Sri Lanka, milk is almost exclusively produced by smallholdings. According to the Central Bank report in 2014 total annual milk production of Sri Lanka was 27.8 million litres. But it has been able to meet only 30-33% of the national requirement. Therefore, the government has planned to increase the domestic production up to 50% by the year 2015 to reduce the imports. Although the government has planned to increase the production, about 20% of milk is discarded at chilling centres in each district due to spoilage. This spoilage is due to bacterial contamination which has been reported to originate at the farm level. Therefore, proper quality should be maintained to maximise the production. Moreover, analysing possible sources of raw milk contamination at farm level is very important to maintain the milk quality. Therefore, the objective of this study was to evaluate the possible sources of raw milk contamination and hygienic practices of small scale dairy farmers.

A total of 30 small scale dairy farmers were selected from Makandura area. Major contamination sources have been identified as hands of milker, udder of cow, water source, milking containers and bulk containers. Samples were collected aseptically from all contamination sources ($n = 150$) in each farm and transported immediately to the laboratory in an ice box. Microbiological analysis was done after serial dilution of each sample. Total plate count (TPC) method was done to estimate the overall microbial count in each sample. Most probable number method (MPN) was done to estimate the coliform count (CC) and presence of *E-coli.* Meanwhile, all the farmers were interviewed using a pre-tested questionnaire to assess hygienic practices. All the data obtained from microbiological analysis and questionnaire was analysed using SPSS version 20. There was a significant difference between population means in TPC among tested types of sources ($p < 0.05$). There was a significant difference between population means in CC among tested types of sources ($p < 0.05$). There was no significant association between different sources and presence of *E-coli* ($p > 0.05$). Highest TPC and CC were reported from bulking containers. The presence of *E-coli* was highest in hands of milker. According to the results from the questionnaire, most of the farmers practised pre-milking practices up to an acceptable level. But practising of post-milking practices was very poor among tested farmers. Therefore, focus on hygienic practices and sanitary measures at farm level is very much important in order to improve the quality of raw milk.

Keywords: Coliform count, *E-coli,* Hygienic practices, Most probable number method, Raw milk, Total plate count

A comparison between microbial culture and PCR methods for diagnosis of sub clinical mastitis in dairy cattle

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Mastitis is one of the most common cattle diseases that affect the dairy industry. It should be diagnosed and controlled as early as possible to minimise the losses to the dairy industry. Different diagnostic methods are used such as microbial culture, Enzyme assays and PCR[1]. We have developed a multiplex PCR method to identify *Staphylococcus aureus* and *Escherichia coli* from pure cultures and it has not been optimized for the milk samples. Further, the sensitivity of this PCR method has not been compared with culture method. Therefore, the objective of the present study was to compare the culture and PCR methods in the diagnosis of sub-clinical mastitis in dairy cows. CMT positive milk samples were collected from three NLDB farms around the university during morning milk. Samples were cultured on sheep blood agar within six hours of collection. Pathogens were identified by sub culturing on specific media and biochemical tests. DNA was extracted and PCR was optimized for samples to identify the pathogens. 4.0μL of genomic DNA, 2.0μL of dNTPs and 10pmol/μL of forward and reverse primer concentrations were introduced under optimized conditions. 83.65% of *Staphylococcus aureus* 25% of *Escherichia coli*, 3.85% of *pasteurella* species and 3.85% of non-pathogenic *Staphylococcus* species were identified by culture method. But only 26.29% of *Staphylococcus aureus* and 2.88% of *Escherichia coli* were identified by PCR method. *Staphylococcus aureus* was the most common pathogen identified by these two methods. Microbial culture method could detect a higher percentage of a specific organism causing sub-clinical mastitis compared to PCR method in the current study. The sensitivity of the PCR method should be optimized further.

[1]Kasikci, G. (2012). Relations between electrical conductivity , somatic cell count , California mastitis test and some quality parameters in the diagnosis of subclinical mastitis in dairy cow. *Journal of dairy science*, 36(1), 49–55.

Keywords: Mastitis, Microbial culture method, Milk, PCR method

Development of a PCR protocol for the detection of *Streptococcus dysgalactiae* in bovine subclinical mastitis

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Bovine mastitis is an inflammation of the udder and it is the most costly disease of dairy cattle. The severity of the inflammation can be classified into subclinical and clinical forms. Subclinical mastitis is the most important cause of economic losses since it is 15-40 times more prevalent than the clinical form and it constitutes a reservoir of microorganisms without causing any gross abnormality both in the gland and milk. The microorganisms causing mastitis are very vast and complex. *Streptococcus dysgalactiae* has been reported as one of the common causative organisms of mastitis in Sri Lanka. Currently, microbiological and biochemical methods are used to detect the causative organisms. But those methods are time-consuming, labour intensive and unreliable in subclinical infection due to low bacterial count. As a solution, PCR method provides a sensitive, rapid and accurate detection of causative organisms during the subclinical stage. Therefore, the objective of this study was to develop a PCR protocol to detect *Streptococcus dysgalactiae* in bovine subclinical mastitis. A pure culture of *S. dysgalactiae* was sub-cultured in sheep blood agar and cells were harvested by centrifugation. DNA was extracted by column purification method and used as the positive control. Species specific primers were synthesized to amplify 572bp PCR fragments for *S. dysgalactiae*. PCR conditions were optimized to initial denaturation at 94°C for 5 minutes followed by 35 cycles of 94°C for 20 seconds, annealing at 60°C for 30 seconds, extension at 72°C for 45 seconds and final extension at 72°C for 10 minutes. Primer concentration was optimized to 20pmol as the optimum primer concentration for amplification of *S. dysgalactiae*. DNA and PCR products were detected under 0.8% agarose gel electrophoresis with UV illumination. However, these conditions should be further optimised to detect all four species in one reaction by multiplex PCR. Reliability of the results should be checked on bovine milk with various CMT scores. In conclusion, this simplex PCR can be used as a diagnostic tool to detect *S. dysgalactiae* in bovine subclinical mastitis.

Keywords: Bovine subclinical mastitis, DNA extraction, PCR, *Streptococcus dysgalactiae*

Ginger as a flavouring agent and natural antioxidant in coconut oil mayonnaise

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Mayonnaise is a thick, creamy dressing that conventionally formulated using vegetable oil and egg yolk incorporating with acidulates like vinegar. Coconut oil is one of the locally available oil that has a beneficial effect on human health, especially flavonoids and polyphenols present in coconut oil can be effective in reducing the oxidative stress involved in the aetiology of various diseases, for instance, cardiovascular diseases and cancer[1]. This study aimed to produce mayonnaise from coconut oil and extend the shelf life of mayonnaise using ginger powder.

Coconut oil was used to replace conventional oil in producing mayonnaise, and emulsion stability test was conducted to get the coconut oil percentage that gives higher emulsion stability. Sensory qualities were evaluated in developed coconut oil mayonnaise samples that were incorporated with 2%,4%,6% and 8% ginger powder, consumer preference for these products were determined using a five-point hedonic scale and data were analysed with non-parametric Kruskal-Wallis test. Based on the findings of the sensory evaluation, the most preferred ginger percentage containing mayonnaise was further evaluated for antioxidant effect by monitoring the peroxide values, free fatty acid, pH and the microbial quality was evaluated during 5 weeks storage period. A control mayonnaise sample that was prepared from coconut oil without incorporating ginger powder was also monitored for the antioxidant effect and microbiological quality during the storage period.

The mayonnaise containing 70% to 80% coconut oil demonstrated the highest emulsion stability. According to the sensory analysis, 2% ginger powder incorporated mayonnaise obtained the highest consumer acceptance. The pH value of the mayonnaise significantly ($p < 0.05$) decreased with the storage period. The rate of decreasing pH value in 2% ginger powder incorporated mayonnaise was significantly ($p < 0.05$) lower than that of the control. The peroxide and free fatty acid values significantly ($p < 0.05$) increased with the storage. However, the rate of increase in peroxide and free fatty acid in 2% ginger powder incorporated mayonnaise samples was significantly ($p < 0.05$) lower than that of the control. According to the microbial analysis, the mean aerobic microbial count, yeast and mold count of mayonnaise that incorporated with 2% ginger powder was significantly ($p < 0.05$) lower than the control. *Salmonella* was negative in the formulated coconut oil mayonnaise. According to the findings, the coconut oil could be used as a non-traditional oil in the preparation of mayonnaise and ginger extract can be utilised as a natural antioxidant to hinder lipid oxidation in fat rich food product such as mayonnaise.

[1]Boemeke, L., Marcadenti, A., Busnello, F. M. and Gottschall, C. B. (2015). Effects of Coconut Oil on Human Health, *Open Journal of Endocrine and Metabolic Diseases*, 5(7), 84–87. doi: 10.4236/ojemd.2015.57011.

Keywords: Coconut oil, Lipid oxidation, Emulsion stability, Ginger

Development and storage studies of whey-based pineapple (*Ananas comosus)* beverage

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Whey is a nutritious by-product obtained during coagulation of milk from cheese industry. One of the attractive possibilities of whey utilization is producing different kind of beverages[1]. The present investigation aimed to develop a value-added whey-based pineapple beverage with acceptable sensory and nutritional characteristics along with its storage stability. The beverage samples were prepared using five different proportions (0%, 15%, 25%, 35% and 45%) of pineapple juice in cheese whey. The amount of sugar was fixed at 5g per 100ml of prepared beverage. The best formulation was selected through a sensory evaluation of five point hedonics scale using thirty untrained panellists. The physico-chemical parameters of prepared beverages were determined at 7°C (SD 1) within 28 days of storage period.

Results revealed that whey beverage with 35% pineapple juice have scored the highest mean scores for taste (110.53) and overall acceptance (118.05). According to the statistical analysis effect of five treatment levels on all sensory characteristics were significantly different ($p < 0.05$). Based on the storage study results; mean values of total soluble solids (from 12.43 to 13.20 °Brix), acidity (from 0.98% to 1.06%) and reducing sugar content (from 2.67% to 2.78%) were increased while pH (from 4.22 to 4.01) and ascorbic acid content (from 4.01mg/100g to 0.96mg/100g) were decreased significantly in all five treatment levels. Total sugar content had a non-significant effect ($p > 0.05$) during storage period. The reason for increasing total soluble solids may be solubilization of insoluble portion of beverage samples due to the presence of acids. The decrease in pH and increase in acidity of all five treatment levels during storage period were due to the conversion of lactose present in whey into lactic acid. The increasing in reducing sugars during storage period might be due to the inversion of sucrose. The reduction of ascorbic acid can be due to the high sensitive nature of ascorbic acid towards storage.

Based on the results of sensory analysis and storage studies, it can be concluded that whey beverage combination with ripe pineapple juice can be prepared successfully by using the tested levels of, T3 (35% pineapple juice + 65% whey) and T4 (45% pineapple juice + 55% whey) as compared to other proportions used.

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Keywords: Physico-chemical, Pineapple, Sensory, Storage, Whey

Potential application of black pepper (*Piper nigrum*) as a natural preservative in cheddar cheese

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Cheese is a dairy product that develops through fermentation of milk by the action of lactic acid bacteria. Cheeses are contaminated by foodborne microbes at various stages of production process and storage. Preservatives are added to improve the quality of cheese. Synthetic preservatives are not safe for consumption. Therefore, spices and herb extracts have gained more attention as natural preservatives[1]. Therefore, present study was focused to develop a cheddar cheese by adding black pepper as a natural preservative. Antimicrobial, antioxidant properties, and pungent flavor of black pepper are gained with the presence of 'piperine' as the active component in black pepper.
In this study, black pepper powder was incorporated into cheddar cheese samples at 0%, 0.5%, 0.75%, and 1% of wet cheese weight. Microbiological aspects and storage stability were evaluated for one month storage period at 5 days intervals. Total viable colony counts were obtained by performing standard plate count method. Storage stability was determined with respect to pH, titratable acidity, and free fatty acid value. Sensory attributes were evaluated by 30 untrained panelists using five-point hedonic scale. The lowest total viable colony counts after one month of storage period were obtained for 0.5%, 0.75%, and 1% black pepper added samples ($1.85*10^7$, $9.85*10^7$, and $2.5*10^7$ CFU/g respectively) when compared to control sample ($3.48*10^8$CFU/g) because of the antimicrobial properties of black pepper. Black pepper added cheese samples were shown the reduction in pH from 5.17 to 4.587 ($p<0.05$), increase in titratable acidity from 0.097 to 0.265 ($p<0.05$) with increasing acid production during cheese ripening. Increase in free fatty acid value from 0.221 to 1.584 ($p<0.05$) in black pepper added samples was observed due to the conversion of lipids into free fatty acids with the action of lipase enzyme during ripening. This study concludes that cheese sample with 0.5% black pepper was selected as the best product with respect to microbiological analysis and sensory evaluation.

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Keywords: Antimicrobial, Antioxidant, Black pepper, Natural preservative, Piperine

Development of processed cheddar cheese considering purchasing behaviour of Sri Lankan cheese consumers

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Cheese is a most versatile, nutritious and fermented luxurious dairy product in the world. Therefore, formulation and marketing of new food products are very complex and there are many interacting influences on consumer acceptance, e.g. the person, the food product and the environment[1]. The present study was focused to develop a processed cheddar cheese based on a Sri Lankan consumer preference. A survey was used to determine consumer preferences for cheese varieties. Consumers' purchase behaviour were investigated by means of a survey questionnaire. It was completed by 300 consumers from randomly selected six districts (Kandy, Matale, Kurunegala, Puttalam, Colombo and Gampaha) based on population density in Sri Lanka. Socioeconomic circumstances, purchasing behaviour, sensory and packaging attributes related to cheese varieties available in the market were assessed using questionnaire. Results revealed that Sri Lankan consumer preferred to butter flavour, soft texture and cream colour in cheese at 52.22%, 70.96% and 53.50% respectively. Aluminum foil was most preferable packaging material among respondents. There was a relationship between purchasing behaviour and the education level of consumers ($p < 0.05$). Based on the questionnaire result, processed cheddar cheese was developed. Proximate composition, sensory characteristics and standard plate count were determined for the processed cheddar cheese during 21 days of storage period. Total bacterial plate count significantly increased while pH was significantly declined ($p < 0.05$). Titrable acidity was increased (from 0.83g lactic acid to 1.10g lactic acid) during 21 days. Moisture content was reduced from 34.85% to 0.18% which had a strong correlation with storage periods ($r = -0.956$). Total solids was increased from 65.14% to 99.82% which had a strong relationship with storage days ($r = 0.956$). Protein content increased with storage days ($r = 0.936$) and total fat content also increased from 24.3% to 42.11%. It could be concluded through sensory evaluation, developed processed cheddar was existed as "moderately acceptable" by the panellists. Future studies are needed to improve the developed cheddar to prevent the rapid reduction in moisture content.

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Keywords: Cheddar, Consumer, Purchasing behaviour, Sri Lanka

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