



ABSTRACTS

Third Undergraduate Research Symposium

Faculty of Livestock, Fisheries and Nutrition

Wayamba University of Sri Lanka

2015

‘Nourishing the nation through sustainable food production’

14 October 2015

Third Undergraduate Research Symposium

**Faculty of Livestock, Fisheries and Nutrition
Wayamba University of Sri Lanka
2015**

‘Nourishing the nation through sustainable food production’

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“Nourishing the nation through sustainable food production”: blooming of young scientists – From the Editor

I am pleased to present the Book of Abstracts of the Undergraduate Research Symposium (UReS 2015) of Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka containing 94 abstracts. Those abstracts will be presented on 14th of October 2015 in several oral and poster sessions. All undergraduates in the Faculty of Livestock, Fisheries & Nutrition following the BSc in Food Science & Nutrition and BSc in Food Production & Technology Management successfully completed their final year research projects for full one semester and now they are ready to present their research findings at the Symposium. The research carried out by the undergraduates covers the disciplines of applied nutrition, food science and technology, aquaculture, fisheries, livestock and avian sciences within the theme of ‘nourishing the nation through sustainable food production’.

On behalf of the publication committee, I wish to thank all the supervisors of the undergraduates who groomed the research, scientific writing and presentation skills of the undergraduates. I wish to convey my sincere gratitude to all authors and reviewers for their contribution. The publication committee along with reviewers put a tremendous effort in reviewing abstracts and compiling the abstract book in this format. Also, I wish to thank the Dean of the Faculty, Co-ordinator of the UReS and her energetic team for supporting our task.

Dr Renuka Silva

Editor

Undergraduate Research Symposium 2015

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

As the Dean of the Faculty of Livestock, Fisheries & Nutrition, I would like to cordially welcome you to the Third Undergraduate Research Symposium (UReS 2015). As a rapidly growing faculty in Wayamba University of Sri Lanka it has always promoted scientific research and excellence in teaching. The symposium provides opportunity for final year undergraduate students of the faculty to present their research findings. UReS 2015 will be a stimulating moment for the final year students and their supervisors to disseminate knowledge to the fellow scientists in the discipline. This annual event will motivate and encourage budding scientists who are planning to pursue higher studies, research and other careers in their respective disciplines.

The theme of this year's symposium is 'Nourishing the nation through sustainable food production'. As the faculty is dedicated to the training, research and outreach in 'food production technology' and 'food science and nutrition', this theme matches strongly with the vision and mission of the Faculty. This symposium would be an interactive session for students, academics and colleagues from private and public institutions to exchange views and engage in discussions on a variety of topics under four major disciplines; Aquaculture & Fisheries, Applied Nutrition, Food Science & Technology and Livestock & Avian Sciences.

I congratulate all undergraduates who will make presentations. I also take this opportunity to thank all my colleagues who worked hard to make this event a reality and I wish the presenters and participants a fruitful time at the technical sessions.
I wish the UReS 2015 every success.

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**

As the Vice Chancellor of the Wayamba University of Sri Lanka, I am pleased to welcome you to another very important annual scientific event of the University. Carrying out research and dissemination of the findings to stakeholders is a primary responsibility of the University. Our main aim is to support the fulfillment of social responsibilities of the Sri Lankan population through the advancement of science. I am so pleased to see another group of young scientists about to be graduated from our university have done research successfully and sharing with experienced scientists and other stakeholders in their disciplines.

The theme for this symposium 'Nourishing the nation through sustainable food production' is highly appropriate and timely as the Faculty of Livestock, Fisheries & Nutrition always the frontiers in this discipline. I understand that the research carried out by the undergraduates and academic staff represents a common goal of the diversified fields of specialty in the Faculty. Food production must be sustainable in terms of environment and human health. I am convinced that the participants in this Symposium will at least make an effort to solving the issues related to unsustainable and unhealthy food production systems through their research.

I wish to extend my congratulations to the Dean, Faculty of Livestock, Fisheries and Nutrition, Organizing Committee of the Symposium for organizing this event. I specially congratulate the undergraduates who are presenting their research today. I hope that 3rd Undergraduate Research Symposium (UReS) 2015 is a most fruitful and memorable experience for you.

Professor S.J.B.A. Jayasekara
Vice Chancellor
Wayamba University of Sri Lanka

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Proximate analysis of selected locally available underutilized fruits in Sri Lanka

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Underutilized fruit crops are the fruit crops which are high in value but not widely grown, rarely found in the market and not cultivated commercially (1). Although Sri Lanka has over 60 varieties of underutilized fruit crops, Sri Lankan food composition tables contain only limited data on underutilized fruit varieties. In current research, the edible portions of ten selected locally available underutilized fruits collected from various locations of North Western Province were analyzed for moisture (oven drying), ash (gravimetric method), crude protein (Kjeldahl), crude fat (Soxhlet) and total sugar content (Lane-Eynon volumetric method). Total carbohydrate content was determined 'by difference'.

Selected underutilized fruit varieties for the analysis include: Rose apple (Var.Malaysian) *Syzygium jambos*, Rambutan (Var.Malaysian red) *Nephelium lappaceum*, Star fruit (Var. Pani carambola) *Averrhoa carambola*, Guava (Var. sudu) *Psidium guajava*, and local selection of Pummelo *Citrus grandis*, Jew plum *Spondias dulcis*, Bilimbi *Averrhoa bilimbi*, Soursop *Annona muricata*, Ceylon olive *Elaeocarpus serratus* and Governor's plum *Flacourtia indica*,. The mean values (n=3) of proximate composition in g/100g of fresh edible portion of fruits are summarized in the table.

Among the analyzed fruits Governor's plum and Ceylon olive contain the highest carbohydrate content. Total sugar content varied between 0.5% - 12.9% and >10% of total sugar was found in governor's plum, soursop and rambutan. Protein content is very low, fat is negligible and Ceylon olive is the highest in total mineral content, among analyzed fruits.

Table: Proximate composition of fresh edible portion of fruits (g/100g)

Type of Fruits	Moisture	Protein	Fat	Ash	Total Sugar	Carbohydrate
Guava	85.7	0.5	0.1	0.5	5.2	13.1
Star fruit	90.5	0.5	0.1	0.4	6.7	8.5
Bilimbi	94.0	0.7	0.2	0.5	0.5	4.7
Rose apple	92.5	0.3	0.1	0.3	2.7	6.7
Ceylon olive	79.2	1.2	0.1	0.8	9.7	18.3
Governor's plum	73.4	1.3	0.7	0.7	12.9	23.9
Sour sop	85.1	0.9	0.1	0.4	11.1	13.5
Rambutan	83.8	0.7	0.1	0.3	10.0	15.2
Pummelo	90.2	0.7	Traces	0.6	2.3	8.5
Jew plum	85.5	0.8	Traces	0.5	4.2	13.1

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Promotion of utilizing agro-biodiversity to enhance household food and nutrition security

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Agro-biodiversity refers to the variety and variability of animals, plants and micro-organisms those are used directly or indirectly for food and agriculture (1). Food systems with many local varieties can be used to enhance the household food and nutrition security. The objective of the present study was to design intervention programmes to promote agro-biodiversity and pilot testing of selected programmes. The study focused on promoting agro-biodiversity in Gampola village in Giribawa divisional secretariat division (Low country dry zone) having rice based cultivation under village tank system and Aluthgama village in Nawalapitiya divisional secretariat division (Mid country wet zone) having organized home garden systems. Gaps in utilization of agro-biodiversity were identified by conducting focus group discussions, knowledge, attitude and practices questionnaire and observations of agro-biodiversity in two sites.

Lack of documented data about botanical, agronomical and nutritional value of local varieties, lack of consumer awareness on the nutritional value of locally available foods, low availability of local foods, poor knowledge about preparation methods, lack of motivation to eat local foods, diminishing of traditional knowledge and practices transfer from older to younger generation and lack of government and policy support for local food systems were identified as gaps in utilization of agro-biodiversity. Five multi-sectoral intervention programmes were planned for Gampola village: promotion of locally available crop varieties through home gardening, open farm managing system, local food promoting programme among school children and preschool children, health and nutrition development project and in-situ conservation of local varieties in chena. Three multi-sectoral intervention programmes have been planned for Aluthgama village: introduction of locally available foods into home gardens, series of awareness programmes to promote local foods among villagers and promotion local foods among school and preschool children. Two pilot programmes were conducted in two sites and positive comments were received from participants and nutritionists. Intervention programmes pilot tested in two selected sites to promote utilization of agro-biodiversity to enhance household food and nutrition security were successful.

Financial support for the study was provided by Biodiversity, Food & Nutrition Project funded by Global Environment Facility & Nestle Foundation, Switzerland.

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Keywords: Agro-biodiversity; food and nutrition security; multi-sectoral approach

Determination of non-nutrient antioxidants and their activities of underutilized tubers as affected by different cooking methods

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The use of tubers is limited to common types and many underutilized varieties remain neglected though they perform benefits especially in terms of their antioxidant value. The preparation of these tubers to get the maximum nutritional benefits is unknown. Therefore, this study was conducted to determine the non-nutrient antioxidants and their activities of underutilized tubers as affected by different cooking methods.

Twelve different underutilized tubers belonging to five species namely, *Dioscorea alata* (Thembala, Dam ala, Ini ala, Kirikondol, Hingurala, Kahata ala, Guru ala, Athpaada), *D. esculenta* (Kukulala), *Xanthosoma sagittifolium* (Kiri ala), *Alocasia indica* (Ratala) and *Amorphophallus campanulatus* (Keedaram) were collected from Agriculture Department. The flesh of the tubers were subjected into six different cooking methods, namely oven drying, roasting, frying, open boiling, pressure cooking and steaming. Processed samples were analysed for their total phenolic content (TPC), 2,2- diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (DRSA), reducing power (RP), and ferrous ion chelating ability.

Ratala pressure cooked sample had the highest TPC while Hingurala flesh possessed the lowest, which ranged from 1.8-95.2 μmol gallic acid equivalent/g of dry weight (DW) (Figure). The pressure cooked samples of Kukulala and Kiriala had the highest and the lowest DRSA, respectively which ranged from 1.2-245.1 μmol trolox equivalent/g of DW. The best Fe ion chelating ability was exhibited by Kahatala peel while Guru ala open boiled sample possessed the lowest which ranged from 0.1-77.0 μmol of EDTA equivalent /g of DW. Ratala pressure cooked sample performed the highest RP ability while Thembala pressure cooked sample showed the lowest ability. The results suggested that Thembala was the richest source of phenolics in its' raw form and Ratala performs the best antioxidant activities. Out of the 6 cooking methods, pressure cooking and steaming appeared to be the best to retain the high antioxidant value of these tubers. Therefore the potential of these underutilised tubers as natural source of antioxidants depends on

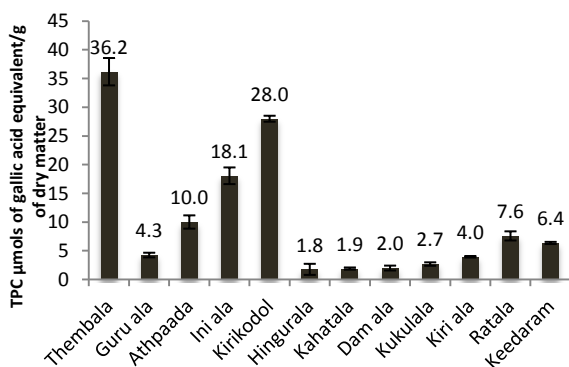


Figure: Variation of TPC of flesh of tubers

the variety and the cooking method that they undergone.

Keywords: Antioxidants; antioxidant activities; cooking methods; underutilized tubers

Development of a nutrition information system on Sri Lankan plant foods

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Food composition data provide fundamental information in the field of food and nutrition. The existing Sri Lankan food composition tables are obsolete and exclusive Sri Lankan food compositions are necessary for users. Although some food items grown in Sri Lanka were analyzed for nutrient composition, they are not compiled systematically. This study focused mainly to compile the analytical food composition data of Sri Lankan plant foods and to develop a paper based and an electronic nutrition information system.

The data were collected through online published literature via two search engines; Google Scholar and Science Direct, online issues of scientific journals and publications of universities. The standards and guidelines which are provided by International Network of Food data Systems (INFOODS) for compilation of food composition data were used to scrutinize the collected compositions (1). Further conversions and calculations were done to make original data more comprehensive (2).

Fifty research articles were retrieved by the search strategy and only 36 articles which were compatible with defined criteria were considered for the final documentation. Edible portion of both raw and processed foods were included. A total of 138 food items, categorized into 8 plant food groups (Table) were compiled to the nutrition information system. The database contains only the original analytical values but not any calculated, imputed, borrowed values. Using the data, a paper based food composition table was developed as 'Nutrition Compositions of Sri Lankan Plant Foods' and an electronic nutrient

Table: Number of food items compiled by main plant food groups.

Plant food group	Number of compiled food items
Cereals	43
Fruits	26
Roots and Tubers	22
Legumes	15
Green leaves	15
Vegetables	10
Spices and Herbs	4
Nuts and Seeds	3

information system was developed as 'NUTREE'. The paper based version describes additional details about food items and it contains information on selected nutrient components extracted from the published literature. NUTREE assembled with all the nutrient and non nutrient components described in INFOODS food composition data. The nutrient information system facilitated with all basic features such as a food search, contact details of compilers and a user guide as well as some other features such as online accessibility to referred original data sources and photographs of foods to make the system user-friendly.

This study was funded by National Agriculture Research Policy (NARP)

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Keywords: Food composition; compilation; plant foods; data base

Antioxidant content and activities of sweet potatoes (*Ipomoea batatas*) commonly grown in Sri Lanka

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Sweet potatoes (*Ipomoea batatas*), is the seventh most important food crop of the world producing over 105 hundred million metric tons of edible food products annually , although it is categorized as “poor man’s food”. In addition to the nutrients, it contains secondary metabolites like antioxidants. The antioxidant content and activities in sweet potato have not widely appreciated yet. The objectives of this study were to determine the total phenolic content (TPC), total flavonoid content (TFC) and their antioxidant activities using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay (DRSA) and ferrous ion chelating ability (FICA). Six varieties of sweet potatoes commonly grown in Sri Lanka including ‘Ranabima’, ‘Gannoruwasudu’, ‘Ama’, ‘Hordi-mali’, ‘Dhawala’ and ‘Wariyapola rathu’ were selected. Whole tuber and raw flesh of each variety were subjected to three different processing methods as open boiling, pressure cooking and frying, respectively. Processed samples were freeze dried, ground to make fine powder, extracted using 80% methanol and analysed.

The results showed that the peel of Ranabima variety had the highest phenolic content with 31.34 (SD 2.17) μmol of gallic acid equivalent (GAE) /g of dry weight (DW) and when it was fried, gave the highest DRSA reporting 32.23 (SD 1.60) μmol of trolox equivalent /g DW. Pressure cooked Ranabima whole tuber had the highest TFC reporting 59.87 (SD 2.53)

Table: TPC of Ranabima variety

Processing condition	TPC (μmol of GAE /g DW (SD)
Whole tuber	8.58 (0.48)
Raw flesh	4.23 (0.48)
Raw peel	31.34 (2.17)
Pressure cooked with peel	31.10 (0.48)
Boiled with peel	17.19 (0.43)
Fried with peel	16.46 (0.08)

μmol of catechine equivalent (CE) /g DW, while its open boiled whole tuber had the highest FICA with 10.46 (SD 0.13) μmol of Ethylene diamine tetra acetic acid (EDTA) equivalents/g DW. The range of TFC in processed samples was 17.38 – 0.19 mg of CE / g DW. DRSA in whole tuber samples was reported as 1.29-2.59 mg trolox equiv / g DW. Ranabima

processed samples exhibited higher degree of antioxidant content in terms of TPC (Table) and TFC, and also their antioxidant activities were considerably high. Although Dhawala had the lowest phenolic content, its FICA was higher in whole tuber samples accounting for 8.10 (SD 0.43) μmol s of EDTA equiv / g DW. In six varieties FICA in raw flesh samples was 0.184-2.296 mg of EDTA equiv /g DW. Pressure cooking is the predominant method which increased both antioxidant contents and activities. Cooking sweet potatoes with peel provides more antioxidants in the diet.

Keywords: Antioxidants; sweet potato; varieties; processing; bio activities

The economics of type 2 diabetes mellitus, dietary energy density and diet cost of employed individuals

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Diabetes exerts a substantial burden on the economy related to increased health system costs and loss of productivity. Evidence is accumulating that dietary energy density contributes to development of insulin insensitivity and the quality of the diet is influenced by diet costs. The aims of this study were to assess the economic burden of medically diagnosed employed type 2 diabetics and to estimate diet costs and diet quality. A total of 100 employed, diabetic patients were interviewed using pretested structured questionnaire. The study was based on the cost of illness approach to estimate the direct costs and the indirect costs. Dietary energy and nutrients intake estimations were based on a validated semi quantitative food frequency questionnaire. Dietary energy density (kcal/g of edible weight of all the foods and beverages) and energy adjusted diet costs (Rs/2000kcal) were calculated with supermarket food prices. The estimated average cost for a diabetic patient is Rs 2795.72 /month. This included Rs 1408.32 of direct cost (50.37%) and Rs 1387.40 of indirect cost (49.63%). Costs were escalated with prolonged diabetes and presence of diabetic related co-morbidities. Patients with chronic complications had higher costs (Rs 819.27/patient), compared to those without any reported chronic complications (Rs 588.74) related to diabetes. A considerable proportion (25%) of monthly medicine costs were borne due to hypertension and hypercholesterolemia. The mean dietary energy density was 1.43 kcal/g and was correlated with total and saturated fat intakes ($P<0.05$). The estimated mean energy adjusted diet cost for a diabetic patient was Rs 200.04/ 2000 kcal.

Table: Correlation between energy adjusted diet costs and dietary factors

Variable	Energy adjusted diet cost	
	r	P value
Dietary energy density (kcal/100g)	0.33	0.001
Total protein	0.25	0.014
Saturated fat	0.37	<0.0001
Cholesterol	0.36	0.000
Potassium	0.22	0.025
Iron	0.26	0.009
Vitamin A	0.23	0.023
Vitamin C	0.26	0.010

The diet costs were inversely correlated with the dietary energy density ($P<0.05$) (Table). The lower cost diets were high in total and saturated fats and tend to be more energy dense but poor in nutrient density. The cost estimation

highlights the economic burden of diabetes could be prevented by initial identification of the disease, avoidance and delaying of diabetes co-morbidities and complications. Further studies are needed to investigate the cost effective interventions to reduce the economic burden of diabetes.

Keywords: Economic burden; diabetes mellitus; direct and indirect costs; diet quality

Development of low glycemic porridge using finger millet (*Eleusine coracana*)

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The prevalence of non-communicable diseases (NCDs) like diabetes mellitus, cardiovascular diseases, hypertension, and cancers is rapidly increasing in Sri Lanka. Finger millet which is known to have several health benefits including down regulating blood sugar level is one of the popular food source for diabetics in traditional medical system. However, concerns on high glycemic index (GI) of finger millet foods hinder its usage in modern health care system. Hence, this research was carried out to develop low glycemic foods using finger millet prepared by subjecting to different processing conditions.

Finger millet porridge was selected as candidate food and flours were submitted to parboiling, roasting and size reduction. The prepared porridge types were evaluated by a semi trained sensory panel of 30 individuals. These porridges which include 25g available carbohydrate were given to 10 selected healthy subjects who were in 10-12 hours fasting state and the blood glucose levels measured at 0 (fasting), 30, 60, 90 and 120 minutes after ingestion of the test meal using finger prick blood test. The incremental area under curve (IAUC) of blood glucose response curves and the GI were calculated. Each porridge types were analyzed for total phenolic content (TPC), DPPH radical scavenging activity and resistant starch content.

Results showed that 15 minutes and 30 minutes parboiling beneficially affected on TPC and DPPH radical scavenging activity by increasing the values when compared with raw flour. The resistant starch content has increased in the porridge types prepared by parboiling, giving highest value of 23.89 g/100g of dry matter in porridge made out of 15 minutes parboiled flour when compared to porridge made out of raw flour (23.24 g/100g of dry matter). All porridges types except those made out of raw small roasted and raw large roasted flour showed low GI value ranging from 38.0 (SEM 3.56) to 48.0 (SEM 5.1). The porridge types prepared by raw roasted flour was given moderate to high GI values, whereas the porridges made out of 15 minutes parboiled and 30 minutes parboiled with roasted flour in both small and large particle showed a low GI.

In conclusion, considering the highest antioxidant content and their activities 15 minutes parboiling followed by roasting is beneficial to reduce GI and glycemic load of finger millet porridges irrespective of the particle size of the flour.

Acknowledgement: NRC Grant 12-096 for financial assistance.

Keywords: Finger millet porridges; glycemic index; parboiling

Determinants of dietary diversity in rural, urban and estate communities

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A diverse diet is a vital feature in healthy eating, signifying diet quality and dietary balance. Despite various attempts to diversify the diet, a considerably large proportion of Sri Lankan households still rely on monotonous diets. Therefore, the objective of this study was to determine the factors associated with dietary diversity of households, women and preschool children in rural, urban and estate communities. A cross-sectional survey was conducted in rural (Ipalogama and Matale DS divisions), urban (Gampaha and Negombo DS divisions) and estate (Agalawatta DS Division) communities (n=658) during March through July, 2015. The sample included mothers with children aged 2 to 7y. A 24-hour dietary recall was used to determine household and individual dietary intakes. Dietary diversity score (DDS) of households was determined using a 12 food group scale, whereas DDS of both mother and child were calculated using an 8 food group scale.

Urban households had a significantly lower DDS compared to rural households. Urban mothers had a significantly higher DDS compared to rural mothers. DDS of children did not show any difference between communities. There was a significant positive

Table. Mean (SD) dietary diversity scores in different communities			
	Rural (n 317)	Urban (n 246)	Estate (n 95)
Household (Out of 12)	8.2 (1.2) ^a	7.8 (1.3) ^b	8.0 (1.1) ^{ab}
Individual-Mother (Out of 8)	5.3 (1.0) ^a	5.5 (1.1) ^b	5.3 (1.1) ^{ab}
Individual-Child (Out of 8)	5.4 (1.1) ^a	5.6 (1.1) ^a	5.4 (1.1) ^a

Means that do not share the same letter in the row are significantly different at $P < 0.05$.

association of father's education level (OR= 6.36) and monthly household income (OR= 2.09) with household DDS of rural community, whereas none of the socioeconomic factors studied had a significant association with household DDS of urban and estate communities. Monthly household income (OR= 1.78) showed a significant association with DDS of children, whereas mothers education level (OR=1.41) had a significant positive association with DDS of mothers in rural community. None of the socioeconomic factors studied showed a significant association with DDS of child and mother in urban and estate communities.

In conclusion, parents' education level and household income seems to be determinants of diversity of the diet in rural community. The factors determining the dietary diversity in urban and estate sectors need to be further investigated.

Funded by National Science Foundation, Sri Lanka.

Keywords: Children and mothers; dietary diversity score; rural; urban and estate

Association of higher parity and prolonged breast feeding with age at diagnosis among breast cancer patients

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Breast cancer is the most common cancer in women both in the developed and developing world, with nearly 1.7 million new cases diagnosed in 2012 (1). Incidence rate of breast cancer is increasing in Sri Lanka (2). In 2012, 25 women for every 100000 suffered from breast cancer in Sri Lanka (1). The objective of the study was to determine the prevalence of internationally established risk factors among breast cancer patients. A hospital-based cross sectional study was conducted in oncology units in Kandy and Karapitiya teaching hospitals. The sample included 100 histologically confirmed breast cancer cases aged 20-70 years. All cases were diagnosed within 2 years prior to the interview. Detailed information on reproductive history, body composition, contraceptive usage, disease history, smoking, behavioral and physical activity information were collected using interviewer administered pretested structured questionnaire. Pretested semi quantitative food frequency questionnaire was used to collect information on food consumption within 5 years prior to the diagnosis.

The prevalence of internationally established risk factors of breast cancer was determined in the sample. Majority of cases (96%) was diagnosed after 30 years. Majority of cases (67.8%) out of postmenopausal women had experienced natural menopause after 45 years. A higher proportion of cases (67%) was inactive based on the categorization of General Practice Physical Activity Questionnaire (GPPAQ). Physical Activity Index (PAI) depends on being employed ($P<0.05$). Based on dietary information the presence of meat and fast food more frequently consuming cases and cases with low consumption of fish, carotenoid rich vegetables, fruits, red onion prior to the diagnosis was higher in the study sample. Age at diagnosis was positively associated with parity ($r=0.388$, $P<0.05$). Further a positive association was observed between age at diagnosis and prolonged cumulative time duration of breast feeding ($r=0.228$, $P<0.05$).

In conclusion, higher parity and prolonged cumulative time duration of breast feeding were found in breast cancer patients with later age at diagnosis.

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Keywords: Breast cancer; General Practitioners Physical Activity Questionnaire; menopause; Physical Activity Index; parity

Ferric reducing antioxidant power of cinnamon (*Cinnamomum zeylanicum*) infusion and the effect of cinnamon on blood pressure and lipid profile of mild hypertensive patients

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Hypertension and dyslipidemia are major risk factors for development of cardiovascular diseases. Previous studies have showed that consumption of cinnamon (*Cinnamomum zeylanicum*) reduce blood pressure and improves blood lipid profile (1). The objectives of the present study were to determine the effect of brewing time and amount of cinnamon powder on the antioxidant capacity of infusion to be used in a clinical trial and to investigate the effect of cinnamon beverage on blood pressure and lipid profile of mild hypertensive patients. Different amounts of cinnamon powder (1.5g, 3.0g, 4.5g, 6.0g and 7.5g) were brewed for 2, 3 and 5 minutes and the total antioxidant capacity of the infusions was determined by using ferric reducing antioxidant power (FRAP) assay (2). For the intervention study, eight mild hypertensive patients age between 25-55 y from both sex were recruited and randomly assigned either treatment (cinnamon beverage) for eight weeks or control group. Anthropometry, systolic and diastolic blood pressure, fasting plasma lipid were determined at baseline and four weeks after intervention.

Of the combinations of different amounts and brewing times, 6g of cinnamon powder brewed for 3 minutes showed the highest antioxidant capacity and it was used as the treatment in the intervention study. After the four weeks of intervention, the mean systolic blood pressure was significantly decreased ($P<0.05$) in treatment group compared to control group. There were no significant differences in diastolic blood pressure and plasma total cholesterol, HDL, LDL and triglycerides between two groups after four weeks of intervention.

In conclusion, we found that 6g of cinnamon powder brewed for 3 min is best combination for an intervention study. Consumption of cinnamon infusion showed a trend of improving systolic blood pressure but not diastolic blood pressure and blood lipid profiles of mild-hypertensive subjects.

This study was funded by a Wayamba University Research Grant.

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Keywords: Cardiovascular diseases; blood pressure; cinnamon; lipid profile; hypertension

Nutrient intake through diet and dietary supplements by Sri Lankan athletes

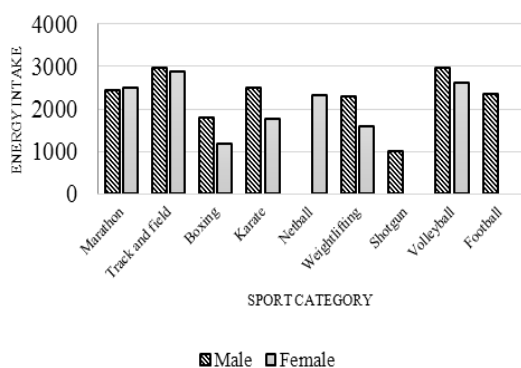
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Athletes can fulfil their nutritional requirements through diet and dietary supplements. Limited studies showed that Sri Lankan athletes consume high carbohydrate, protein and low fat diet (1). Although another study reported that Sri Lankan athletes fulfil carbohydrate and fat requirement but not the protein requirement (2). The objective of the present study was to determine the nutrient intake through diet and dietary supplements and to investigate knowledge, attitude and practices in relation to sport nutrition and its effect on nutrient intake of Sri Lankan athletes. Sixty sportsmen and 40 sportswomen age between 13 to 35 y engaging in marathon, track and field, boxing, karate, weight lifting, netball, shotgun play, volleyball and football in Sri Lanka were recruited. Information regarding knowledge on sport nutrition, attitude related to nutrition and different practices such as type of supplements, percentage of supplement usage, sources of information were collected.

Mean carbohydrate, protein and fat intake of sportsmen were 361 g, 82.5 g and 66.5 g, respectively. Mean carbohydrate, protein and fat intake of sportswomen were 304 g, 73.4 g and 61.7 g respectively. Highest energy intake of 2981 kcal (SD 223) was observed in volleyball players (Figure). Highest carbohydrate intake of 559 g (SD 16) and protein intake of 112 g (SD 21) was observed in male volleyball players and male track and field players, respectively. Volleyball players had highest calcium intake of 1513 mg (32). Iron intake



(46.1 mg SD 8.2) was highest in volleyball players. Around 16% of athletes consumed dietary supplements. Popular supplements included creatine, protein, multivitamins and iron. Supplements usage was higher among track and field players (50%) than others. A significant association was observed between knowledge level and energy intake of athletes. Monthly income and usage of supplement showed a significant positive

association. In conclusion, knowledge, attitude, practices and socio economic factors are associated with nutrient intake of athletes.

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Keywords: Athletes, nutrient intakes, dietary supplements

Development of commercial cereal based complementary foods using locally available ingredients

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After the 6 months of exclusive breast feeding infants are to be provided with additional nutrient requirements through complementary feeding. This may fulfill their high energy requirements and replace depleted nutrient stores. Two types of complementary foods (CF) are used by mothers as home based and commercial CF. Home based CF preparation is more time consuming practice than commercial CF. The objective of the present study was to develop different commercial complementary cereal products after determining the availability of commercial CF in Sri Lanka and mother's attitudes knowledge and practices (KAP) on commercial CF. A market survey was conducted to find out available complementary foods in the market. Mothers' attitudes knowledge and practices on CF was determined. Five different CF were developed. All 5 products contained rice, soy bean, sesame, coconut milk powder as the base ingredients. Finger millet, yellow fleshed sweet potato, carrot, mango and gotukola were used separately to specify the characteristics of each CF. Sensory, chemical and functional properties were analyzed to assess the acceptability of each developed product. The results of market survey revealed that available CFs in the market contain salt, sucrose and cow's milk as ingredients which were not allowed to infants under 1 year of age. The KAP survey found that 28% of mothers used commercial CF but 93% did not consider commercial CF as balance CF.

Table: Nutrient composition per serving of 25 g

Nutrient	Amount
Energy (kcal)	110
Carbohydrates (g)	15
Protein (g)	3
Dietary fiber (g)	0.4-0.6
Fat (g)	4.75
Calcium (mg)	44
Iron (mg)	1.25
Moisture (g)	1.25-2.0

Nutritional composition of the developed CF is given in the Table. A serving of complementary food can be prepared adding 250 mL of water and boiling for 10 minutes until a desirable consistency was achieved. The infants aged 6 to 8 months can be fed the product two times per day.

Estimated zinc and iron contents of the products were lower than those other commercially available cereal based CF. The study developed a nutritionally balanced commercial CF range without added sugar, salt and cow's milk. Future investigations are required to analyze for microbial quality and proximate composition of micronutrients.

Keywords: Complementary food; cereals; infants; local ingredients

Validation of a modified Physical Activity Questionnaire (PAQ) to determine physical activity levels of rural and urban school children in Jaffna

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Being active can help the children in improving their health, fitness and their self confidence, grow stronger, feel happier, maintain a healthy body weight, and learn new skills. This study aimed to assess the validity of a modified physical activity questionnaire (PAQ) against a 5 day-physical activity diary (5D-PAD) to develop validated physical activity questionnaire for the future use in school children in rural and urban areas in Jaffna. Eighty school children (40 boys, 40 girls), aged 9–12 y from 3 elementary schools from urban and rural area of Jaffna were selected. A modified PAQ which assesses activities of individuals in the school system and 5D-PAD includes 4 weekdays and a weekend day were administered with the proper instructions. Body weight, height and demographic and socioeconomic information of school children were collected using a questionnaire.

From the PAQ, physical activity score (PA-Score) was calculated using standard procedures as described by the developers of the questionnaires (1). Using 5D-PAD, physical activity level (PAL) for 24 h was calculated by multiplying the time duration of each activity and PAR of a particular activity.

Table: Comparison of PA-Score and PAL estimated from PAQ and 5D-PAD

Study Sample	PAQ score mean (SD)	5D-PAD mean (SD)	r
Total	3.01 (0.54)	1.54 (0.10)	0.27*
Rural	3.16 (0.53)	1.55 (0.09)	0.37*
Urban	2.86 (0.51)	1.54 (0.11)	0.16

*significant at 0.05 level

Mean PA-Score for the sample was 3.01 (SD 0.54) and mean PAL value was 1.54 (SD 0.10). Weak positive relationship was observed between PAQ and 5D-

PAD ($r=0.27$, $P<0.05$) (Table). But among the age group of 11-12 years acceptable significant correlation was observed ($r=0.33$, $P < 0.05$).

Kappa analysis showed a fair agreement between PAQ and 5D-PAD (weighted Kappa = 0.20, $P<0.05$). Approximately 62.5% of school children were correctly classified into the same or adjacent quartiles, whereas only 3.8% of children were grossly misclassified. There is a significant difference in time duration spent on sedentary practices in weekday and weekend day of school children in Jaffna. The modified PAQ showed week positive relationship with the 5D-PAD in assessing the physical activity levels among school children, whereas in the age category of 11-12 year it showed a moderate positive relationship.

- (1) Kowalski KC, Crocker P & Donen RM (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science*, 9, 174-86.

Keywords: Physical activity questionnaire; physical activity diary; validation

Assessment of nutritional status of pregnant women in Pannala MOH area

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Nutritional requirement increases during pregnancy in order to meet the needs of the mother and the growing fetus. Proper maternal nutrition is an important factor for good health outcomes of mother as well as newborn. Maternal nutritional problems remain as one of the public health problems in Sri Lanka (1). The objective of this study was to assess the nutritional status of pregnant women in Pannala MOH area. A cross sectional study was conducted among pregnant women in second trimester, who were attending 16 Maternal and Child Health Clinics (MCH) during data collection period. A pre tested interviewer administrated questionnaire, anthropometric measurements (maternal height, weight, hemoglobin, urinary iodine), MCH records, validated food frequency questionnaire (FFQ), 24h dietary recall and knowledge determination questionnaire were used as data collection

Table: Nutritional status of pregnant women		
Nutritional status related parameters		
	n	%
<i>MUAC (cm)</i>		
< 23 (Malnourished)	7	17.5
23 - 33 (Normal)	30	75.0
> 33 (Over nourished)	3	7.5
<i>Median urinary iodine (µg/L)</i>		
<150 (Insufficient)	7	13.5
150–249 (Adequate)	28	53.9
250–499 (Above requirement)	9	17.3
≥500 (Excessive)	8	15.4
<i>Blood hemoglobin (g/dl)</i>		
>11 (Normal)	49	76.6
10 - 10.9 (Mid anemia)	11	17.2
7 - 9.9 (Moderate anemia)	4	6.3

tools. Anthropometric and biochemical data were analyzed by using WHO cut offs values. Dietary data were analyzed by using FoodBase 2000 and compared with Recommended Dietary Allowance (RDA) for pregnancy. The age of the study sample ranged from 18-40 years. BMI values of the study sample indicated that 25.8%, 47%, 16.7%

and 10.6% were underweight, normal, overweight and obesity, respectively. Other nutritional indicators of the subjects are given in Table. In the study sample 23.5% had anemia. Dietary information revealed that, mean daily energy intake was 1471 kcal and daily energy from carbohydrate, protein and fat were 62.1%, 10.2% and 27.2%, respectively. Mean daily intake of; Ca 395 mg (RDA 1000 mg), Fe 12.4 mg (RDA 33 mg), folate 185.3 mg (RDA 600 mg) were less than RDA level.

The study concluded that considerable proportion of pregnant women has nutritional problems.

- (1) Medical Research Institute Sri Lanka (2009) Nutrition and Food Security Assessment in Sri Lanka, Sri Lanka: Medical Research Institute Sri Lanka.

Keywords: Anemia, nutritional status, pregnant women, RDA

Validation and reproducibility of food frequency questionnaire to assess the energy and nutrient intakes of chronic kidney disease patients

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There is an increasing trend in mortality and morbidity due to chronic kidney disease (CKD) in Sri Lanka. Assessment of dietary intake is vital in prevention and treatment of CKD. The semi food frequency questionnaire (SFFQ) is the most used method for measuring dietary intake in epidemiologic studies. The objectives of this study were to develop a validated SFFQ for CKD patients and to check the reproducibility of the FFQ. A four day diet diary (DD) and an interviewer administered SFFQ (SFFQ1) consisting 95 food items were administered to 65 CKD patients who were recruited by convenient sampling method. Thirteen patients from them were given the SFFQ again after one month period to check the reproducibility of the SFFQ (SFFQ2).

Table shows the results of the validation and reproducibility tests. The mean daily energy and nutrient intake values of the DD were lower than the SFFQ1, except for fat and calcium. Pearson correlation coefficients between the DDs and SFFQ1s ranged from 0.53 to 0.70 for energy, carbohydrate, protein and Mg. When adjusting for energy, correlation decreased for most of the selected nutrients. Cross-classification analysis showed that on average, 80% were classified in the same or adjacent quartile of energy, carbohydrate, protein and Mg intakes when comparing data from the SFFQ and DD. According to Cohen's weighted kappa values, energy, carbohydrate and Mg indicate moderate agreement. Pearson correlation coefficients between SFFQ1 and SFFQ2 ranged from 0.990 to 0.997 ($P < 0.01$). The developed SFFQ is a valid tool for determining of energy, protein, carbohydrate and Mg and it has a good reproducibility for all selected nutrients and energy.

Table: Validation and reproducibility of the SFFQ

Nutrient	Validation			Reproducibility		
	Mean (DD)	Mean (SFFQ1)	r	Mean (FFQ1)	Mean (SFFQ2)	r
Energy (kcal)	1792	1982	0.674*	2167	2081	0.997*
Protein (g)	51.8	57.4	0.579*	62.1	58.9	0.995*
Fat (g)	47.7	46.4	0.207	49.8	45.3	0.981*
CHO (g)	306.7	354.4	0.702*	390.6	382.0	0.997*
Ca (mg)	581.9	522.6	0.139	492.9	474.7	0.986*
Mg (mg)	320.9	394.9	0.530*	396.2	382.5	0.997*
Na (mg)	2000.7	2556.2	0.037	2604.2	2394.3	0.983*
K (mg)	1658.0	2139.4	0.012	1999.0	1887.1	0.990*

Roshan K Dela Bandara and Lanka Rain of Water Harvesting Forum, Kilinochchi are acknowledged for assisting subject recruitment.

Keywords: Chronic kidney disease; food frequency questionnaire; reproducibility; validity

Dietary adequacy of nutrients in women and pre-school children in rural, urban and estate communities

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Women and children are more susceptible for malnutrition in many communities. Dietary adequacy can be used as an indicator of malnutrition and thus helpful to assess and plan interventions to prevent malnutrition. The objective of the present study was to assess the dietary adequacy of some important nutrients in non-pregnant non-lactating mothers and their children age between 2-6 y living in rural, urban and estate communities. Subjects were selected using multi-stage cluster sampling from 5 divisional secretariat divisions (rural: Ipalogama and Matale; estates: Agalawaththa; urban: Negombo and Gampaha) during March to July 2015. A 24 hour recall was taken from subjects to assess the dietary intakes. The Mean Adequacy Ratio (MAR) was calculated using Nutrient Adequacy Ratio (NAR) and truncated that into 1.

The results showed higher nutrient adequacy in children than mothers (women) regardless by the community. Following table shows MAR and NAR in three communities.

Table: NAR and MAR of women and children in different communities.

NAR	Rural			Estate			Urban		
	M (n 318)	C 2-3y (n 131)	C 4-6y (n 185)	M (n 73)	C 2-3y (n 59)	C 4-6y (n 39)	M (n 216)	C 2-3y (n 80)	C 4-6y (n 171)
Energy	0.75	0.74	0.57	0.69	0.81	0.62	0.69	0.78	0.57
Protein	0.95	2.23	1.61	0.93	2.41	1.79	0.96	2.45	1.69
Calcium	0.33	0.67	0.58	0.31	0.75	0.56	0.39	0.76	0.54
Iron	0.60	1.05	0.84	0.54	1.32	0.93	0.62	1.20	0.83
Zinc	1.37	0.92	0.83	1.28	0.99	0.90	1.31	0.99	0.90
Iodine	0.38	0.74	0.74	0.37	0.85	0.66	0.40	0.87	0.77
Folate	0.38	0.76	0.55	0.39	0.76	0.68	0.46	0.79	0.67
Vitamin C	0.66	0.89	0.83	0.29	0.32	0.47	0.52	0.53	0.55
Retinol	0.80	0.96	0.96	0.71	0.91	0.84	1.03	1.10	1.18
MAR	0.68	0.84	0.82	0.58	0.89	0.82	0.71	0.91	0.82

M – Mother; C - Children

This study suggests that apart from energy, calcium, iodine, folate and vitamin C, the NAR for other nutrients studied in rural, estate and urban communities are about 80% of the recommended level in children and about 70% in mothers. The intakes of protein, iron, zinc, iodine, folate and retinol in mothers and children of the three communities were not significantly different.

This study was funded by National Science Foundation.

Keywords: Dietary intake; mean adequacy ratio; nutrient adequacy ratio

Knowledge and attitudes of young adults on functional foods

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Concerns of people on their foods to prevent disease conditions and to be healthy are increasing. Thus, the term “functional foods” has been attracted considerable interest among researchers. The objective of this cross sectional study was to determine the level of knowledge and attitudes of young adults on functional foods. The data were collected from students studying at agriculture schools (n=444) using a self-administered pre-tested, structured questionnaire. Collected data are expressed using descriptive statistics. Knowledge and attitudes were analyzed using a scoring system.

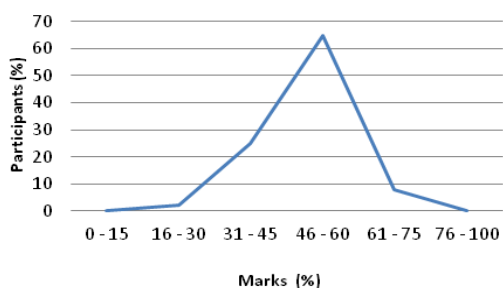


Figure: Scores distribution for knowledge among participants

Distribution of scores obtained for knowledge about functional foods is shown in the figure. The results showed that 65%, 25% and 10% of participants got 46-60%, 31-45% and 61-75% of marks, respectively. None of them got marks between 76 - 100% or <15%. Among participants 19% and 18% identified banana and Cassia (Kohila), respectively as foods which contain dietary fiber. Majority (80%) of the

participants agreed that the functional foods can be used as a disease treatment or management agent. Among those participants majority agreed that gastrointestinal diseases (64%) and high blood pressure (61%) can be managed using functional foods. In determination of attitudes, majority of participants selected fruits and vegetables as the most health beneficial food item whereas black tea was selected as the least beneficial food item. Sensory properties and health benefits of the food items are major concerns in food choices of participants. Results showed that level of knowledge was not significantly different among males and females but level of attitude was significantly different in food choices ($P=0.015$).

In conclusion, only about half (57%) of young adults have fair knowledge about functional foods. Attitude level is different among genders. Sensory characteristics of the food and health benefits are the major concerns in food choices.

Keywords: Attitudes; functional foods; young adults

Phenolic content and antioxidant activities of commonly consumed legumes in Sri Lanka

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Legumes are excellent sources of protein, carbohydrate, dietary fiber, micronutrients and phytochemicals such as phenolics. Phenolic compounds act as antioxidants which can protect the body from harmful effects of free radicals. Information on varietal and processing effect on phenolic content and antioxidant activity (AOA) of legumes are scanty. The aim of this study was to determine the varietal and processing effect on phenolic content and AOA of commonly consumed legumes in Sri Lanka. Different processing methods, namely soaking, boiling, peeling and germination were performed for the selected legume varieties (Dhal var. black maisoor; chickpea var. Red and Yellow; cowpea var. Varuni, MICP1, MI35, Dawala, Bombe and Vijaya; soy bean var. PB1, PM13; green gram var. Ari, MI5 and MI6; black gram var. Anurada, MI1). Phenolic content was determined by total phenolic content (TPC) and total flavonoid content (TFC). AOA were assessed by 2,2-diphenyl-1-picrylhydrazyl

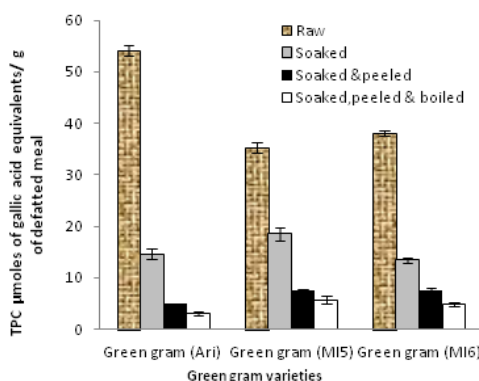


Figure: TPC of different varieties of green gram

(DPPH) radical scavenging assay and ferrous ion chelating ability. TPC expressed as μmol gallic acid equivalents (GAE)/g of defatted meal ranged from 10.4-79.5 of whole raw beans; 2.6-20.8 of soaked seeds; 2.3-26.3 of soaked and boiled seeds with peel; 2.2-17.8 of soaked and boiled seeds without peel; 3.2-16.2 of soaked and peeled seeds; and 4.9-16.1 of germinated seeds (Figure). The lowest TPC was reported for cowpea var. MICP1, whereas the highest TPC was reported for cowpea var. Varuni. DPPH radical

scavenging assay and ferrous ion chelating ability of whole raw and processed legumes were ranged from 0.44-209.14 μmol of trolox equivalent, 0.15 -26.31 μmol of EDTA equivalents/g of defatted meal, respectively. The results indicated that TPC of legumes with coloured seed coat such as black gram, green gram and cowpea (Varuni) was higher than those with light seed coats. Boiling with peel was found to be better than boiling without peel in terms of conserving phenolic compounds. Processing methods and variety influenced on TPC, TFC and antioxidant activities of selected legumes.

Acknowledgement: University Research Grant Wayamba University SRHDC/RP/04/15-20 for financial assistance.

Keywords: Antioxidant; DPPH; ferrous chelating ability; total phenolic content; total flavonoid content

Nutritional status of infants age between 6-12 months in Pannala Medical Officer of Health area

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Malnutrition in infancy leads to nutritional problems such as underweight, stunting, wasting and over-weight. Age of six months is the determinant point of these problems because first complementary feeding is introduced at this age. This cross sectional study was conducted to determine nutritional status of infants aged between 6-12 months in Pannala MOH area.

This study was conducted among infants in complementary feeding age (6-12 months) (n=75) who were attending Maternal and Child Health (MCH) clinics during data collection period. Data were collected from mothers of infants using an interviewer administered socio-demographic, lifestyle and health questionnaire, measuring anthropometric measurements and using information in Child Health Development Records (CHDR). Dietary data were obtained through 24 h dietary recall. Knowledge about infant feeding among mothers of infants was determined by a questionnaire. Nutritional status of infants were assessed using WHO Anthroplus and classified as normal, underweight, stunting and wasting according to WHO reference values. Nutrient intake of the study sample was analyzed by Foodbase 2000 software. Knowledge level of mothers was determined as good if their score for the questionnaire is higher than mean score and as poor when it is less than mean score of the study sample.

Table: Nutrient intakes of infants

Energy & Nutrient Intake (from complementary feeding)	Mean intake	Range (min-max)
Energy (kcal)	692	40-1679
Carbohydrate (g)	100	9-294
Protein (g)	21	1-60
Fat (g)	25	0.1-71
Iron (mg)	8.6	0.3-24.9

Mean age of subjects was 9.7 (SD 2.1) months. Of the infants, 13.3% had low birth weight and 4% were overweight at birth. Prevalence of underweight, stunting and wasting were 6.7%, 12% and 4%,

respectively. Table shows the intake of selected nutrients from complementary foods. Mean % energy intake from carbohydrate, protein and fat were 57.9, 11.9 and 29.6, respectively. Percentage of infants who received exclusive breast feeding up to 6 months was 57.3. Majority (55%) of mothers of infants had good knowledge about complementary feeding. Prevalence of underweight and stunting among infants in Pannala area was less than the prevalence reported in Kurunagala district and also national values. However it is important to plan nutrition intervention programmes to reduce nutritional problems further among infants in Pannala area.

Keywords: anthropometry; infancy; malnutrition; stunting; undernutrition

Nutritional status and dietary intakes of Alzheimer's disease patients

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Alzheimer's disease is a progressive disease which is the most common cause of dementia in the elderly. It slowly destroys brain cells causing memory loss and behavioral problems that are severe enough to affect an individual's quality of life. Alzheimer patient has difficulty in recognizing family members and friends, misplacing things and even forgetting to eat and drink water. It has been shown that Alzheimer's patients may often suffer from malnutrition and malnutrition can have a serious impact on the symptoms of dementia and general well-being (1). Sufficient information in relation to nutritional status and dietary habits of Alzheimer's patients is not available in Sri Lanka. Therefore, the objectives of this study were to assess the nutritional status, current dietary intakes and to evaluate the risk of malnutrition associated in Alzheimer's patients. Twenty one (9 males and 12 females) Alzheimer's patients (60 y <) with mild/moderate dementia were recruited. If the patients' cognitive status did not permit them to participate directly, the surrogates (patient's caretaker) were interviewed. A general health and lifestyle questionnaire, a food frequency questionnaire, a 3-day diet diary and a Mini Nutritional Assessment (MNA) were used as data collection tools. Table shows the nutrient intakes and achievement of RDA.

Table: Nutrient intakes of Alzheimer patients

Nutrient	Male		Female		Mean	SD	% RDA	
	mean	SD	mean	SD				
Energy (kcal)	1634	616	1459	293	Calcium (mg)	667	380	95
Energy (% RDA)	73.7		78.6		Zinc (mg)	7	4	119
Fat (% energy)	32.2	8.0	32.7	12.6	Iron (mg)	18	18	78
Protein (%energy)	12.5	1.9	12.2	2.2	Vitamin B ₁₂ (µg)	2.3	1.2	152
Carbohydrate (%energy)	54.5	10.0	54.8	11.9	Vitamin C (mg)	79	89	197
Saturated fat (%energy)	17.5	7.7	16.2	6	Folate (µg)	189	93	95
Added sugar (%energy)	9.7	12.7	5.7	5.4	Vitamin D (mg)	2.4	1.2	24

Among Alzheimer’s patients (mean age 75 y) who participated in this study, 71%

Among Alzheimer's patients (mean age 75 y) who participated in this study, 71% were found to be malnourished or at risk of malnutrition according to MNA. In conclusion, the prevalence of malnutrition among Alzheimer's disease patients is high and their current energy intake is lower than RDA but % contribution of macronutrient to the energy intake was at recommended level in both male and female patients. Micronutrient requirements have been met by the subjects except for iron and vitamin D.

Authors acknowledge the financial support of S.A. Silva & Sons Lanka (Pvt) Ltd, Colombo 8.

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Keywords: Alzheimer patients; dietary intake; malnutrition; nutritional status; mini nutritional status assessment (MNA)

Types of nutrition education materials available in Sri Lanka and community perception on them

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Different types of nutrition education materials can be used to aware the people about nutrition. Several materials such as posters, leaflets, booklets are available in Sri Lanka. The objective of the study was to compile and analyze the nutrition education materials published in Sri Lanka and get the community perception about them. Education materials are collected from government and non government organizations. Community perception about the education materials was collected from 105 pregnant and lactating mothers using an interviewer administrated questionnaire from MOH clinics in Jaffna.

Among the collected materials 44% were leaflets and 35% were posters. With compare to posters and booklets, leaflets are the most commonly published type of material. This may be due to low cost and small in size, so people can use them conveniently. Majority of the materials (63.8%) were targeted to general public and 22.5% were targeted to pregnant and lactating mothers. Based on the content, most of the materials have the food based dietary guidelines and health related guidelines. Considerable proportion of them has the information about guidelines for breast feeding and complimentary feeding. According to the perception of the target group, majority (66.7%) of the target group prefers to read the posters and 24.8% of them prefer to read the leaflets. About 96.2% of the study population was aware about nutrition related posters, 59.1% of them aware about the nutrition related leaflets and only 31.4% of them aware about posters, leaflets and booklets. About 97% of the target group agreed that the posters help them to improve their nutrition knowledge and 52.5% of them agreed that they share the nutrition messages obtained from the posters with others. There is a significant different in the improvement of nutrition knowledge from posters among the age groups (age groups are under 20 years, 20-29 years, 30-39 years and over 40 years) ($P < 0.05$).

In conclusion, most of the nutrition education materials published in Sri Lanka are leaflets and the major target group is the general public. Most materials contain the information about food based dietary guidelines. Most preferred materials by the pregnant and lactating mothers are posters. Knowledge gained by the posters is related with the age of the study population.

Keywords: Intervention; nutrition education materials; nutrition education

Evaluation of using millet phenolics as natural antioxidants in food models

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Lipid peroxidation is a major phenomenon in reducing food quality during cooking and storage that is leading to rancidity, losing nutrients and increasing toxicity. The use of plant extracts to increase shelf life is a promising new frontier in the prevention of lipid oxidation. Phenolic compounds are ubiquitous in plants and are increasingly becoming a subject of intensive research due to their bioactive properties such as antioxidant activity. The objective of this study was to determine the phenolic content and antioxidant activity of extracts of hull and dehulled grains of millets, namely finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), and proso millet (*Panicum miliaceum*). The extracts were tested for phenolic content and their antioxidant activity by total phenolic content (TPC) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, respectively. To determine the antioxidant effect of millet phenolic compound in food models, phenolic extracts and dehulled grain flour from those three millet varieties were evaluated for their inhibitory effects on lipid peroxidation in three food model systems, namely cooked boneless pork, cooked boneless tuna and gingerly oil. Inhibition of Thiobarbituric acid Reactive Substances (TBARS) was determined to monitor lipid peroxidation.

Table. Inhibition percentage of TBARS formation in food models by BHA and millets

Model	Inhibition of TBARS formation (%)		
	BHA	High effective millet	Less effective millet
Pork			
Day 3	93.3	25.2 (Finger HE)	9.6 (Proso DGF)
Day 14	80.8	12.8 (Foxtail DGF)	4.4 (Proso HE)
Tuna			
Day 3	84.1	19.3 (Foxtail HE)	0.4 (Finger HE)
Day 14	62.2	77.3 (Proso HE)	0.3 (Foxtail DGF)
Gingerly oil			
Hour 6	2.98	19.05 (Proso HE)	11.9 (Finger HE)
Hour 48	1.24	8.47 (Finger HE)	2.48 (Foxtail HE)

DGF - Dehulled grain flour; HE - Hull extracts

Phenolic extracts of finger millet had the highest TPC and DPPH radical scavenging activity compared to other two millet varieties. The presence of millet grain extracts at a concentration of 0.2% (w/w) and dehulled grain flour at a concentration of 2% (w/w) in

pork and tuna model systems significantly ($P < 0.05$) reduced the lipid oxidation, during two weeks of storage period compared to the control with no additives. Hull extracts exhibited higher inhibition of lipid peroxidation than BHA in gingerly oil model at 48 hours (Table). The results of this study indicate that hull extracts and dehulled grain flour from the millets have possibility to use as natural food additives to prevent lipid oxidation in foods.

Keywords: Antioxidants; lipid oxidation; phenolic compounds; plant extracts

Nutritional status of 6-12 months old infants in West- Kuliyaipitiya Medical Officer of Health area

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Infant from birth to 12 months of age has the highest growth rate comparing with other stages of the human life cycle. Infant nutritional problems remain as one of the major public health problems in Sri Lanka. Therefore this research was conducted to determine nutritional status of infants at the complementary feeding age in West-Kuliyaipitiya.

This study was conducted as a cross-sectional study at West-Kuliyaipitiya Medical Officer of Health (MOH) area using 64 infants. An interviewer administered socio-demographic, life style and health questionnaire, 24 hour dietary recalls, a knowledge determination questionnaire were used to collect data from mothers about their infants. Anthropometric data were recorder from Child Health Development Records (CHDR) and standard measuring techniques. Anthropometric data was analyzed using WHO Anthroplus software and WHO weight-for-age and length for age were used as cut-offs. Dietary data was collected using 24 hour dietary recalls and analyzed using Foodbase 2000 software.

The mean age of studied infants was 9.3 (SD 2.4) months. Mean birth weight of studied infants was 2.93 (SD 0.45) kg and mean birth length of studied sample was 52.5 (SD 3.0) cm. Majority (62%) of infants were given colostrum within 30 minutes after birth and 77% of mothers practiced exclusive breastfeeding up to 6 months. Seventy eight percent of mothers started complementary feeding at the age of 6 months. ‘Beri bath’ with breast milk

Table: Characteristics of the study sample, nutritional status and nutrient intakes

Characteristics	n	%
Birth weight (kg)		
Low (<2,500)	5	8.3
Normal (2,500-3,800)	55	91.7
Nutritional status		
Under-weight (<-2SD)	10	15.6
Stunting (<-2SD)	16	25.0
Energy & nutrients intake		
Nutrient/energy	Mean intake	RDA
Energy (kcal)	501.56	676 - 743
Protein (g)	16.4	13.6
Iron (mg)	7.3	11
Calcium (mg)	247	260

was given for 90% of infants as their first complementary food. Mean intakes of energy, iron, calcium, magnesium, vitamin A, vitamin C and vitamin K of the sample were lower than Recommended Daily Allowance (RDA). Majority of mothers have good knowledge on infant nutrition. Prevalence of underweight was 15.63% and stunting was 25% in the studied sample. This study concluded that there were nutritional issues among infants in West-Kuliyaipitiya MOH area.

Keywords: Anthropometric; dietary; infants; nutritional status; stunting; underweight

Relationship between television watching, physical activity, nutritional status and food intake of 11-13 years old school children in Pannala

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The term food habits refers to why and how people eat, which foods they eat, and with whom they eat, as well as the ways people obtain, use, and discard food. Several factors influencing food habits of youth. Among them one of the main factor is exposure to TV food advertising. This study was conducted to assess the relationship between TV watching, physical activity levels (PAL), nutritional status on food intake of 11-13 y old school children in Pannala Educational division and to determine type and the frequency of advertisements in mostly viewed two TV channels. Twenty school children from three different grades in each of 4 schools were randomly selected. Two hundred and forty school children completed an interviewer administered general questionnaire, food frequency questionnaire and international physical activity questionnaire. Height and weight of the children were assessed. To define thinness, normal, overweight and obesity, BMI cut offs recommended by World Health Organization (WHO) were used (1).

Of the children, 49.2% watched TV between 2-4 h/day. Majority of school children (51.7%) buy advertised food products by their own and considerable number of children (38.7%) requested from mother to buy advertised food products. Majority of the student (77.9%) eat while watching TV. Around 35% of all advertisements broadcasted in a day were food related advertisements of which mainly were on confectionaries and dairy. Fifty percent of the children consumed confectionary 1-2 times per day and those confectionaries were commonly advertised on TV. More than 70% of children were in the category of moderate level of physical activity and majority of the students (65.8%) had normal BMI for age. Around 8% and 5% of students were overweight and obesity respectively. There is no association between frequency of food consumption and physical activity level and BMI for age of school children in Pannala Educational division.

The study concluded that television viewing is associated with food preference of school children in Pannala Educational division. Majority of the advertisements shown in TV are confectionaries and dairy products.

- (1) WHO (2007) BMI for age (5-19 years) [online] Available from:
http://www.who.int/growthref/who2007_bmi_for_age/en/ [Accessed on 02.09.2015]

Keywords: School children; TV viewing; physical activity level; BMI for age; food habits.

Socioeconomic determinants of household food security in rural, urban, and estate communities

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Household food insecurity is a major problem in low income countries and even in some developed countries. The objective of this cross sectional study was to determine the household food security levels and socioeconomic determinants of the food security status in selected rural, urban and estate communities in Sri Lanka. A total 325 rural (Ipalogama and Matale DS divisions), 221 urban (Negombo and Gampaha DS divisions) and 94 estate (Agalawaththa DS division) households having at least one child age between 2-5 y were selected using multi stage cluster sampling technique. Study was conducted from March to August, 2015. Modified United States Department of Agriculture (USDA) food security core module was used to assess food security levels of households (1).

Prevalence of food security, food insecurity without hunger, food insecurity with moderate hunger and food insecurity with severe hunger in urban (67%, 17%, 15% and 1%, respectively), rural (64%, 29%, 6% and 1%, respectively) and estate (47%, 33%, 19% and

Table: Associated determinants with food security

Variable	Odds ratio	95% CI
Household income	3.8	2.2 - 6.6
Household expenditure	4.6	1.6 - 13.3
Education level of mother	3.0	2.1 - 4.3
Education level of father	2.9	2.0 - 4.1
Household size	1.5	1.1 - 2.0

1%, respectively) communities were reported in the study. Table shows the determinants that have significant (95% CI and $P < 0.05$) relationship with food security. Food secure households were more likely to have higher household

income, household expenditure, education level of father and mother and lower household size compared to food insecure households. Among the other factors, age of father and mother, employment status of mother and food ratio did not show any significant associations with household food security. In conclusion, estate community showed greater household food insecurity. Households with higher income, expenditure, better education level of father and mother and lower household size are more likely to be a food secure.

This study was funded by National Science Foundation.

- (1) Bickel GW, Cook J, Hamilton W, Mark N & Price C. (2000) Measuring food security in United States. Guide to Measuring Household Food Security. USDA: Food and Nutrition service, USA.

Keywords: Household food security; urban- rural- estate communities; socioeconomic determinants

Nutritional status of pregnant women in West-Kuliyapitiya MOH area

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Nutrition during pregnancy plays an important role in the well-being of the mother and fetus and it may further influence the health of the child later in life. The nutritional problems in pregnancy are considerably high in Sri Lanka. Hence, the objective of this study was to assess the nutritional status of pregnant women in West-Kuliyapitiya MOH area. This cross sectional study was conducted among pregnant women in their 2nd trimester who were attending to Maternal and Child Health (MCH) clinics during data collection period. An interviewer administrated socio demographic, health and life style questionnaire, validated Food Frequency Questionnaire (FFQ), 24 h dietary recall, anthropometric measures, information of MCH records, biochemical measures, knowledge determining interviewer administrated questionnaire were used for gathering information. Nutritional status was determined using WHO cut-off values for pre pregnancy Body Mass Index (BMI), Mid Upper Arm Circumferences (MUAC), blood haemoglobin level and urinary iodine excretion level. Adequacy of dietary intake was determined using Recommended Dietary Allowances (RDA) values. Nutritional knowledge was assessed by giving scores to correct response to each question in questionnaire. Based on mean score, subjects were divided into two groups as satisfactory and poor nutritional knowledge.

Table: Nutritional status of the subjects

Nutritional status	n	%
Pre-pregnancy BMI		
Under weight	22	22.7
Normal	52	53.6
Over weight	19	19.6
Obese	4	4.1
MUAC		
Under nutrition	27	27.8
Normal nutrition	49	50.5
Over nutrition	21	21.7
Haemoglobin		
Normal	68	70.1
Anaemia	29	29.9
Urinary iodine		
Insufficient	5	9.3
Adequate	37	73.2
Above requirements	3	6.2
Excessive	6	11.3

Majority (57%) of the study sample was in the age between 25 to 35 y with the mean age of 28 (SD 6) and 52% had educated up to GCE O/L. Nutritional status of the pregnant women is given in the Table. Although all pregnant mothers were taking iron tablets, 30% of them had iron deficiency anemia. Only 35% of subjects had eaten fruits more than twice per week. Mean percentage of daily energy intake from the carbohydrate, protein and fat were 57.6%, 10.2% and 32.2%, respectively. None of them meet the RDA for folic acid, vitamin C and calcium from the diet. Majority of the subjects (63%) had poor knowledge on nutrition

during pregnancy. It can be concluded that nearly one fourth of the subjects in the study sample were underweight, overweight and 30% had iron deficiency anemia. Their micronutrient intake from diet was low.

Keywords: Pregnancy; nutrition status; undernutrition; anemia; dietary intake

Eating habits of preschool children in Pannala

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Worldwide there is an increase in childhood non communicable diseases such as child diabetes, metabolic syndrome, and child obesity. On the other hand in Sri Lanka still there is considerable number of children suffer from undernutrition. Diet is the strongest causative factor for both under- and overnutrition. Thus childhood eating habits highly affect the adulthood eating behavior therefore it is thoughtful to give nutrition education as early as possible. To plan effective community intervention programs in order to address these issues it is vital to know the child eating behaviors. The objective of this cross sectional study was to investigate the eating habits of preschool children and to determine the factors affecting those habits. A convenient sample including 100 preschool children was selected from five preschools in Pannala Divisional Secretariat division. Children's parents were interviewed about their child's frequency of food intake using qualitative food frequency questionnaire. Information about socio-economic background, television watching and dietary habits were also obtained using a questionnaire.

Most of the subjects consumed fast foods during television watching, and mostly consumed snack in between meals were also fast foods. Among subjects 36% skip breakfast and main reasons were not being hungry in the morning and replacing breakfast with small snack. Majority of the subjects consumed fruits 1-2 times, vegetables 2-3 times, dairy products 1-2 times and fast foods 1-2 times per day. In fact, they consume fast foods more frequently than fruits or dairy products. Fruit consumption among the study subjects was lower than the other food groups. There was a positive association between vegetable and fruit intake. There was no significant association between household income, duration of TV watching, with the consumption of fruits, vegetables, dairy or fast foods.

In conclusion, fast food consumption during television watching, breakfast skipping, unhealthy snack consumption in between meals, and low fruit intake remain as unhealthy eating habits among preschool children.

Keywords: Food habits; fruits and vegetables; fast food; preschool children; snack consumption

Assessment of nutritional impact of the livelihood program in Batticaloa district, Sri Lanka

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A livelihood program conducted in Batticaloa district provided financial assistance to poor families under certain conditions for enhancing their livelihood practices. Nutritional impact of this program was still unknown. Therefore, a study was conducted to examine the impact of the livelihood program on economic level and food availability of household as well as nutritional status of children in the program participants' household. A sample of 200 households was selected by using convenience sampling method. An interviewer administrated questionnaire was used to collect data both before and after the livelihood program.

Results of the study showed that monthly income of program participants' households had been increased, and also average production and consumption of livestock related food items (milk and egg) in the households were increased after the program compared with situation before the program. Further, cattle rearing ($P=0.007$) and small scale business ($P<0.0001$) had a significant contribution to household's monthly income. There was a positively weak correlation between household's income and expenditure for food ($r=0.37$,

$P<0.0001$). In this study, prevalence of undernutrition among 2-7 year old children increased after the livelihood program compared to the situation before the program (Figure). The study concluded that livelihood program was successful to improve household economic level and availability of livestock related food items in the household but there was no improvement on nutritional status

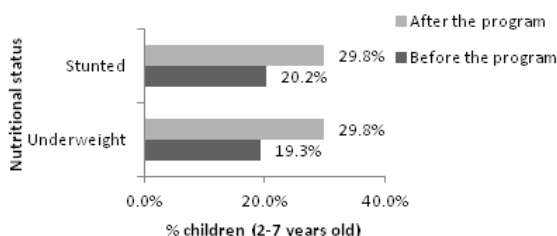


Figure: Nutritional status of children before and after the program

of 2-7 year old children. It can be suggested that other nutrition intervention programs like nutrition education and awareness programs should be combined with the livelihood program in future to improve nutritional status of children, and further evaluation should be done after more than two years.

Keywords: 2-7 year old children; economic level; food availability; livelihood practices; nutritional status

Assessing the effectiveness of a set of nutrition educational materials on nutritional knowledge, attitude and practice of young children and their caretakers

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Nutrition education is a set of learning experiences designed to facilitate voluntary adoption of eating and other nutrition related behavior leads to health and well-being. Childhood nutritional problems are still major public health problems in Sri Lanka. The nutritional status of young children is a sensitive indicator, since children are most vulnerable to nutritional imbalances. Changes in dietary pattern are important to overcome these problems. Teaching young children may help to make nutritious food choices. Since caretakers play major role in food selection and preparation, they also have to be educated well. To provide proper and excellent knowledge through education, the educational tools should be effective. This study aimed to assess the effectiveness of a set of nutritional educational material developed for young children and their caretakers.

Interviewer administered nutrition related knowledge, attitude and practice (KAP) survey questionnaire for young children and self-administered nutrition related KAP survey questionnaire for caretakers were developed and pretested. Respective survey questionnaires were used to assess the nutrition related KAP of 180 young children aged 4-7 y and 60 caretakers in Batticaloa district before and after intervention. The nutrition educational intervention was carried out for young children and their caretakers separately for 4 weeks of period. Set of education materials used were a kids nutrition story book on promoting fruits and vegetables consumption and eating variety of foods and nutrition base game called 'my plate' on promoting variety of food intake per day for young children and a nutrition fact sheet for their caretakers on the proper nutrition for young children. The effectiveness of the set of educational material was assessed using Chi-square test.

In children, percentage of correct responses for knowledge and attitude related questions increased significantly after the intervention when compared to the pre intervention. But percentage of correct responses for practice related questions increased slightly compared to pre intervention. However caretakers showed comparatively slight improvements in their nutritional knowledge, attitude and practice after the intervention.

The study demonstrated the effectiveness of nutrition education tools developed for young children for the improvement of their nutrition knowledge, attitude and practices. However, the educational material developed for caretakers need to be revised to improve the effectiveness of the tool as behavioral change is difficult in adults within a short duration.

Keywords: Young children; care takers; educational material; intervention

Contribution of home gardening to household food security in a village in Nawalapitiya, Sri Lanka

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Home gardening is known as a small scale farming practice to facilitate direct access by households which facilitates to achieve diversity of nutritionally rich foods. This ensures household food security which is defined as availability, accessibility and utilization of safe and nutritious foods in all time. Objectives of this study were (i) to compare the food security level of households having organized and without organized home gardens (ii) to determine the relationship between daily intake of nutrients and home gardening practices and (iii) to find out the contribution of home gardening to household food security.

A cross sectional study was carried out using 60 households having at least one child less than 5 years of age with organized (n=30) and without organized (n=30) home gardens in Aluthgama village, Nawalapitiya in Kandy District. Socio demographic data, information about home gardening, knowledge and attitudes and practices were collected using questionnaires. USDA Food Security core module was used to determine the household food security status. Diet diary and Food Frequency Questionnaire were used to obtain daily nutrient and food intakes, respectively.

Among the households with organized home gardens, 93% and 7% were food secured and food insecure without hunger, respectively. Among the households without organized home gardens, 79%, 7% 14% were reported as food secured, food insecure without hunger and food insecure with moderate hunger, respectively. The results show that there is no significant relationship of socio demographic factors with household food security in the study population. Daily intakes of energy (OR=26.6), calcium (OR=5.8), thiamin (OR=12.5), vitamin A (OR=8.173) and vitamin C (OR=36.6) were significantly related to home gardening ($P<0.05$). There was no significant difference between the mean dietary diversity score of households having organized home gardens (9.51) and unorganized home gardens (8.04). There is no significant contribution of home gardening (OR=1.524) to household food security in this study population.

In conclusion, households with and without organized home gardens in this community did not show a difference in household food security status. Households with home gardens consumed higher amounts of energy, calcium, thiamin, vitamin A and vitamin C compared with those who did not practice home gardening.

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Keywords: Home gardening; household food security; dietary nutrient intake

Production of organic vinegar by utilization of waste pineapple peel

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Developed countries have higher demand for the Sri Lankan pineapple (Fresh and dried), especially organic form, contributing to foreign exchange earnings. During pineapple processing (excluding crown), it results 45% of fresh chunks and 55% of waste having 10% middle core, 25% first peel and 20% second peel. Pineapple juice is extracted from the second peel to fill the bottles with chunks, therefore second peel is utilized to some extent and other parts are considered waste under the present setup. Yet middle core and first peel, altogether 35% of total, has about 8.5% reducing sugar that has potential to convert into many valuable food items. As the organic pineapple is used as ingredients in industries, experiments were conducted to explore the opportunities to develop organic vinegar using the pineapple waste.

Pineapple peel juice was extracted and concentrated up to 18% of reducing sugar using vacuum evaporator. For the formation of alcohol, yeast culture was incorporated. When 8% of alcohol was developed, acetic acid culture was incorporated and specific two treatments were introduced as aeration (n=3) and non-aeration (n=3) separately. Pasteurization was done at 72°C for 1 minute at the 4% of acetic acid level. Sedimentation of vinegar under different storage temperatures (room and refrigerator) was tested on third day after pasteurization. Dynamics of pH, acidity, brix, alcohol and reducing sugar were measured till the vinegar pasteurization. Brix percentage and reducing sugar percentage were decreasing with time ($P=0.00$). Correspondingly alcohol percentage has increased up to 8% within 7 days ($P=0.002$) and decreased there after due to acetic acid culture incorporation. Both aeration and non-aeration treatments developed acetic acid over 4% (by 14 and 15 days, respectively) having significantly higher ($P=0.016$) acid development in aerated sample, thus lower pH value ($P=0.024$) also observed in aerated samples compared to non-aerated samples. About 5% of sedimentation was resulted within three days of sedimentation treatments having higher sedimentation under room temperature compared to refrigerator temperature yet they were not significant ($P=0.95$). The vinegar development process with aeration and non-aeration, developed vinegar having 2.9 (SD 0.0)% and 3.0 (SD 0.0)% of pH, 4.38 (SD 0.01)% and 4.09 (SD 0.01)% of acetic acid, 1.03 (SD 0.00)% g/mL and 1.04 (SD 0.00)% g/mL of density respectively. It is possible to develop organic vinegar by concentrating the pineapple peel juice up to 18% of reducing sugar and by aeration within 15 days of process.

Keywords: Organic vinegar; pineapple peel; sedimentation; acetic acid

Freeze drying as a potential shelf life extension method to fresh grated coconut

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Non-thermal or low temperature processed coconut oil has high potential due to its effect towards curing Alzheimer's disease. Other than the virgin coconut oil, fresh coconut has similar effects. Presently available above market form is fresh coconut under frozen condition. Cold chain maintains is required for the transportation of fresh grated coconut and it has a lower shelf life of two weeks. Freeze drying is a novel technique which can be used to increase the shelf life of fresh grated coconut, protecting the nutrients and other physio-chemical properties. This study was conducted to find out the shelf life of freeze dried grated coconut (FDGC). Further, the study determined the effect of storage temperature conditions and effect of moisture and light barrier properties on the shelf life of FDGC.

Selected mature coconuts were grated to obtain the fresh grated coconut (FGC) and it was freeze dried to obtain FDGC. FGC and FDGC were separately packed in metalized polypropylene and polypropylene packages under vacuum conditions. Packs were stored in room temperature (32°C), refrigerator (5°C) and freezer (-18°C) conditions. Quality parameters Moisture; water activity; PH; free fatty acid (FFA); peroxide value (PV) of FDGC and FGC were tested for 8 weeks with 2 weeks intervals. FFA (>1%) and PV (>10 mEq/kg) of FGC under three temperature conditions exceed the recommended level before 2nd week. Respective values of FDGC were below the recommended level (FFA = 0.76% and PV = 4.46 mEq/kg) even at the 8th week. pH of the FDGC was change from 6.23 to 6.58 from the beginning to the 8th week. Microbe content was not at the countable range for FGC and FDGC at the initial stage and, microbial content of FDGC increased to 6.66 log CFU/mL at the 8th week. There was no significant difference observed for the overall acceptability of FDGC stored under different storage temperature conditions and packaging materials. Though there was no significant difference between the metalized polypropylene and polypropylene packaging materials at the end of the 8 weeks, higher moisture and gas barrier properties were evident with metalized polypropylene. The study showed that freeze drying can be utilized to increase shelf life of grated coconut with maintaining its essential characteristics and consumer acceptability.

Keywords: Freeze dried coconut; fresh coconut; quality parameters; shelf life

Extraction, purification and characterization of pectin from fruit wastes

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Pectin is a water soluble polysaccharide and it is used as a gelling agent, stabilizer, emulsifier, and thickener in food industry. Commercially pectin extracted from citrus peel and apple pomace. However there are potential sources of pectin available in Sri Lanka including fruit wastes. Therefore it is worthy to identify potential source of pectin. This study was focused to identify potential source of pectin. Pectin was isolated from peels of pineapple, papaya, banana, lime, jackfruit, passion, sidaran and mango, press cake of wood apple and golden apple and cashew apple then yield was recorded. Based on pectin yield, jackfruit (*Artocarpus heterophyllus*) and sidaran (*Citrus aurantium*) were selected for further studies. The effect of maturity stage of jackfruit and sidaran on pectin yield was also studied. Then isolated pectins were characterized based on moisture, ash, methoxyl content, equivalent weight, acetyl value, anhydrouronic acid (AUA) and degree of esterification (DE). Gelling properties (gel strength, setting time, setting temperature and gel grade) of isolated pectins also compared with commercial pectin. Sensory evaluation was carried out to compare extracted pectins and commercial pectin.

Among the selected fruit wastes, sidaran peel (3% SD 0.06) and jackfruit rind (1.65% SD 0.10) showed highest pectin yield. At mature stage, pectin yields of jackfruit rind and sidaran peel were higher than premature and ripen stages. Moisture (%), ash (%), methoxyl content (%), equivalent weight, acetyl value (%), AUA (%) and DE (%) of jackfruit pectin were 10.15 (SD 0.80), 0.86 (SD 0.12), 8.58 (SD 0.04), 746.61 (SD 19.59), 1.59 (SD 0.04), 62.69 (SD 0.29), 77.67 (SD 0.67) respectively, whereas that of sidaran pectin were 10.47 (SD 0.22), 0.86 (SD 0.11), 6.26 (SD 0.06), 607.31 (SD 4.24), 1.94 (SD 0.04), 50.33 (SD 0.52), 70.63 (SD 0.20) correspondingly. Gel strength (%), setting time (s), setting temperature (°C) and gel grade of jackfruit pectin were 15.63 (SD 0.23), 125.67 (SD 7.77), 67.33 (SD 2.08), 110 respectively while that of sidaran pectin were 26.27 (SD 0.44), 184.33 (SD 2.08), 51.33 (SD 1.53), 90 correspondingly. Sensory properties revealed that there were not significant different among texture, taste and overall acceptability of jackfruit, sidaran and commercial pectin as a gelling agent in pineapple jam ($P < 0.05$). Owing to this results, jackfruit (*Artocarpus heterophyllus*) rind and sidaran (*Citrus aurantium*) peel were rich source of pectin and jackfruit pectin can be classified as high methoxyl rapid set pectin and sidaran pectin can be classified as low methoxyl pectin.

Keywords: Characterization; fruit waste; jack fruit (*Artocarpus heterophyllus*); pectin; sidaran (*Citrus aurantium*)

Agrochemical usage and Cadmium accumulation in leafy vegetables grown in Hanguranketha DS division, Sri Lanka

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Agrochemicals are widely used in crop production in Nuwaraeliya district. Due to high demand for fresh vegetables some farmers do not follow the prescribed pre-harvest intervals before harvesting. Intensification of agrochemical application for vegetables is likely to result in the accumulation of heavy metals in the food products that could reach the consumers directly or indirectly and may cause a wide variety of changes in biological systems, even at very low concentrations and a significant health risk to humans. This study focused to investigate agrochemical usage practices of vegetable farmers and level of Cadmium (Cd) accumulation on major upcountry crops. Pretested questionnaire based survey was conducted for randomly selected 185 farmers who involved in cultivation of cabbage (*Brassica chinensis*), carrot (*Dacuscarota*), leeks (*Allium ampeloprasum*) and knol-khol (*Brassica oleracea L*) in Mathurata, Mandaramnuwara and Hewaheta Grama Niladhari divisions of Haguranketha DS in Nuwaraeliya district, Sri Lanka. Further, raw and processed (with and without coconut milk, shallow fried) leeks and knol-khol were analyzed for Cd by Graphite Furnace Atomic Absorption Spectrophotometry. Survey data revealed that respondents used three major weedicides i.e. Glyphosate, Metribuzin, and Pendimethaline, however the usage levels were 219%, 249% and 165% respectively, which higher than permitted levels. Abamectin, Chlorpyrifos, Fipronil, Imidacloprid, LC, Profenofos and Tiamthoxamas were the active ingredients contained in pesticide varieties they used. However, Fipronil (147%) and Profenofos (105%) were applied in higher levels than prescribed in the label. The same trend, applying higher percentages than to the allowable level, could be seen in fungicide application for vegetables e.g. Propineb (35%), Maneb (31%) and Mancozeb (33%), while Leeks farmers applied Maneb 82% than of permitted level. Cd level of leeks and knol-khol at harvesting stage was 0.024 mg/kg and 0.021 mg/kg (dry weight basis) respectively. A reduction of 12.5% and 29% of Cd than the initial level were noted in processed leeks with coconut milk (Kirata) and shallow fried respectively. But <5% changes were observed for processed knol-khol. Both vegetables do not reached the Hazard Quotient (HQ) recommendation level for Cd and the values are 0.00003 and 0.00005 for leeks and knol-khol correspondingly. Results shows that even though the vegetable farmers used higher amounts of agrochemicals than prescribed levels, residual Cd in processed leeks and knol-khol is far below than the HQ recommendation levels. Periodical assessments are required for the detail investigation of this issue.

Keywords: Cadmium; agrochemical; hazard quotient; leeks; knol-khol

Formulation of cereal based instant mix from locally available whole grain cereals with “Good Dietary Fiber source” for elderly population

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Non Communicable Diseases (NCDs) are widely reported in Sri Lanka and becoming a major issue in Sri Lanka's health sector. The unhealthy diet which contained high sugar, high fat and low dietary fiber has been identified as one of the key factors for NCDs. It is well reported that there was an inverse relationship between fiber intake and NCDs. Most of Sri Lankan food habits are based on polished grains and refined flours (wheat flour and rice) which contained relatively low in dietary fiber although the locally available cereals with high dietary fiber (around 12%) such as finger millet and sorghum. The objective of present study was to formulate cereal based instant mix from locally available whole grain cereals with “Good Dietary Fiber source” for elderly population. Selection of raw materials was done based on the availability, cost and the richness of dietary fiber. Finger millet (*Eleusine coracana*), Sorghum (*Sorghum bicolor*) and unpolished red rice (*Oryza sativa*) were used for cereal mixture and Garlic (*Allium sativum*), Red Onion (*Allium cepa*), Cinnamon (*Cinnamomum zeylanicum*) and Curry Leaves (*Murraya koenigii*) were used for spicy mixture and the raw materials were analyzed for proximate composition and dietary fiber. Based on several formulations the both instant spicy flavored and sugar flavored cereal mixtures were selected by analyzing mean scores in sensory evaluation trials. Physical, chemical properties and microbial analysis were done for final product of prepared both types of cereal mixture. Dietary fiber, protein, fat, carbohydrate, ash and caloric value content of the product with spicy flavored(A) (per one serving, 250 mL) contained 3.07 g, 2.74 g, 1.52 g, 22.5 g, 1.33 g, 120 kcal respectively whereas product with sugar flavored contained(B) 3.11 g, 2.74 g, 1.66 g, 1.06 g, 123 kcal respectively. Product A showed that low sugar releasing rate (2mg/ml after 3 hours) than product B (4 mg/ml after 3 hours) and product A could be categorized as low glycemic index (GI) foods while product B came under intermediate GI food. High density polyethylene for cereal mixture and aluminum foil for spicy mixture was selected as the packaging materials depending their properties of moisture, water activity and barrier properties.

Keywords: Good dietary fiber source; glycemic index; non communicable diseases; whole grain cereals

Characterization of physiochemical and antibacterial properties of Sri Lankan bee honey

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Honey is a natural substance produced by bees, mainly by *Apis cerena* L., and is a nutritious food of economic importance worldwide. The therapeutic potential of bee honey has been rediscovered in recent times, and it is gaining recognition as an antibacterial agent. The chemical composition and flavor of honey mainly depends on the vegetation sources from which it derives. Recent studies conducted using bee honey from different botanical and geographical origins around the world reveal that the keeping quality, antibacterial and antioxidant properties of bee honey depends on their physiochemical properties. As there are limited studies dealing with bee honey characterization, the research was conducted to determine selected physicochemical properties and the antibacterial potential of two bee honey types available in Sri Lanka.

Wild honey and red gum honey samples belonging to the June- August honey harvesting period of 2014 were used for the research. Under the physiochemical properties ash, total soluble solids, pH, free acidity and total reducing sugar contents were determined. The antibacterial activity was determined using the agar well diffusion assay against the following pathogens: *Staphylococcus aureus* NCTC 6571, *Escherichia coli* ATCC 10418, *Salmonella enretica serovar* Typhimurium ATCC 13311 and *Pseudomonas aeruginosa* NCTC 10662.

The results revealed that wild honey and red gum honey were significantly different ($P<0.005$) in all physiochemical parameters investigated, except in their reducing sugar contents. The ash, total soluble solid, pH, total acidity and reducing sugar contents in wild honey was 0.42 (SD 0.07)%, 78.63 (SD 0.09) °Brix, 3.41 (SD 0.04), 21.51 (SD 2.42) mmol/kg and 64.75% respectively, while the values of red gum honey were 0.18 (SD 0.04) %, 76.70 (SD 0.08) °Brix, 4.34 (SD 0.09), 33.14 (SD 0.39) mmol/kg and 61.09% respectively. The ash, total soluble solid, total acidity were significantly high ($P<0.005$) in wild honey, while its pH value was significantly lower ($P<0.005$) than red gum honey. According to the antibacterial assay, growth of *Escherichia coli* ATCC 10418 and *Staphylococcus aureus* NCTC 6571 were inhibited by both honey types. However, the growth of *Salmonella enretica serovar* Typhimurium ATCC 13311 and *Pseudomonas aeruginosa* NCTC 10662 were not inhibited by both types of bee honey used for the assay. The physicochemical properties of two Sri Lankan bee honey types investigated fall within the international standard limits and exhibit good antibacterial properties.

Keywords: Bee honey; physiochemical properties; antibacterial activity

Study on suitability of 'Kiri ala' (*Xanthosoma sagittifolium*) incorporated wheat flour in bread making

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Wheat bread plays a vital role in typical Sri Lankan diet. However, bakery industry totally depends on imported wheat though Sri Lanka has locally grown cereals and tuber crops. Substitution of locally available underutilized crops for wheat can reduce extravagant cost of imports. Therefore this study was aimed to evaluate the potential of incorporating 'kiri-ala' (*Xanthosoma sagittifolium*) as a partial substitution of wheat flour. A flour was made out of 'kiri-ala' by a dehydration technique and was analyzed for nutritional and antioxidant properties. Composite flour blends were prepared by incorporating 10%, 20%, and 30% 'kiri-ala' with wheat flour and were evaluated for their rheological properties using farinographs. The breads prepared with composite flour were evaluated for sensory properties (general appearance, crust colour, crumb grain, texture and taste) using 25 semi trained panelists.

'Kiri-ala' flour contains 4.32 (SD 0.03) % crude protein, 2.29 (SD 0.17) % crude fiber, 1.28 (SD 0.02) % crude fat, 6.96 (SD 0.15) % moisture, 3.53 (SD 0.06) % ash and 81.62 (SD 2.68) % carbohydrate. Fiber and ash content of 'kiri-ala' flour significantly higher than wheat flour though protein content relatively low. Total phenol content, total antioxidant capacity, reducing power and free radical scavenging capacity of the flour were 8.79 (SD 1.07) gallic acid equivalent (GAE mg/g), 80.13 (SD 7.17) ascorbic acid equivalent (AAE mg/g), 8.16±0.55% equivalent inhibition of ascorbic acid and 3.6 (SD 0.95) % respectively. Rheological studies have shown that the water absorption, dough development time and arrival time increased with the increase in substitution, while dough stability decreased after 10% substitution level. Sensory study revealed that the bread with 20% 'kiri-ala' flour comparable with 100% wheat bread in term of overall acceptability. As conclusion, up to 20% substitution of 'kiri-ala' could be possible to produce acceptable bread with higher antioxidant and nutritional properties.

Keywords: Antioxidant properties; composite flour; bread; kiri ala (*Xanthosoma sagittifolium*); rheological properties

Physico-chemical variations of copra stored under different conditions and its effect on oil quality

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Copra is one of the major traditional products processed from coconuts and is used primarily as source of coconut oil (CNO). It is the kernel of coconut after reducing the moisture content from 50% to 6% (w. b.) by drying. The drying processes of copra in drying kilns cause various deteriorations in copra during storage and create many quality deteriorations which may lead to hygienic and health issues. Hence the CNO extracted from copra always is considered as a low value product in world market. Therefore, it is important to restrict various deteriorations during storage which may ultimately helps to maintain the quality of copra. Therefore, the objective of the study was to identify best storage conditions that is temperature and time to store copra obtain from charcoal and shell drying.

Copra obtain from two drying methods were stored at three different temperatures namely cool room (CR), air conditioned (AC) and ambient temperature (AT). Copra stored in selected temperatures and oil extracted from copra was tested with three week intervals up to nine weeks. Moisture content, free fatty acid (FFA) value and fat content of copra and moisture content, FFA value, saponification value, peroxide value and insoluble impurities of were evaluated separately. Finally results of copra were compared with Asian Pacific Coconut Community (APCC) quality standards and for oil were compared with the standards of Sri Lankan Standards Institute (SLSI). Factorial design was used to analyze the results at level of significance 0.05.

The moisture content and FFA value in charcoal dried copra were reduced significantly below the standard levels of 6% and 1% while both were increased significantly in shell dried copra. Both factors were increased above standard level in shell dried copra stored at AC and AT. The types of storage conditions do not affect to change fat content in either charcoal copra or shell copra. The qualities of both tested copra in each temperature were also affected to the quality of CNO. The reduction of moisture and FFA that is below the standard levels of 0.4% and 0.8% respectively were appeared in oil extracted from charcoal copra while both were increased in shell dried copra oil. Both factors were increased above standard level in shell dried copra oil stored at AC and AT. The formation of peroxide was only appeared in oil extracted from stored shell dried copra. It clearly demonstrates that type of storage condition do not affect the saponification value and insoluble impurities in oil extracted from both types of copra. These results indicate that storage temperature do not affect the quality of charcoal dried copra and only CR⁰T maintains the quality of shell dried copra by giving good quality CNO during two and half months of storage period.

Keywords: Copra; coconut oil; quality; storage; temperature

Developing a novel method to collect fresh coconut (*Cocos nucifera*) sap for the production of coconut sugar

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Coconut sugar is a value added product which is made from the phloem sap of coconut tree. As tapped coconut sap is easily fermented by microbial activity, the sugar concentration and pH can reduce drastically affecting crystallization process of coconut sap badly. The required quality is not attained by the traditional methods used to prevent fermentation. Development of harsh taste, odor and undesirable colour are resulted from the partial fermentation of the materials used. Therefore, a novel equipment is needed for the collection of fresh coconut sap. The equipment was designed to reduce the fermentation by cooling and preventing the exposure of the collected sap to the environment.

A cylindrical tube was used to insert the tapped spadix of the coconut tree. Oozing sap was collected through the tube and directed to a closed chamber made up of a Styrofoam box with a lid. The chamber was a Styrofoam boxes with a lid which provide heat insulation. The box was connected with a bottle that collects sap. Packeted ice was used as the cooling agent to cool the accumulated sap. In the study coconut sap was collected from both developed and conventional methods. Physico-chemical characteristics of the coconut sap collected from both newly designed equipment and conventional methods were determined at 8 hours and 12 hours time intervals. The results demonstrated that the coconut sap collected from the newly designed equipment reduce fermentation than the coconut sap collected from conventional methods. The coconut sap collected at 8h interval was better in colour, taste and odor than sap collected at 12 h interval from the developed equipment. The coconut sap collected at 8 h interval using developed equipment reported pH 6.97, Brix 15.9⁰, total sugar 12.85% and absence of alcohol. This study indicates that the developed equipment is ideal for the collection of coconut sap which can be used for the production of coconut sugar.

Keywords: Coconut sap; coconut sugar; sap collection equipment; fermentation

Knowledge, usage and antibacterial properties of curd (“Meekiri” and “Deekiri”) starter cultures

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Curd is one of the oldest fermented milk products in Sri Lanka obtained by lactic acid fermentation of cow's milk (“Deekiri”) or buffaloes' milk (“Meekiri”). The way starter cultures are obtained and used mainly affect the probiotic potential and the microbial diversity of the product. However, there is a paucity of information regarding the knowledge and usage of starter cultures during the curd production process and their antibacterial properties in Sri Lankan curd. Therefore, the aim of this study was to investigate the level of awareness and usage patterns of starter cultures during curd manufacturing and to evaluate the antibacterial activity of several *Lactobacillus* species isolated as curd starter cultures.

The knowledge and usage of starter cultures were investigated through a survey which included 45 randomly selected home and commercial scale curd manufacturers from Southern, Uva, North Western and Western provinces of Sri Lanka. A questionnaire based survey was used to gather information regarding the respondents' demographic information, level of knowledge on starter cultures and their functions, starter culture usage patterns and information about the curd production process adopted. The antibacterial activity of the isolated starter culture species (*L. fermentum* LFW 2, *L. plantarum*, *L. fermentum* JCM 8581, *L. fermentum* JCM 7754, *L. curvatus* PON461 and *L. acidophilus* CICC6074) were determined by the agar well diffusion assay against *Escherichia coli* ATCC 10418, *Staphylococcus aureus* NCTC 6571, *Salmonella enterica* serovar Typhimurium ATCC 13311 and *Bacillus cereus*.

The results revealed that there is a good knowledge on starter cultures among commercial scale manufacturers while a fair knowledge exist in home scale manufacturers. Majority of the home scale manufacturers use their own previous day curd as the source of starter culture while few people used a natural acidulant like *Garcinia cambogia* to start the milk coagulation process. However, freeze dried starter culture powders are used in commercial scale curd production. Antibacterial assay revealed that all the *Lactobacillus* spp. tested possess significant antimicrobial activity against the pathogens used ($P < 0.05$) and the highest and the lowest activity were exhibited by *L. plantarum* and *L. acidophilus* respectively. It can be concluded that home scale curd is a good source of natural probiotics with high microbial diversity making it an excellent potential source to isolate new probiotic organisms and *Lactobacillus* starter cultures isolated from curd possess good antibacterial activity.

Keywords: Curd; starter cultures; antibacterial activity

Postharvest losses, embedded energy and renewable energy potential in food value chain in Sri Lanka

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Fruit and vegetable are very important and indispensable part of the human diet and provide most important nutrition to improve the health. Food losses do not merely reduce the availability of food for human consumption, but cause negative externalities to society via cost of waste management, greenhouse gas production and loss of limited resources used in production. The investigation of post harvest losses, energy uses and renewable energy potential in food value chain is most important for food security and energy security in the country. Therefore objective of the research was to estimate post harvest losses, embedded energy, and renewable energy potential along the food value chain in Sri Lanka. The three main fruit and vegetable supply chain; Jaffna to Colombo, Nuwara Eliya to Nochiagama and Dambulla to Matugama were selected and the data were collected from fifteen respondents at each stage of the supply chain through semi structured questionnaire, group discussions, personal interviews and direct observations. Waste segmentation was done from the waste collected from Dambulla economic center and data were related to the fruit and vegetable losses, energy uses and composition of waste. Results clearly indicate that embedded energy accumulates through the food value chain and highest embedded energy was estimated in leeks and carrot, that shown a relationship between price of commodities and embedded energy. When compare the energy levels at different stages of food value chain, highest level of energy was consumed at farmer level that includes energy consumed for water pumping, fertilizer and pesticide applications and for transportation. Embedded energy at farm level and distributor level were 0.760-1.40 MJ/kg and 0.26 MJ/kg, respectively. Estimated post harvest losses were highest at the retailer level and farmer level and they were 12.8% and 12% respectively. Post harvest losses were negligible at distributor level because they do not sort the produce at this point. Estimated total post harvest loss through out the value chain was 30.7%. Main reasons observed for losses were over production and improper post harvest practices. Therefore, it can be concluded that there is a significant post harvest and energy losses through food value chain and proper cultivation planning, maintaining proper post harvest handling practices and use of waste to produce biogas and fibre will be useful in improve energy efficiency.

Keywords: Postharvest losses; energy efficiency; renewable energy potential; food value chain

Determination of factors influencing bottle deformation under refrigerated condition and thermal effect of shrink sleeving process on novelty carbonated beverages – Twistee

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Twistee is a novel, innovative carbonated beverage – Fruit juice with green tea extract of two flavors; apple and peach based on added fruit pulp. It has been identified that 10% - 15% Twistee bottles deform under refrigerated condition causing a critical product issue. As a novel technique, full wrap shrink sleeving process is carried out for Twistee container (Polyethylene terephthalate) PET bottles by using 100 °C steam. The objective of this study was to identify the product and package factors influencing bottle deformation and thermal effect of shrink sleeving process on Twistee. For the study of bottle deformation, Twistee–apple and peach bottles were obtained and stored at refrigerated condition for two weeks. Then deform and non-deform bottles were selected. As product factors, torque, carbonation, head space, pH, brix, acidity and filled weight were analyzed. Bottle height, empty bottle weight, base clearance, bottle thickness and sectional weights were analyzed as package factors. Selected samples were analyzed for aerobic plate count and yeast and mould count. Next Twistee-apple bottles were selected during production process as before and after shrink sleeving for the study of thermal effect of shrink sleeving process. Data was collected for product and package analysis and analyzed using 2- sample t-test and multiple linear regression ($\alpha=0.05$). For the study of bottle deformation, mean values of carbonation, pH, filled bottle weight and thickness-panel were significantly ($P<0.05$) decreased in deformed bottles for product Twistee-peach. Mean values of carbonation and thickness-shoulder were significantly ($P<0.05$) decreased in deformed bottles for product Twistee–apple. Carbonation was the common significantly different factor between both deformed and non-deformed bottles for both Twistee-peach and apple. There was a regression relationship between carbonation and filled weight of product Twistee-peach ($P<0.05$) and positive linear relationship between factors. Aerobic plate count and yeast and mould counts were absent for both types of deformed and non-deformed bottles. For the study of thermal effect of shrink sleeving process, mean values of carbonation, torque and thickness base were significantly ($P<0.05$) decreased after applying steam while pH was significantly increased. The results revealed that the common factor for Twistee bottle deformation was low carbonation and there was a regression relationship between carbonation and filled weight of Twistee– Peach. Further, thermal effect on carbonation, torque, thickness base and pH during shrink sleeving process was observed.

Keywords: Carbonated beverages; deformation; PET bottles; shrink sleeve; thermal effect

Preservation of red colour in chilled yellow fin tuna (*Thunnus albacore*) steaks with incorporation of acceptable food additives

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Yellow fin tuna (*Thunnus albacore*) is popular and expensive fish in local and export market. The price of tuna is varied due to the typical redness of meat produces by higher myoglobin (Mb) content in tuna meat. During cold storage, post harvest discoloration of tuna meat from red to dark brown proceeds gradually due to oxidation of myoglobin which resulted rejection of fish in export industry that directly affect the reduction of global market share. Thus, present study was aimed to preserve red color of tuna meat by addition of acceptable food additives; nitrite, salt, ascorbate and natural food colorants; betanin and cochineal while maintaining the freshness and acceptability. A 100 g of tuna steaks treated by cold curing brines that incorporated with different concentrations of nitrite (10, 20, 30, 40 ppm), ascorbate (0.05, 0.1, 0.15, 0.2 %) and natural food colorants (300 ppm). Treatments were differed as per dipping time (2, 2.5, 3 hrs) and concentrations of additives. Dipped, drained, vacuum packed tuna steaks were treated accordingly and stored at 0-4°C for 8 days and analyzed in two days intervals for color by instrumental color indexes [redness (r%); greenness (g%) and blueness (b%)], pH, total plate count, histamine, total volatile bases (TVB-N) and residual nitrite content.

Results showed that, sample treated with cochineal had significantly ($P<0.05$) highest r% (53.3 SD 0.9) and the lowest g% and b% (23.7 SD 0.7 and 23.0 SD 1.2, respectively) at the 8th day of storage as compared to the sample treated with betanin. As treatments were differ according to the additive concentration and dipping time, obtained results verify that, tuna steaks treated with cochineal (300 ppm), nitrite (40 ppm), salt (5% w/v), ascorbate (0.20% w/v) with 3 hours dipping time was the most suitable treatment for color preservation as it gave the significantly ($P<0.05$) highest r% (52.6 SD 2.2) color value and the lowest g% (23.0 SD 1.7) and b% (24.3 SD 0.7) at the 8th day compared to the other treatments. Total plate count of selected sample lied below 6 log cfu/g and pH decreased from 6.10 (SD 0.10) to 5.98 (SD 0.10) during storage which was below the maximum acceptable levels of 7 log cfu/g and pH 7 respectively. Histamine content (2.83 SD 0.07 ppm) was not significantly different while the level of TVB-N content (14.98 SD 0.24 mg/100g) was significantly lowest ($P<0.05$) from other treatments and all values laid below the maximum acceptable limits. Gradual reduction of residual nitrite content (ppm) in fish flesh from 0.48 (SD 0.00) to 0.17 (SD 0.00) was observed from day 2 to day 8. In conclusion, tuna steaks dipped for 3 hours in curing solution of added 40 ppm nitrite, 5% w/v salt, 0.2% w/v ascorbate and 300 ppm cochineal will preserve red color for 8 days of chilled storage.

Keywords: Tuna steaks; chilled storage; color preservation; freshness

Formulation of a dietary fiber enhanced cracker for adults using selected locally available cereal and legume flours

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Crackers are considered as healthy snacks due to their low levels of salt, sugar and moderate content of fat; yet they are low in dietary fiber. Since there is an inverse relationship between intake of dietary fiber and risk for developing non-communicable diseases in adults, the present study was conducted with the objective of formulating a cracker with enhanced dietary fiber content by incorporating selected locally available whole grain cereals and legumes. Flour composition of a normal cracker formulation (i.e. 100% (W/W) wheat flour) was substituted at 50%, 40% and 30% levels with a mixed-grain flour containing finger millet, brown rice and either mung bean, chick pea or soya bean at different ratios. Since 50% substitution (brown rice: finger millet: legume=1.5:1.5:2) was not able to produce the required rheological properties in the dough, it was left out and the study was continued with 40% and 30% substitutions. The 40% substitution of wheat flour with the mixed-grain flour was only feasible with chick pea. The formulation of cracker with 40% substitution was repeated at 2:1:1, 1:2:1 and 1:1:2 ratios of brown rice: finger millet: chick pea. The 30% substitution was possible to formulate with all selected legumes when the mixed-grain flour had the 1:1:1 ratio of brown rice: finger millet: legume. Proximate composition and the dietary fiber content of both raw materials and final products, glycemic response (*In-vitro*) and sensory attributes of formulated crackers were assayed. Of the raw materials, soya bean had the highest dietary fiber content (24.88%) while, chick pea, mung bean, finger millet and brown rice had a dietary fiber content of 11.27%, 10.58%, 9.57% and 2.99%, respectively. Of the formulated crackers, the highest dietary fiber content of 3.91% was obtained for the 40% substitution where the composition of mixed-grain flour was 1:1:2 in brown rice: finger millet: chick pea and it was significantly higher than that of wheat cracker ($P \leq 0.05$). From the formulated crackers, the lowest predicted glycemic index ($\text{pGI} \times 0.7$) of 57.28% was obtained with 40% substitution at 1:1:2 ratio of brown rice: finger millet: chick pea and it was lower than that obtained for wheat cracker (68.70%). The mean ranks for appearance, color, flavor, crispiness, creaminess, mouth feel and overall acceptability in sensory evaluation obtained by the above cracker were not significantly different from ranks obtained by the wheat cracker. In cracker formulation, 40% of mixed-grain flour was the optimum level of substitution and the cracker thus formulated with 1:1:2 ratio in brown rice: finger millet: chick pea was the best formulation.

Keywords: Cereals; cracker; dietary fiber; glycemic response; legumes

Reformulation of palmyrah (*Borassus flabellifer* L) fruit ready to serve drink and modification of its process to improve some of its selected properties

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Although palmyrah fruits are seasonal they have excellent chemical and physical properties for the development of food and beverages. Though there is a demand for palmyrah ready to serve beverage, existing commercial products are failed because of their poor quality. Hence this study was conducted to improve the quality of palmyrah ready to serve beverage by reformulation and modification of process. Pectin and citric acid were selected as stabilizer and acidulant through ranking test with 11 semi trained panellists. Using general full factorial design, 18 treatments were carried out to optimize the levels of fruit (5%, 8.5%, 12%), sugar (10%, 12.5%, 15%) and pH (3.5, 4.0) in the final formula. The final formulation was evaluated through 31 sensory panelists using 9 point hedonic scale. The formulated beverage contained 12% fruit pulp, 12.5% sugar and pH of 4.0. The level of pectin was adjusted to 0.66% and fruit pulp was subjected to homogenization (30000 rpm, 5 min). Chemical and nutrient analysis of final product and commercially available drink revealed that the reformulated product was significantly better than existing product in nutrients. It contained 0.14% crude protein, 0.78% crude fat, 0.41% crude fibre, 0.17% ash and 11.97% total sugar. Total antioxidant activity, total phenolic content and DPPH radical scavenging capacity of prepared product were 4044.0 AAE mg/L, 137.57 GAE mg/L and 12.43% respectively while the commercial product did not show the latter and did not have even half of the other two properties. The developed product did not show any growth of yeast and mold and did not result total bacterial count though out the shelf life study for 10 weeks. Hence the developed palmyrah fruit ready to serve drink showed better quality in the analysed properties and scored the most in the sensory evaluation than the commercially available product.

Keywords: Palmyrah fruit; antioxidant; homogenization; preserved pulp; ready to serve drink

Formulation of instant herbal porridge mixtures from Ranawara (*Cassia auriculata* Linn) leaves for diabetic patients

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Ranawara (*Cassia auriculata* Linn) leaves based herbal porridge is a well reputed dietary remedy for treating diabetes in Sri Lanka. However there are no any commercial instant porridge mixtures containing Ranawara leaves. This study was conducted to develop marketable Ranawara based instant herbal porridge by using a dehydration method. Each ingredient was separately dehydrated to 6% moisture content, ground, sifted and blended according to an Ayurvedic formula for diabetics. The recipe was slightly modified based on a preliminary sensory analysis. Two formulations were prepared with and without coconut powder and they were evaluated for physio chemical, antioxidant, sensory properties and shelf life. Two packaging materials, low density polyethylene (30 µm) pack - metalized PET (12 µm) and cast polypropylene (25 µm) pack - PET (12 µm) with heat and vacuum sealing were evaluated by monitoring the change in pH, water activity, moisture content, peroxide value and free fatty acid value in two months storage.

Formulated recipe without coconut powder contains Ranawara leaves 38.86%, crushed rice 45.97%, garlic 9.45%, onion 4.09% and pepper 1.64%. Similarly, formulated recipe with coconut powder contained 46.84% coconut powder in dry weight base. The products without coconut powder contains, moisture 4.28 (SD 0.04) %, fat 4.83 (SD 0.12) %, ash 3.07 (SD 0.04) %, protein 10.80 (SD 0.03) %, fiber 6.39 (SD 0.05) % and carbohydrate 74.91 (SD 1.66) %. Total phenolic content and total antioxidant capacity of without coconut powder product was 476.24 GAE mg/g and 715.52 AAE mg/g respectively, whereas the product with coconut powder was 240.14 GAE mg/g and 452.30 AAE mg/g respectively. Sensory results indicated there were no significant differences ($P < 0.05$) among homemade, commercial and formulated products in terms of overall acceptability. The vacuum sealed LDP pack was observed as the least change in water activity, moisture and pH for both products. Within two months period both products did not exceed safe peroxide level (20 mEq/kg) and FFA level (1.2%). In conclusion, organoleptically acceptable instant herbal porridge mixtures from Ranawara leaves can be prepared with minimum two months shelf life.

Keywords: Ranawara (*Cassia auriculata* Linn), herbal porridge, dehydration, antioxidant, proximate compositions

Development of acidified milk drink fortified with Docosahexaenoic acid and strawberry fruit pulp

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Acidified milk beverages are becoming more popular among consumers worldwide due to increasing trend for ready-to eat, convenient food to meet the busy lifestyles nowadays. Direct acidification of milk to lower the pH to a range of 5.4 - 4.2 and use of hydrocolloids to avoid aggregation of milk proteins are common features in these beverages. Nutritional and functional properties of these products are enhanced by fortification with a wide range of food components. Fortification of acidified milk beverages with docosahexaenoic acid (DHA) increases the omega-3 type essential fatty acids which are usually less available in milk. However the distinct fishy odor of DHA in fortified milks makes it less palatable thereby resulting less consumer acceptance. Combination of milk with fruit pulp can mask such odors without compromising the organoleptic properties. This study was done to find out if an acidified milk beverage fortified with DHA can be processed without compromising the organoleptic properties of the product. Different levels of pectin as a stabilizer (0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8% w/w), strawberry pulp (10%, 15% and 20%) and DHA (0.0275% w/w) as one third of the required daily allowance was used in the preliminary screening tests. The milk drink was prepared by mixing all the ingredients with milk, followed by pasteurization (105°C, 2 minutes). A pectin level of 0.65% and 15% of strawberry pulp combination was selected to have the highest organoleptic properties without identification of DHA (0.0275% by w/w), among rest of the combinations as evaluated by 30 semi-trained panellists. The selected best formulation was daily investigated for pH, total soluble solids (BRIX°), proximate analysis and microbiological characteristics (yeast and mould, total plate count and coliforms) and sensory evaluation for a period of 21 days under refrigeration conditions (5 °C SD 1). pH of the product significantly decreased ($P < 0.05$) from 4.77 (day 1) – 4.43 (day 21) and total soluble solids were slightly increased during this period. The product was microbiologically safe up to 14 days under refrigeration, in comparison with the dairy product standards. The final product showed a nutritional composition of fat, protein, total soluble solids, fibre and calcium of 1.72 (SD 0.01) %, 2.98 (SD 0.06) %, 16.9 (SD 0.01) %, 0.53 (SD 0.16) % (w/w) and 86.0 (SD 2) mg/L respectively. This study concludes that DHA fortified fruit milk can be served as a ready to serve fruit milk drink without compromising the organoleptic properties with 14 days of shelf life under refrigerated conditions, meeting low fat (1% - 2%) dairy product standards.

Keywords: Acidified milk; docosahexaenoic acid (DHA); strawberry pulp; organoleptic properties; shelf life

Development of condiment from pineapple peel

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Condiment is a food preparation that contains spices, or spice extraction, which can enhance the flavor of food when added. As the complex mixture of phytochemicals present in fruits and spices provides protective health benefits, the present study was aimed to develop a condiment using industrially wasted pineapple peel juice and spices. Juice was extracted from ground pineapple peel after filtering through muslin cloth. Brix and pH of the juice was adjusted to 16° brix and pH 4. Baker's yeast (*Saccharomyces sp.*) was introduced for the alcoholic fermentation which was done in both 25±1°C and room temperature (30±1°C) until the alcohol level reaches 9%. Acetic acid fermentation was done at room temperature (30±1°C) with continuous aeration until acid levels reach 2% and 3% (in separate batches) followed by pasteurization and filtration to get the pineapple-flavoured condiment. Crushed Cardamom and Cinnamon were added separately in 1.5% and 2% levels to the condiment having 2% and 3% acetic acid levels and eight combinations of mixtures were aged at room temperature for two weeks and filtered to obtain spice added condiment and then subjected to sensory evaluation. Throughout the fermentation process the product was checked for acidity, pH, brix and alcohol percentage. Antioxidant properties of condiment were assessed *in vitro* by total phenolic content (TPC), total flavonoid (TFC) and DPPH radical scavenging activity. The monitoring of successive fermentation indicated that there was a significantly higher ($P<0.05$) alcohol content (8.25%) at 25±1°C in the 5th day compared to room temperature fermentation (alcohol 7.9%). Acetic acid fermentation was completed at 6th day as the acid value reached 3%. Sensory panellists preferred the attributes of condiment prepared by 3% acetic acid with 2% cinnamon followed by 1.5% cinnamon and 1.5% of cardamom. The 3% acetic acid with 1.5% cardamom showed the highest TPC (4.87 mg SD 0.03 gallic acid equivalent/mL) and TFC (2.07 SD 0.02 catechin equivalent/mL) and DPPH radical scavenging activity (9.81 µmol/g SD 0.38) followed by 2% and 1% of Cinnamon. Results conclude that wasted pineapple peel can be utilized to produce the condiment with 3% acetic acid level within 25 days of accelerated process and the 2% cinnamon added condiment was the prominent product compared to others.

Keywords: Pineapple peel; fermentation; condiment; antioxidant activity; spices

Development and storage studies of Ready-To-Serve beverages using pineapple and papaya without preservatives

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Fruit beverages are popular among all groups of society. Almost all the fruit beverages available in the market contain preservatives such as benzoic acid, sorbic acid and sulphites. Addition of preservatives is linked with possibilities of allergies and cancers. Since recent times consumer preference towards “natural” products over those containing chemically synthesised preservatives has increased. Therefore, this study was aimed in developing of Ready-To-Serve (RTS) fruit beverages without preservatives and assessing the storage life at ambient temperature. Pineapple and papaya were selected in this process as an acidic and a low acidic fruit respectively. Three treatments of RTS beverages were prepared for each variety of fruit using 10 % of fruit pulp and maintaining different brix values of 12⁰, 13⁰, and 14⁰ and titratable acidity (TA) levels as 0.3%, 0.325% and 0.35% respectively to maintain a constant brix:acid ratio of 40. The RTS beverages were subjected to two heat treatments, pasteurization (80°C 10 minutes) and sterilization (100°C 20 minutes) at steps prior to bottling and after bottling respectively. The products were analysed for physico-chemical, microbial and sensory quality parameters (7- point hedonic scale) for a period of two months at ambient temperature (28°C SD 5). Brix of beverages increased during the storage period in all the products showing hydrolysis of sucrose by the acids present in the beverage. TA of beverages decreased during the storage period and higher values of TA were observed in RTS beverages of pineapple over papaya due to higher inherent acidity. The vitamin C content of the RTS was found to reduce significantly ($P = 0.05$) at levels of 57% and 60% for papaya and pineapple respectively due to heat treatment while no significant change of vitamin C was observed during the storage period. Both papaya and pineapple RTS beverages having a brix value of 13⁰ and TA of 0.325% obtained significantly higher hedonic scores in terms of odor, taste and overall acceptability. The aerobic plate counts of 50 and 100 CFU/g were observed in RTS beverages of pineapple and papaya respectively (brix of 12⁰ and 0.30% TA) while no aerobic plate counts were observed in all other RTS beverages after eight weeks. Yeast and mould, and coliform were absent in all products throughout the storage period. Both RTS beverages with a brix of 13⁰ and 0.325% of TA could be successfully stored at ambient temperature for the period of 2 months without significant changes in sensory quality profile.

Keywords: Brix-acid ratio; papaya; pineapple; preservatives; Ready-To-Serve beverage.

Effect of spices on physico-chemical properties and microbiological safety of virgin coconut oil

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Virgin coconut oil (VCO) is obtained from fresh, mature kernel of the coconut by mechanical or natural means, with or without the use of heat and without undergoing chemical refining. Incorporation of locally available spices; garlic, black pepper, ginger and chili to VCO could be beneficial in value addition of the existing products. The main objective of this study was to determine the changes in physico-chemical and microbiological parameters of spices incorporated VCO. Crushed spices were added separately as 5% (w/v) to VCO and physico-chemical and microbiological parameters were evaluated within 5 days intervals for one month of storage. Antioxidant properties of spices incorporated VCO were assessed as total phenolic content and % DPPH radical scavenging activity after one month of storage. A sensory analysis was conducted to identify the acceptable combinations of spices incorporated VCO with 20 semi trained panelists using simple ranking test. The most preferable spices (garlic, black pepper and chili) were incorporated in 2.5% (w/v) as combinations of; garlic+black pepper, garlic+chili, black pepper+chili to VCO and the same above mentioned parameters were evaluated.

The highest total phenolic content was achieved 5% chili incorporated VCO (344.42 µg/mL SD 0.30) and the 5% garlic incorporated VCO was obtained the highest radical scavenging antioxidant activity (78.27 % SD 0.33). Iodine values and refractive indexes were ranged within the APCC standard values as 6-11 gI₂/100g of oil and 1.448-1.454 at 30°C respectively, but there was a reduction of values during storage. Saponification values were laid within the APCC standard range of 250-275 mg KOH/g. FFA values of 5% black pepper incorporated VCO was shown significantly higher ($P < 0.05$) value compared to control which increased from 0.367 to 0.954 during storage. Spices incorporated VCO could be considered as microbiologically safe (due to the reduction of total plate counts and yeast and mould counts) when compared to the control samples. This may be due to the effect of antimicrobial compounds present in these spices. A 5% garlic and combination (2.5% garlic+2.5% chili) incorporated VCO were identified as the most preferred in sensory evaluation. Incorporation of spices can modify the physico-chemical properties, increase antioxidant activities and microbial safety by value addition to the VCO.

Keywords: Spices; virgin coconut oil; total phenolic content; antioxidant activity

Phytochemical composition and antimicrobial properties of Nutmeg (*Myristica fragrans* Houtt.) pericarp

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The increasing trend among consumers to look upon the nutritional composition of foods and the intention of food producers to produce healthy long life foods have gained the scientific eye leading to number of experiments on both quality and microbial safety of foods. Since spices provide not only flavor enhancement but also antimicrobial properties against food borne pathogens, this study was to investigate the phytochemical composition and antimicrobial properties of nutmeg pericarp, which has increasingly used for the production of variety of foods in order to give some value to the waste. For the selection of best extraction procedure along with the sample of extract with high functional properties, matured sample of pericarps was processed by peeling. Dehydration and freeze drying were used to dry the processed samples and extraction was carried out using both methanol and acetone following maceration and centrifugation. Identification and quantification was taken place for total phenol content (TPC), total flavonoid content (TFC), alkaloid, tannin and saponin contents and the free radical scavenging activity. The antimicrobial activity was tested by agar well diffusion method for the selected species of Yeast/ *Saccharomyces cerevisiae*, *Escherichia coli* and *Bacillus cereus*.

The best sample to get higher amount of phytochemicals was the unpeeled, freeze dried methanolic extract and the phytochemical contents; TPC, TFC, alkaloid, tannin, saponin and free radical scavenging activity were; 23.09 (SD 0.15) mg GAE/g D.W, 876.03 (SD 6.77) μ g CE/g D.W, 1.65 (SD 0.02)%, 8.34 (SD 0.37) mg GAE/g D.W, 1.56 (SD 0.02)% and 70.83 (SD 1.53) IC₅₀% respectively. The minimum inhibitory concentrations (MIC₈₀) of methanolic nutmeg pericarp extract against *Saccharomyces cerevisiae*, *Escherichia coli* and *Bacillus cereus* were 25, 100 and 100 (mg/mL) respectively. Thereby, nutmeg pericarp can be considered as a good source of total phenols and flavonoids with higher antioxidant activity as well as an effective antimicrobial agent for Yeast, Gram positive and Gram negative food borne pathogens.

Keywords: *Myristica fragrans*; phytochemical content; antimicrobial activity

Nutritional composition, antioxidant activity and sensory properties of selected Sri Lankan rice (*Oryza sativa* L.) varieties

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Rice (*Oryza sativa* L.) is the most important crop and staple food in Sri Lanka. At present 2.1 million metric tons of rice is annually produced within the country, which is 95% of the local requirement. New recommended white rice varieties account over 70% of the country's rice harvest and traditional red varieties are also gaining gradual popularity among health conscious consumers. However, characterization of local rice varieties in terms of nutritional composition, antioxidant potential and sensory properties is rather seldom taken into consideration and is investigated in the research.

Twelve popular red and white rice varieties available in Sri Lanka were selected for the research and first they were analyzed for their proximate and mineral composition. Total phenolic content of the selected rice varieties were measured by Folin-Ciocalteu method while 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging ability was used to analyze their antioxidant activity. The sensory properties of the cooked rice samples were evaluated by a simple ranking test conducted using 30 untrained panelists. The appearance, taste, tenderness, aroma and overall acceptability were investigated using a 5-point hedonic scale.

The moisture content in the used varieties ranged from 6.52 to 11.13%, carbohydrate from 77.19 to 82.30%, soluble starch from 40.75 to 78.41%, ash from 1.37 to 2.07%, crude fiber from 0.96 to 2.35%, crude protein from 2.36 to 4.72%, crude fat from 0.95 to 1.74% and energy from 350.6 to 366.5 kcal/100g. In relation to mineral content, "Pokkali" had the highest Zinc content (0.0584 mg/g) while "Herath banda" had the highest Magnesium (1.040 mg/g) content. Traditional red rice varieties had higher total phenolic content than recommended white rice varieties such as "Maa wee" showed highest total phenolic content of 28.81 mg GAE/g where "Iginimitiya" was lowest total phenolic content of 4.48 mg GAE/g. Several traditional red rice varieties like "Pokkali", "Kahata wee" and "Herath banda" had the highest DPPH radical scavenging activity than recommended white rice varieties. According to sensory evaluation, "Bg 352" obtained the highest sensory scores while "Maa wee" obtained the lowest values. The overall acceptability scores were relatively low in red rice varieties than white rice varieties used. It can be concluded that the selected rice varieties possess variation in nutritional composition, antioxidant activity and sensory profile. Furthermore, traditional red rice variety possesses higher antioxidant activity although their consumer acceptance is poor.

Keywords: Rice; nutritional composition; antioxidant activity; sensory properties

Enhancing disease resistance and improving quality of papaya (*Carica papaya* L.) by postharvest application of silicon

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Papaya (*Carica papaya* L.) is a less firmer fruit with high nutritional value and susceptible to many diseases especially anthracnose, causing higher postharvest losses. The purpose of this study is to investigate the effect of postharvest application of silicon on anthracnose disease development, physicochemical characteristics and the shelf life of papaya fruits.

Mature fruits were harvested at colour breakage stage from a papaya garden located in Kuliyaipitiya area. They were washed using clean water and dipped in 0, 1000, 2500, 5000 and 7500 mg/L solutions of Sodium silicate for 20 min and subsequently fruits were air dried. Fruits were inoculated with *Colletotrichum gloeosporioides* by placing 25 µl drops of spore suspension at three different places along the longitudinal axis of each papaya fruits. Spore suspension was prepared using a pure culture of the organism, isolated by Anthracnose disease containing papaya fruits. The concentration of the spore suspension was adjusted to 10^5 - 10^6 per mL. After, the fruits were kept in moisture chamber, area of inoculated spot, physico-chemical parameters; fruit firmness, Brix (Total Soluble Solid), pH and titrable acidity of fruit juice were measured at full ripening (CI-6) stage. Shelf life of papaya fruits were also measured calculating no of days at full ripening stage. However, there was no significant effect observed on Brix, pH and titratable acidity of silicon treated fruits compared to untreated control. But, silicon was affected on fruit firmness and it was increased with increasing Sodium silicate concentration. There was a significant ($P<0.05$) reduction (50-60%) in disease development in fruits treated at 5000 mg/L and 7500 mg/L sodium silicate compared to control fruits. The shelf life was increased up to 4-5 days in fruits treated at 2500 and 5000 mg/L sodium silicate compared to control fruits. In conclusion, postharvest dip treatment at 5000 mg/L sodium silicate has significantly ($P<0.05$) reduced the anthracnose disease development and increased the shelf life and quality of the fruits.

Keywords: Papaya; sodium silicate treatment; shelf life; anthracnose

Residual heavy metals in Tilapia (*Oreochromis sp.*) from Padaviya and Huruluwewa reservoirs, Anuradapura district, Sri Lanka

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Chronic Kidney disease (CKDu) has shown a significant increase in some areas of North Central Province (NCP), Sri Lanka. The people who live in rural areas of NCP mostly consume Tilapia (*Oreochromis sp.*) fish as an animal protein source of their regular diet. The consumption of inland fish that are contaminated with heavy metals is considered as a potential causative factor for this issue. Thus the scientific evidences of accumulation of heavy metals in processed tilapia are needed to confirm, as the CKDu has become a national health issue in Sri Lanka. The aim of the study was to determine of residual heavy metal in fresh and processed Tilapia from Padaviya and Hurulu reservoirs in NCP. Scaled, degutted, washed Tilapia was used as raw samples while processed samples were obtained by preparing tilapia under three different general cooking methods; spices with coconut milk (kirata), spices with water (mirisata) and deep fried in coconut oil. The housewives who live in catchment areas of Padaviya and Hurulu reservoirs were processed tilapia using their home kitchen utensils and water resources. The freeze-dried, microwave digested samples were analyzed for heavy metals by using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Result showed that Fe, Zn, Mn, Cu, Cr, Ni, Pb, Co, Mo, Hg, Ag, As and Cd were presence in both raw and processed Tilapia. Beneficial heavy metals; Fe ($16.46 \times 10^3 - 11.4 \times 10^3 \mu\text{g/kg}$), Zn ($13.67 \times 10^3 - 16.41 \times 10^3 \mu\text{g/kg}$), Mn ($2281.73 \mu\text{g/kg} - 955.44 \mu\text{g/kg}$) concentrations were higher in raw Tilapia from both Padaviya and Huruluwewa reservoirs. Most hazardous heavy metal; Pb, Hg, Cd and As concentrations in raw tilapia from Padaviya reservoir were $152.21 \mu\text{g/kg}$, $42.02 \mu\text{g/kg}$, $11.83 \mu\text{g/kg}$ and $16.56 \mu\text{g/kg}$ respectively, while $110.82 \mu\text{g/kg}$, $86.40 \mu\text{g/kg}$, $8.84 \mu\text{g/kg}$ and $0.66 \mu\text{g/kg}$ values correspondingly were reported for the tilapia obtained from Huruluwewa reservoir. Mn, Co, As and Cd concentrations were significantly ($P < 0.05$) higher in Tilapia from Padaviya reservoir with compared to Huruluwewa reservoir. Noticeably, Pb concentration ($2819.21 \mu\text{g/kg}$) was significantly ($P < 0.05$) increased in deep fried Tilapia, while, Cr concentration was reduced by 52.27%, 47.70% and 43.18% when tilapia was cooked with coconut milk ($210.13 \mu\text{g/kg}$), without coconut milk (water) ($230.02 \mu\text{g/kg}$) and fried in coconut oil ($257.07 \mu\text{g/kg}$), however, the values are quiet higher than the FAO recommended limits. Results conclude that Tilapia from Padaviya and Huruluwewa reservoirs do not posses hazardous level of heavy metals. However, periodical studies are further needed.

Keywords: Chronic kidney disease; heavy metals; inductively coupled plasma mass spectrometry; Tilapia processing,

Development of quality improved Palmyrah (*Borassus flabellifer*) tuber flour

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Palmyrah (*Borassus flabellifer*) tuber is widely grown in Jaffna Peninsula. People consume tubers as boiled tuber or products made out of the tuber flour in household level. The Palmyrah Development Board assists farmers to scale up this industry. However, common improper practices in post harvest handling and processing of tuber, downgrade the quality of the flour and flour based products. The study is aimed to improve the quality of palmyrah tuber flour by modifying the processing procedures and selects the best flour types for different snacks. Palmyrah tubers in same age, variety and batch were obtained from the seedbeds grown by the local farmers. After peeling the outer cover, washed and drained tubers were subjected for different methods of precooking i.e. pressure cooking for 30 min, steaming for 40 min and boiling for 30 min. Precooked tubers cut into uniform slices and dried under different conditions; sun drying for 7 days, oven drying at 55°C for 10 hours and oven drying at 85°C for 4.5 hrs. Dried tuber slices were ground, sieved and analyzed for yield then packed in high-density polyethylene bags and kept in room temperature. Developed twelve type of flours were analyzed for proximate composition, crude saponin, physical (bulk and tapped density) and functional properties i.e. solubility, swelling power, water and oil absorption capacity, foaming capacity and foam stability. Tuber flours were assessed the suitability for preparation of cookies, snack ball and soup mix using 26 semi-trained panelists. The lowest reduction of tuber weight (51%) was shown by steamed and oven dried (55°C, 10 hrs) process. The results indicated that pretreatments was significantly ($P<0.05$) affected chemical, physical and functional properties of tuber flour while drying methods did not have significant effect ($P<0.05$) on crude fiber, tapped density and crude protein contents. The flour obtained by steamed and oven drying (85°C, 4.5 hrs) had the highest carbohydrate (87.3%), bulk density (0.7 g/cm³), and tapped density (0.8 g/cm³). Significantly higher ($P<0.05$) sensory scores were obtained by cookies made out of flour from raw and oven dried (55°C, 10 hrs) tuber, soup mix from steamed and oven dried (85°C, 4.5 hrs) tuber, and snack balls from pressure-cooked and oven dried (85 °C, 4.5 hrs) tuber flours when compared to all other types of tuber flours. Pressure cooking and steaming reduced the crude saponin in the flour. By considering all above physico-chemical properties, it can be concluding that, there is high possibility to use steamed and oven dried (85°C, 4.5 hrs) palmyrah tuber flour in preparation of many snacks. The study confirmed that proper pretreatments reduce the postharvest loss and increase the utilization of palmyrah tuber flour in food industry.

Keywords: Palmyrah tuber flour; postharvest handling; functional properties; saponin; snacks

Effect of thermization on hygienic quality of raw milk in Sri Lanka

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Thermization is a mild heat treatment given to raw milk to extend its shelf life for few days until used in further processing. Thermization further activates microbial spores in raw milk which enables destroying of consequent vegetative cells by stronger heat treatments such as pasteurization or sterilization. A thermization treatment provided to raw milk in an industrial facility was studied for its effects in hygienic quality of milk during storage in silos. Total bacterial count (TBC) and spore forming bacterial count (SFBC) of milk at the point of receiving and after thermization (65°C for 15 seconds) was determined. Samples were collected from twenty different collecting centers were at three different points; just before unloaded, just after thermization and 1 hour after delivering to the silo. Samples were prepared for microbial tests from milk in two different ways; by subjecting milk to a heat treatment of 80 °C for 5 minutes to destroy the vegetative cells present and without heat treatment to identify spore forming bacterial counts and vegetative bacterial counts respectively. Serial dilutions were prepared from both types of milk samples, plated in nutrient agar and incubated at 37°C for 3 days. Colony forming units (CFU) were counted and subjected to statistical analysis using ANOVA and paired t-test at 95% confidence level.

The mean TBC value of raw milk was significantly reduced from 3.27×10^5 (SD 0.8×10^5) CFU/ ml to 3.4×10^4 (SD 0.7×10^4) CFU/ml due to thermization process while the reduction of SFBC in raw milk was from 3.3×10^3 (SD 0.74×10^3) CFU/ml to 2.9×10^3 (SD 0.2×10^3) CFU/ml. After one hour storage period in the silo, samples have shown TBC of 5.0×10^4 (SD 0.32×10^4) CFU/ml and SFBC of 3.3×10^3 (SD 0.32×10^3) CFU/ml. This result reveals that one hour storage time in the silo has not effectively changed both spores and vegetative cells. Milk from Island wide collecting centers showed a similar pattern in reduction of both spores and vegetative cells although the cell counts of different collecting centers showed a vast variation. This study suggests that thermization process is important in significant reduction of the vegetative cell counts and slight reduction of spores thereby enhance the hygienic quality of milk during storage of 1 hour without significant increase in both types of cell counts until further processing.

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Keywords: Quality; thermization; raw milk; process; bacteria

Development of low sugar flavoured drinking yoghurt

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Yoghurt is an oldest bacterial fermented milk product in the world. Drinking yoghurt is one of an unconventional dairy product with beneficial probiotic effects. In most part of the world Cow milk use as main ingredient when making yoghurt. Drinking yoghurt comes under stirred type yoghurt. Usually higher level of sugar is added to increase shelf life and total soluble solid content of drinking yoghurt which helps to achieve desirable texture. High sugar level can be affected to healthier life and when consume regularly may result increase in calorie consumption and many other chronic medical problems. Therefore, this research was designed to develop low sugar drinking yoghurt to substitute market available drinking yoghurt which is prepared using high level of sugar. The product was prepared by using 3 different levels of sugar, flavours and colour. Sensory evaluations were done in 3 stages to select best levels of sugar, flavour and colour using 5 point hedonic scale using 30 semi trained panellists. Sensory evaluation was conducted to compare sweetness, texture, sourness, aroma and appearance among developed low sugar drinking yogurt and CIC drinking yogurt. pH, titrable acidity, brix value, specific gravity, and fat content were measured for the selected samples at 0, 5, 10, 15 and 20 days of storage. Samples were analyzed for yeast and mould and total *Enterobacteriaceae* counts to evaluate the stability through shelf life. Strawberry flavour was selected by panellist's most favourable fruity flavour among strawberry, mango, and mix fruit flavours. Twelve percent sugar level was selected as the best sugar level that gives proper creaminess and textural properties. This sugar level has reduced the brix level to 17.1° (SD 0.1) from the 23° of brix of the CIC vanilla flavoured product. Flavour level of 0.09% and colour level of 0.02% were preferred which gave the highest some of mean ranks over others. Significant higher scores ($P < 0.05$) were obtained for flavour and aroma for low sugar drinking yogurt compared to high sugar drinking yoghurt. The scores for texture, sourness, overall taste and sweetness were higher for CIC yoghurt drink. It may be resulted due to low sugar level. Titrable acidity increased and pH value decreases with storage time but both were in acceptable level at the end of the storage time. All the samples were negative for *Enterobacteriaceae* or yeast and mould counts up to 20 days of storage time. Finally it can be concluded that consumer preferred strawberry flavoured low sugar drinking yoghurt can successfully produce which can consume with low calorie intake.

Keywords: Yoghurt; drinking yoghurt; low sugar; strawberry

Attributes of *Garcinia quaesita* towards curd preparation in traditional setup

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Curd is a cultured dairy product. Modern industries use lactic acid starter to make curd. Traditional Sri Lankan curd industry used a piece of *Garcinia* for the curdling. However, still there is less awareness for the properties of *Garcinia* which are responsible for curdling. Presence of acids, particular microorganism/s, or combination of those can be the reason/s for the curdling. Therefore, the present study was carried out to evaluate the effectiveness of the characteristics of *Garcinia quaesita* towards curdling of milk and to explore the possibility of development of new starter culture using *Garcinia quaesita*. Microbial culture extracted from *Garcinia* equivalent to the microbial load of commercial curd (to test microbial effect), sterilized *Garcinia* juice equivalent to acid in 1, 2 and 3 pieces of *Garcinia* [0.50 mL, 1.00 mL, 1.50 mL respectively, (to test acid effect)], and non-sterilized *Garcinia* equivalent to 1, 2 and 3 pieces of *Garcinia* [3 g, 6 g, 9 g, (to test combine effect)] were used as curdling agents and curd was prepared by following the traditional steps. Curd samples were tested for pH and titrable acidity for three successive days. Gram staining test, catalase test and motility test were done for microbial identification. With the use of identified microbial species, three types of starter cultures were prepared (two individual cultures and one mix culture with the same ratio). Sensory evaluation was done to select the best starter culture and that was compared with the commercial curd.

In microbiological identification Gram +, catalase – and coccus shape bacterial strain and Gram +, catalase – and bacillus shape bacterial strain were identified in *Garcinia*. Acids extracted from *Garcinia* individually did not develop curd with similar acidity and texture to commercial curd ($P < 0.05$). Individual effect of coccus bacterial culture from *Garcinia* showed seven times of initial load, similar acidity and texture to the commercial curd ($P = 0.056$), while bacillus bacterial culture exhibited six times of initial load, similar acidity and texture to the commercial curd ($P = 0.552$). Mixed microbial culture showed five times of initial load, similar acidity and texture to commercial curd ($P = 0.052$). Combined effects of acid and microbial cultures of *Garcinia* presented significantly higher acidity and textural properties than commercial curd ($P < 0.05$). Results revealed that consumer preference was higher for the curd made from mixed microbial culture and it is applicable as a starter culture in curd preparation with further development.

Keywords: Curd; *Garcinia quaesita*; pH; starter culture; titrable acidity

Quality and shelf life evaluation of crude tuna fish oil with the addition of tocopherol

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Fish oils have been recognized as good sources of polyunsaturated fatty acids (PUFA), which are widely used for pharmaceutical purposes and as food supplements. Consumptions of these PUFAs have been perceived to be important in human nutrition, health and disease prevention. Tuna (*Thunnus sp.*), an important industrial fish, generates a substantial amount of wastes (the head, fins and intestine) which are good sources of fish meal production. Press liquor, a byproduct of the fish meal production, is used worldwide for fish oil extraction. This study was done to evaluate the quality of tuna fish oil extracted from press liquor during fish meal production. Fish oil was extracted by centrifugation at 10,000 rpm. Proximate composition of extracted oil was determined. The shelf life of the extracted oil was evaluated by the treatment with 50 ppm and 150 ppm tocopherol during three weeks of storage at 31°C, 37°C and 47°C. Fatty acid profile was analyzed before and after treatment of tocopherol.

Results showed that press liquor contained 71.8 (SD 0.5)% moisture, 15.8 (SD 0.7)% fat, and 8.7 (SD 0.3)% protein and 0.63 (SD 0.02)% ash. The percentage of total extractable oil from press liquor by centrifugation at 10,000 rpm was 51.8%. It was found that the reddish brown colored crude oil consists of 1.1 (SD 0.4)% moisture, 5.4 (SD 0.8)% insoluble impurities, 4.63 (SD 0.04)% free fatty acids and 1.07±0.02 cg/g iodine. Peroxide formation was not observed during three weeks of storage at 31°C, 37°C and 47°C. The iodine value of treated and untreated tuna fish oil ranged from 0.55-0.70 cg/g at the third week. Fatty acid profile of tuna fish oil showed high content of palmitic acid (C16:0; 22.51%), oleic acid (C18:1; 16.02%) and DHA (C22:6; 23.47%). The PUFAs of extracted lipid accounted for about 33.07% of the total fatty acids, while the monounsaturated fatty acids and the SFAs were around 24.55% and 42.38%, respectively. With the results showing no significant effect of tocopherol addition to improve the keeping quality, crude fish oil extracted from press liquor can therefore be stored without natural antioxidant for about one month.

Authors thank the Industrial Technology Institute for providing funds and other facilities.

Keywords: Press liquor; quality; tocopherol; tuna fish oil

Variability of by-catch recovered from shrimp trawlers of Pesalai, Mannar

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A systematic study of the variability in yield and composition of shrimp by-catch recovered from shrimp trawlers at Pesalai was undertaken in relation to the potential utilization of the by-catch as a non-food source. Of the total catch, 72% consisted of by-catch and 28% was the targeted species (shrimp). The mean shrimp: by-catch ratio during the study period was 1:2.6. The mean by-catch yield was 5.59 kg/hour and the mean shrimp yield was 2.1 kg/hour. A significant difference ($P < 0.05$) was found between weight of targeted group and by-catch. The total monthly shrimp production was more or less similar in April and May but it was slightly lower in June, 2015. However a slightly increasing trend was observed in total monthly by-catch produced during the study period. A total number of 41 species belong to 23 families were identified in trawl catches recovered during the study. The percentage in weight composition of most commercially important by-catch species were *Leiognathus sp* (29.7%), *Octopus sp* (8.5%), *Portunus pelagicus* (5.7%), small prawns (5.6%), *Arius sp* (5.2%), *Clupeid sp* (4.4%) and *Tetraodon sp* (4.0%). However, *Arius sp*, *Octopus sp*, *Clupeid sp*, *Gerres sp*, *Leiognathus sp* and *Portunus pelagicus* were identified as most abundant species in by-catch with the relative frequency over 0.9 followed by *Selaroides leptolepis*, *Sillago sihama*, *Platycephalus tuberculatus*, *Terapon theraps*, *Sepia sp* and *Arothron immaculatus*. Although the overall size range of the by-catch ranged between 3 and 54 cm, the commonly occurring length range was 5 cm – 15 cm in total length with the general mean value of 11.3 cm. This study provide information on the composition and variability of by-catch of shrimp trawl fishery at Pesalai and the possibilities of using the by-catch as non-food sources.

Keywords: By-catch; Pesalai; trawl fishery; relative frequency; shrimp

The effects of different drying methods on the quality of dried seaweed and extracted agar processed from red algae *Kappaphycus striatum*

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Seaweeds are important sources of food, industrial materials such as biofuels, cosmetics, biomedical compounds etc. Properties like thickening, gelling and stabilizing abilities of agar, extracted from seaweed are used for many applications. *Kappaphycus striatum* is recently introduced Rhodophyte species to Sri Lanka for promoting dried seaweed export market which caters agar extraction industries. Still in Sri Lanka sun drying is used for producing dried seaweeds in commercial scale. This study evaluates the efficiency of solar drier for drying *K. striatum*, based on the quality of dried seaweed and extracted agar. This study compared two drying methods: open sun drying and solar drying of 12 hours. The effect of the two drying methods on dried seaweed products were evaluated based on visual sensory evaluations while quantity and quality of extracted agar were determined by physical, chemical and microbiological properties. In addition, three different raw material categories of *K. striatum*: thick, thin and fish grazed were compared, under the two drying conditions, for the quantity and quality of agar.

Weight and moisture content of dried seaweed products of all three categories were reduced with increasing drying time under both the drying methods while physical properties of agar like pH, yield, and microbiological properties as presence of gram negative and positive bacteria were differed. However, weight and moisture content of sun dried seaweed products of all three categories of seaweed were significantly lower ($P<0.05$) than solar dried products. Agar yield differed with respect to three different categories of raw seaweeds and drying method. Thick and thin seaweed categories produced higher yield under solar drying than sun drying while grazed parts resulted lower agar yield in solar drying than sun drying. All three categories of raw seaweeds resulted higher pH in extracted agar from solar dried raw materials than sun dried materials. As per microbiological analysis extracted agar samples from solar dried materials had gram negative bacteria but low amount of gram positive bacteria. Solar dried seaweed samples were well accepted in visual sensory attributes compared to sun dried samples.

The present study revealed that the sun drying is better to enhance storage period and shelf life of dried seaweed products but agar extracted from solar dried samples had better qualities of agar than sun dried samples.

Keywords: Agar; microbiological qualities; physical qualities; solar drier

Species diversity of fish in the by-catch collected from dumps in fish landing sites from Halawatha to Kalpitiya, Sri Lanka

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Fish by-catch is one of the significant issues affecting fisheries management. In Asia, by-catch is mostly discarded and undocumented. Since the global capture fisheries is collapsing in major fishing grounds, ensuring sustainable fisheries also includes understanding the species that are discarded, and the fishing practices that are responsible for by-catch. In Sri Lanka, Gulf of Mannar has been fished for centuries, but by-catch has not been documented. Current study attempted identifying the fish in dumps at 29 landing sites in the lower part of Gulf of Mannar from Halawatha to Kalpitiya. The fishing practices were also evaluated through an interviewer based questionnaire analysis (n= 29) between March to June 2015. Species were identified using standard published keys.

Thirty nine fish species of class Actinopteri and Elasmobranchii belonging to 7 orders, 28 families and 36 genera were identified (Table).

Table: Summary of taxonomic details of identified fish by-catch

Class	Order and the number of species identified
Actinopteri	Beryciformes (2), Clupeiformes (1), Elopiformes (1), Perciformes (24) Syngnathiformes (1), Tetraodontiformes (8)
Elasmobranchii	Myliobatiformes (2)

Amongst the identified fish 28 were reef associated. Of the total by-catch, 28.2% was demersal and pelagic. One day boats, mutli-day boats, theppam, vallam, line boats and canoes were used as main vessels. Of that 65% of one day boats were mechanized. Gillnets, shrimp trawl nets, long lines and beach seine were used as main gears in study area. Part of by-catch was utilized as food fish, fish meal, dried fish and bait. Improving the awareness and facilities for law- enforcement agencies to monitor fishing, along with improved landing site facilities, can reduce the by-catch in the area.

Keywords: By-catch; fish; Gulf of Mannar

How multi-gear, multi-species artisanal fisheries sustained for last 100 years in Koggala lagoon, southern Sri Lanka?

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Management of multispecies and multi-gear fisheries is challenging due to conflicts and competitions of fishers. But such a complex fishery exists for the last 100 years in Koggala lagoon, which extends only 6.15 km² area, in southern Sri Lanka. This study evaluated the fish catch and income sharing mechanisms which enable to survive these fisheries in highly dynamic biological and socio-economical environments. Eight landing sites at the lagoon body, lagoon mouth and adjacent coast were weekly visited from April to August 2015 in drawing random samples to determine gear-based catch per unit effort (CPUE), species diversity and income levels. Questionnaires and discussions among fishers were used to identify potentials and threats to the fishery. Dominant 25 fish species and 6 shrimp species were observed in the catches of 11 fishing methods including snares, and a fish trap which was not recorded from Koggala lagoon. During the study period high variations of CPUE were observed within and among fishing methods. Hierarchical cluster analysis based on present-absent data showed two clearly separated clusters (Fig) ($P < 0.05$). Though the educational level and years of experience significantly differed between lagoon and coastal fishers ($P < 0.05$), the respective income was not significantly different. Targeting different species and different life history stages by different gears seems to be the key in sustaining multi-gear fisheries in the lagoon for last 100 years. Though formal school education does not have any effect on selecting fishing location, fishing experience seems to be important in operating some specific gears. Species aggregation and their susceptibility for different gears revelled in this study must be important in developing fishery management strategies for the lagoon. Despite to the effective catch sharing mechanism, the sand bar formation, which is the most concerned issue to both lagoon and costal fishers, will determine the future of the Koggala lagoon fishery.

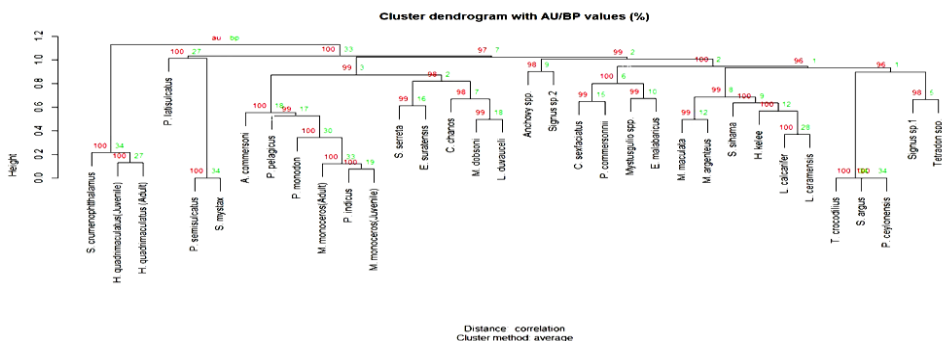


Fig: Cluster dendrogram with au/bp values (%) based on all species. Values at edges of clustering are P-values (%) calculated via multi-scale bootstrap of 1000 resampling. Values on left side = au (approximately unbiased) P-values, and values on right side = bp (bootstrap probability) values.

Keywords: Artisanal fisheries; catch composition; socio-economic status

Situation analysis of commercial fishery resources in Sri Lankan side of Cauvery basin

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Very rich fishery resources are found in Cauvery basin and this basin supports a thriving fishery. Marine fisheries around the Cauvery basin are highly vulnerable to impacts of other different activities that have been carried out in these areas. Poaching of fishery resources by Indian fishermen, hydrocarbon exploration activities, coral mining, sand mining and release of industrial wastages can create an adverse impact on marine fishery. The current study evaluated the trends and turning points in marine fish production and explored the strengths, weaknesses, opportunities and threats in the Cauvery basin fishery. Beside, it reviews the social status of the fishing communities.

The study revealed that, there was no trend observed in total annual marine fish production in Mannar during 1999-2014. Kilinochchi and Mullaitivu districts showed a significantly decreasing trend in marine fish production during 2004-2009 and a significantly increasing trend during 2009-2014. Jaffna district showed a decreasing trend during 2004-2007 and a significantly increasing trend during 2008-2012. There was no trend in small pelagic fish production in Mannar during 2005-2013. All the other districts showed a significantly decreasing trend during 2004-2009 and a significantly increasing trend during 2009-2013 with exception for Kilinochchi district in 2013. Large pelagic productions showed increasing trends during 2008-2013 in Jaffna and Mullaitivu. Although there were no trends in large pelagic productions in both Mannar and Kilinochchi during 2005-2012, a considerable increase was observed in 2013. There was no trend in demersal catches in Kilinochchi during 2005-2012. All the other districts showed a significantly increasing trend during 2009-2013 except for Mannar in 2013. All districts have exhibited only one turning point in monthly production trends during Jan-2009 to Dec-2014. Turning points for Jaffna, Kilinochchi, Mullaitivu and Mannar have been observed in Jul-2009, Mar-2012, Sep-2011 and Sep-2009 respectively. Highest number of fishermen was registered in Jaffna followed by Mannar. There were no fishermen engaged in fishing in Mullaitivu and Kilinochchi in 2009. With the end of war the numbers have increased.

Beginning of hydrocarbon exploration activities greatly affected the fisheries in Mannar. The large pelagic fishes have increased in recent years due to the increasing availability of multiday boats. Fisheries were crippled by Tsunami and civil war in Northern Province. After the Tsunami and relaxation for restriction in fishing areas, an increase tendency was observed in marine productions.

Keywords: Cauvery basin; hydrocarbon exploration; Indian poaching; marine fishery; trends

Salinity tolerance of invasive Orinocosail fin catfish

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Invasive species are considered as a threat to aquatic ecosystems worldwide. Orinocosail fin cat fish is wide spread invasive fish belongs to the family Loricariidae and scientifically known as *Pterygoplichthys multiradiatus*. It is called as a scavenger or janitor fish that disperses rapidly within and among river systems and inland waters of Sri Lanka after accidental introduction through ornamental fish trade. They have been reported from eight provinces except northern Sri Lanka. The rapid increasing of this non-commercially important fish population have resulted high catch rates in gillnets while lowering catches of traditional marketable species and this has been subsequently affecting the livelihood of the fisher folk. The sail fin catfish have been recently recorded under the brackish water environment in Batticaloa estuary areas and creating a risk of invading. Present study attempted to evaluate, the salinity tolerance levels of Orinoco sail fin catfish and the histological changes in gill and kidney tissues after exposing to saline water.

Samples were collected from Victoria dam in Kandy and they were transferred into the laboratory acclimation tank. Acclimatized sail fin catfishes were exposed to 0 ppt (control), 5 ppt, 10 ppt and 15 ppt of saline water for 96 hours with three replicates per treatment and each replicates consisting of six juveniles with standard length of 20 – 25 cm for range finding test. Kidney and gill arches were removed from treated fish of range finding test and they were stained for the histological analysis.

Total mortality was observed in 15 ppt and 100% survival was observed in 10ppt salinity. According to the range finding test, concentration of 11ppt, 12ppt, 13ppt and 14ppt were determined as the range for testing LC₅₀ level. Three replicates were performed for each concentrations with consisting of six juveniles for 96 hours for LC₅₀ finding. The LC₅₀ value estimated by probit analysis was 12.22 ppt. Fish under the stress condition showed some significant behavioral changes including surfacing, fast swimming, upside down and increased mucus secretion rate in saline water. At the concentration of 15ppt significant mucus secretion was observed. Lifting gill epithelium, Telangiectasis in gill filaments, Fusion of primary gill filaments and shrinking of secondary gill filaments of histological alterations were observed in gills of the treated fish. Shrinking of Bowman's space, increasing the diameter of renal tubules and severe cellular degeneration of histological changes were observed in the kidney tissues of the treated fish. Present results indicate the tolerance of low salinity levels of the *P. multiradiatus* and potential to adapt in low salinity areas of estuaries.

Keywords: Histological analysis; LC₅₀; Orinoco sail fin catfish; salinity tolerance

The invertebrate diversity in the by-catch collected from dumps in fish landing sites from Halawatha to Kalpitiya, Sri Lanka

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Fishery by-catch discard practices constitute a purposeless waste of valuable living resources, which play an important role in the depletion of marine populations (1). Invertebrate by-catch is mostly undocumented for in Asia in productive and ecologically sensitive marine ecosystems. This includes Gulf of Mannar where various fishing gears and vessels are being operated. The current study identified invertebrates in dumps at 29 landing sites in lower part of Gulf of Mannar from Halawatha to Kalpitiya. Fishing practices were described using an interviewer administered questionnaire between March to June 2015. Species were identified using taxonomic keys (2,3).

Forty nine invertebrates falling into three phyla, 14 orders, 31 families and 39 genera were recorded (Table). *Calappa bilinatae* (Phylum Arthropoda, Order Brachyura) and *Oratosquilla oratoria* (Phylum Arthropoda, Order Stomatopoda) were recorded for the first time in Sri Lanka. Family Portunidae and Veneridae had the maximum species composition. The most abundant species were *Asteropecten andersoni* and *Murex auduncospinosus*. Main vessels operated in the area were one day boats, Theppam and Vallam. The main gears were gill nets of various mesh sizes, beach seines, traps and hand nets. Gear regulations, area management plans and awareness for by-catch reduction and opportunities for unavoidable by catch utilization, need to be introduced.

Table: Summary of taxonomic details of identified invertebrate by-catch.

Phylum	Class	Order	Family and number of species in each family
Arthropoda	Crustacea	Achelata	Scyllaridae (1) Portunidae (6), Matutinae (1), Calappidae (2), Dromiidae(2), Parthenopidae (1), Epialtidae (2)
			Squillidae (1), Lysiosquillidae (1)
			Bullidae (1)
			Muricidae (5), Olividae (2), Clavatulidae (1), Fasciolaridae (1), Turbinellidae (1), Melongenidae (1)
		Caenogastropoda	Potamididae (1), Turritellidae (1)
		Vetigastropoda	Trochidae (2)
		Littorinimorpha	Littorinidae (1), Cassidae (1), Naticidae (1), Strombidae (4)
			Veneridae (6)
			Pectinidae (1), Placunidae (1), Psammobiidae (1)
			Pteriidae (1)
		Carditoida	Crassatellidae (1)
	Bivalvia	Valvatida	Oreasteridae (2)
		Paxillosida	Asteropectinidae (1)
Echinodermata	Asteroidea		

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Keywords: By-catch; Gulf of Mannar; invertebrates

Assessment on the present status of coastal fisheries at Gurunagar, Jaffna

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Fishery is a major income source of the Sri Lankan people reside in the coastal region. Among those, Jaffna contributes a considerable proportion to the total fishery production of the island which was 4.5% of the total fish production in Sri Lanka in 2013. Gurunagar is one of the main landing sites in Jaffna where fishing community mostly concentrates and engages in active fishing with multiple fishing practices. This study aimed to collect recent updated fisheries information as the government already identified Gurunagar as a potential site to develop to the status of a harbor. Fishery related data was collected during the period April to June 2015 from commercial fishing vessels and Sirakuvalai fishing operations landed at Gurunagar. Primary data was collected through direct observations during the field visits and secondary information was collected from the records of the fisheries office at Jaffna. Catch, effort species composition, fishing craft and gear information were collected from randomly selected fishing crafts on randomly selected days. Fishers at Gurunagar engage in different fishing practices. Fishing activities of this area are regulated by the Fisher's societies with the assistance of Department of Fisheries and Aquatic Resources. A total number of 27 species, representing 22 families were identified in commercial landings during the study period and also the species diversity and size of the fish (2.4 to 69 cm) varied with gear types. The types of gears used varied with the craft types. The catch rates of OFRP one day boats recorded as higher than in-board day boats. Total fish production was recorded as around 100 tons during the study period. Production of sirakuvalai was accounted for 7.4% of the total production in the study area. Commercial production per day is recorded around 3972.5 kg/day and the average number of boats actively operated is 150. The existing facilities in the Gurunagar landing site for anchoring boats, sorting the catches, auctioning, storing and distribution are not up to the level required for an export oriented fish landings. Results of the present study suggest the need of further monitoring of this landing site to gather reliable information at least one year of time to cover seasonal variations of fish landings.

Keywords: Gurunagar; fishing crafts; Sirakuvalai fishery; fish production; commercial fishery

Identification of Ecologically and Biologically Significant Marine Areas (EBSAs) in Sri Lanka

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Identification of Ecologically and Biologically Significant Marine Areas (EBSAs) under seven scientific criteria is a recent initiative of the United Nations Convention on Biological Diversity (UNCBD) (1). In Sri Lanka, three areas have been identified as EBSAs by the biodiversity secretariat of the Ministry of Environment and these are the Gulf of Mannar, the Trincomalee Canyon and the Southern waters. For all the areas, data and information deficiency have been identified as the key drawbacks to optimize conservation. The objectives of this study were 1) to analyze the current status of marine biodiversity research in Sri Lanka, 2) to evaluate the biodiversity of three areas under the criteria adopted by CBD for future trends in marine biodiversity research for the purpose of conservation and 3) to identify the constraints in conducting marine biodiversity to promote this type of work. Thirty experts conducting marine biodiversity research in the advisory group of the Biodiversity Secretariat were selected and data were collected from 23 of these individuals through an interviewer administered questionnaire. The mean rank was taken to evaluate the three areas under each criterion.

Study findings provided that 74% of marine research had been conducted in deep sea areas while 26% were in sea shelf of Sri Lanka. Nearly 70% researchers had known the EBSA concept including its scientific criteria. In the evaluation of the three areas identified as EBSAs according to established criteria, there were information gaps in Trincomalee canyon under the aspect of importance for life history stages of species and biological productivity. As a suggestion to promote marine biodiversity research, around 54% of those interviewed stated that allocation of funds to conduct the prospective marine biodiversity research is important.

In conclusion, more research should be conducted in deep sea areas as most scientific studies have focused on easily accessible coastal waters. Specifically, further knowledge is required on the Trincomalee canyon due to the information gaps revealed during the evaluations made in this work. Conservation management should be carried out in the three areas based on the assessments done according to the scientific criteria.

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Keywords: EBSA; Gulf of Mannar; marine research; Southern waters; Trincomalee canyon

Present status of dry-fish production at Western and North Western coastal belt in Sri Lanka

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Fish contributes around 70% of the animal protein consumption in Sri Lanka and provides considerable number of livelihood with related industries. Fresh fish is more liable to be spoiled quickly hence, traditionally sun drying with salting has been using to preserve fish in Sri Lanka. But the present status of Sri Lankan dry-fish industry is not investigated before. Therefore this study tried to identify the present status of dry-fish production at western and north western coastal belt in Sri Lanka. Three main dry-fish producing areas in western (Negombo) and north western (Ulhitiyawa and Kandakuliya) coastal belt were visited regularly from April to July 2015 in gathering information on the market chain of dry-fish industry, socio-economic status of dry-fish producing communities and to identify threats and potentials for the dry-fish industry through personnel interviews, semi structured questionnaires and group discussions with market actors: fishermen, processors, fresh/dry-fish distributors and wholesale/retail sellers. Fish catches used for dry fish production was

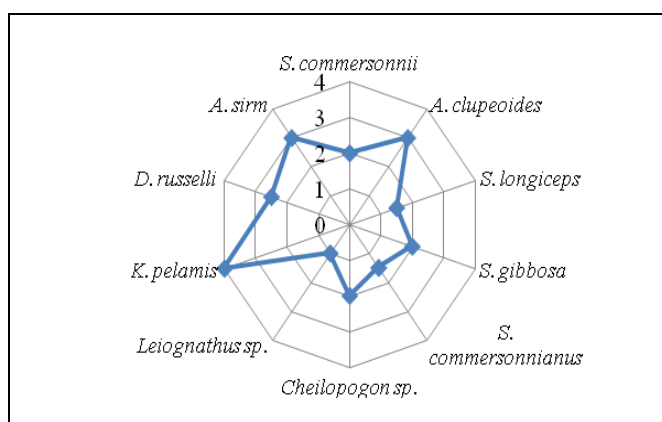


Fig.: A schematic composite diagram proposed as a visual illustration of evaluated visual quality of fish used for dry fish production. The solid line represents respective visual scoring given for each species.

randomly selected to evaluate visual quality. Among three sampling sites, significantly higher fish catch and dry-fish production were recorded in Negombo ($P < 0.05$) while Ulhitiyawa has the lowest. Though several fish species used for dry-fish production, their availability differs throughout the year. *Leiognathus sp.*, *Scomberoides commersonnianus* and *Sardinella longiceps* were the best quality fish used for the

dry-fish production while *Katsuwonus pelamis* was in lowest quality (Figure). Establishing continuous supply chains of raw fish from other parts of the country, as in Negombo & Kandakuliya will definitely uplift the production & income levels at Ulhitiyawa dry-fish industry. Similarly decreased dry-fish market price and increased net income of the processors can be achieved by reducing the cost associated with salting. However, as a tropical island Sri Lanka has a great potential to develop dry-fish industry if identified opportunities and constraints in this study are adequately addressed.

Keywords: Dry-fish; sun drying; salting; market actors

Assessment of the changes of the fishery in Koggala lagoon and consequence to the lagoon mouth alteration

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Koggala lagoon served numerous livelihood activities such as fishing, mat weaving, coir production and paddy cultivation, etc. prior to the unplanned removal of sand bar at the lagoon mouth in 1992. Consequently, a rubble mount groyne was built at the mouth area in 1994 to protect Kathaluwa Bridge from intense erosion while converting the lagoon into an inland saline water body by high influx of sea water though the permanently opened lagoon mouth. Due to the elevated salinity, paddy cultivation was totally abandoned in the inlet area while a change in the composition of flora and fauna distribution over the longitudinal axis of lagoon has taken place. Hence, the groyne was modified in 2012 to reduce the seawater influx to the lagoon, allowing the sand to accumulate to form the sand bar at the mouth region. During the present investigation, it was aimed to explore the changes caused over the fishery in Koggala lagoon consequence to the changes made at the lagoon mouth (outlet).

Twenty five fishermen were selected randomly to collect the fisheries data (from April to July, 2015) while the past fisheries data (June, 2014 to March, 2015) were collected from the records of the fisheries society. Meanwhile, a questionnaire survey and an in-situ personal interviews were carried out to collect the past fisheries related information. Water quality survey was conducted to determine the different physico-chemical parameters of lagoon water in three different layers (surface, middle and bottom) along the longitudinal axis while some historical data relevant to the salinity of the lagoon were collected through literature. According to the results, it was noted that the salinity was very low before 1992 (below 9.25ppt) while it was increased up to more than 30ppt (1993) and reduced to a level of (17.18-25.38ppt) consequent to the alteration of lagoon mouth in 2012. It was observed a decline in total fish catch in the lagoon ($r=-0.27$), might be due to the lowering catch of high salinity preferred fishes such as *Hilsa kelee sp.*/ Katumassa ($r=-0.882$), *Gerus sp.*/Olaya ($r=-0.822$), and *Siganus sp.*/ Leello ($r=-0.58$). Meanwhile, freshwater preferred fish such as *Eetroplus sp.*/Malkorali ($r=0.749$) reappeared in the catches which was disappeared previously might be due to the elevated salinity. According to the questionnaire survey, it was noted that the species such as Katumassa, Pannaa, Olaya were also enhancing their numbers inside the lagoon while the catches of species such as Katilla, Godaya and Loola (*Channa striata*) were remained unchanged. Similarly, fishermen were claimed about the disappearance of species such as Tatudandiya (*Chela laubuca*), Ratapethiya (*Cyprinus carpio*), Podidandiya (*Puntius vittatus*) etc. since 1995, might be due to the high salinity. Therefore it is possible to conclude that the recourse profile of Koggala lagoon is now changing back to its original level as a result of the changes done to the lagoon mouth.

Keywords: Fishery; groyne; salinity

Situation analysis of commercial fishery resources in Sri Lankan side of Mannar basin

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Marine fishery is very important to the economic and primary livelihood of the coastal communities in Sri Lanka. Fisheries sector accommodate around 1.7 to the GDP and supply 65% of the animal protein requirement of the communities in Sri Lanka. Present per capita fish availability of Sri Lanka is 16.1 kg and is expected to increase to 21 kg. The sector provides employment to around 650,000 people. Present study is based on the situation analysis of commercial fishery resources in Mannar basin. Five coastal districts (Puttalam, Gampaha, Colombo, Kalutara and Galle) are located in Mannar basin were selected for this study. Highly rich fish species exist in Mannar basin and majority of the fishermen are engaged in artisanal fishery. Activities include oil exploration, sand and coral mining, industrial waste disposal, warm water generation from thermal power plants, and over exploitation and destructive fishing methods pose a threat to the marine resources in the basin. Available data on Fish production (1999-2014), fishing fleets and social information (2003-2013) were utilized in this study. Simple linear regression analysis and Sequential Mann-Kendall test were used for data analysis. The result indicates that, there were significant decreasing trend in annual fish production during 1999 to 2005 due to the decline in beach seine varieties in Puttalam, Galle and Colombo. Multiday boats increased during post Tsunami period since 2004. As a result, there was a significant increasing trend in Puttalam, Galle and Colombo during 2006 to 2014. Large pelagic fish production in Puttalam and Galle districts have shown a significant increasing trend during 2003 to 2013 due to the increased number of multiday boats which mainly target large pelagic species. Numbers of active fishermen were very low in Colombo. The study attempts to identify strengths, weaknesses, opportunities and threats in Mannar basin. Very rich fishery resources found in Mannar basin and contribute significantly to the total fish production in Sri Lanka are the main strengths, and oil exploration, destructive fishing methods, coral & sand mining are the main activities identified as threats in Mannar basin.

Keywords: Marine fishery; activities; impact effects; Mannar basin; Sri Lanka

Potential of using giant fresh water prawn as a candidate for ornamental fish industry

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The giant freshwater prawn, *Macrobrachium rosenbergii* is the largest known palaemonid in the world. It inhabits both freshwater and low salinity water. This species is commercially important for its value as a food source. In addition, it also exhibits attractive morphology and behaviors when reared in an aquarium so that it is a good candidate for the ornamental fish industry in Sri Lanka. There have been no enough studies done in rearing *M. rosenbergii* as an ornamental species. Therefore, the aims of this research were to (1) evaluate the performance of *M. rosenbergii* as a candidate for the ornamental fish industry, (2) identify the attractive features of *M. rosenbergii* during aquarium rearing, (3) identify the problems and issues related to *M. rosenbergii* when introduced as ornamental species and (4) evaluate the suitability of *M. rosenbergii* as an ornamental candidate. Three different sets of aquariums were designed as follows: The first aquarium was stocked only with *M. rosenbergii*. The second aquarium was stocked with a combination of *M. rosenbergii* and *Poecilia reticulata*, The final one was stocked only with *P. reticulata*. All other conditions in the three aquariums were the same. Two hundred and fifty respondents including hobbyists were randomly selected from the study area and questionnaires were filled during face to face interviews after observing the three set-ups. Results showed that the preference levels for aquarium set-ups containing *M. rosenbergii* only, *M. rosenbergii* and *P. reticulata* combination and *P. reticulata* only were 2, 1 and 3, respectively. Preference levels for behaviors, nature with fish, morphology, body size and coloration of *M. rosenbergii* were 1,2,3,4 and 5, respectively. Therefore, *M. rosenbergii* is suitable for rearing in an aquarium and has the potential to become an ornamental fish in Sri Lanka. Among the characteristics of *M. rosenbergii*, higher preference towards its distinguishing behavior patterns, external morphology and pleasurable nature with fish was apparent. Problems and issues related to *M. rosenbergii* when introduced as ornamental species were also identified.

Keywords: Aquarium; *Macrobrachium rosenbergii*; palaemonid; *Poecilia reticulata*; prawn

Truss network analysis for identification of exotic sail fin catfish species in Sri Lanka (*Pterygoplichthys*, *Loricariidae*)

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Sail fin catfishes have been introduced to Sri Lankan waters accidentally through ornamental fish trade. Two species of Genus *Pterygoplichthys* have been reported from Sri Lanka and identified as *P. pardalis* and *P. disjunctivus*. They are becoming a severe invasive fish fauna in Sri Lanka and reported from eight provinces of the island except Northern Province. The body shape characteristics of *Pterygoplichthys* species are similar and main identification characteristic is dark colour pattern on the ventral side. *P. pardalis* is covered with distinctive spots, while *P. disjunctivus* is covered with vermiculations on the ventral side. However, some fish show intermediate colour patterns between spots and vermiculation and difficult to identify as any of the above two species. Therefore, an attempt was made to identify sail fin catfish species collected from Victoria and Kalawewa reservoir in Sri Lanka using truss network (TN) analysis techniques.

TN is a series of measurements between morphological landmarks that form a regular pattern of connected quadrilaterals or cells across the body form. TN is widely used in identification of fish stocks and fish species as conventional morphometric and phenotypic characteristics are not effective in identification of fish species, which are bearing similar characteristic features, especially when it comes to hybrid forms. In this research, truss measurements of 68 specimens of *Pterygoplichthys* from Victoria reservoir and 68 specimens from Kalawewa were measured for 20 morphometric measurements. Among those measurements 18 truss lengths were measured between 9 homologous landmarks of the fish and other two were standard and total lengths. Prior to the multivariate analysis all morphometric data were standardized for fish size using the method described by Senar *et al.* (1) and Doherty and McCarthy (2). Transformed data were analyzed by using principal component analysis (PCA). In PCA ordination of morphometric characteristics, first two components explained 0.89% of overall variance which is not sufficient to distinguish species and or hybrids in the population. However, in the PCA, two broad clusters appeared and were shown mild separation of *P. pardalis* from others. Reason for these results may be due to low variation among the morphometric characteristics due to hybridization of the two species or poor representation of morphologically different individuals in the samples. Increased sample size and measurement of other potential truss lengths are advisable for future studies.

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Keywords: Morphometric characteristics, truss analysis, *Pterygoplichthys*

Effect of vitamin E supplementation on fecundity, hatchability and larval survival rate of *Barbustetrazona*

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Vitamin E is a fat soluble antioxidant, which is naturally available as tocopherols and tocotrienols. Among tocopherols, α -tocopherol has the highest vitamin E activity and it is used as a feed additive in feed formulation for brood fish. Vitamin E improves the growth, survival and immunity of fish. Vitamin E also increases the fecundity, hatchability and larval survival of fish which are considered as main parameters of successful fish breeding. Although the influence of vitamin E is well known in fish diet the required amount of vitamin E for different fish species has to be identified. The present study attempted to identify the suitable α -tocopherol content for fresh water ornamental fish, *Barbustetrazona* which is commercially known as tetra barb. It is a continuous spawner, which has fourteen days of breeding interval.

Four weeks old barb fish were collected from Ornamental Breeding and Training Centre of National Aquaculture Development Authority. Brood stock were divided into four groups and fed with a formulated feed including α -tocopherol of 300 mg/kg, 500 mg/kg, 700 mg/kg and control fish fed without α -tocopherol. Once the fish reached to the level of sex differentiation, male and female fish were separated and same concentrations of α -tocopherol added feed was feed 5% of the body weight twice per day and control followed the same feeding regime without the additive. Beef heart and spleen (3:1 ratio) ground mixture was provided two days per week for all fish. Selected pairs of fish were bred in separate tanks. Five pairs of fish from respective treatments and control were bred for three times and breeding interval was maintained at fourteen days. Initial and final length and weight of fish samples were measured with a top loading balance. Food conversion ratio and Specific Growth Rate (SGR) of fish were calculated. Fecundity, hatchability and larval survival were measured in breeding tanks of control and treatments.

The highest SGR ($0.37\% \text{ day}^{-1}$) was obtained in fish fed with 500 mg/kg of α -tocopherol. Feed conversion ratio was very low in female fish fed with 500 mg/kg of α -tocopherol and reported as 0.78. In all three spawning periods, fecundity (Number of egg 94), hatchability rate (83.7%), and larval survival (94.3%) were higher in the treatment of 500 mg/kg of α -tocopherol. Although observed values were not significantly higher than the respective treatments, the best performances of food conversion ratio, fecundity, hatchability and larval survival were obtained from the feed with 500 mg/kg α -tocopherol indicating the suitability of this concentration in the brood stock feed of *B. tetrazona*.

Keywords: α -tocopherol; brood stock feeding; fecundity; hatchability, larval survival

Debris in Negombo estuary and adjacent coastal area

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Increasingly accumulating rate of debris in aquatic ecosystems is a worldwide threat and a great challenge because it adversely effects on fisheries and tourism, kills and injures a wide range of marine life, and can threat to human health. Negombo estuary in western coast of Sri Lanka faces similar issues due to high anthropogenic pressure and poor waste

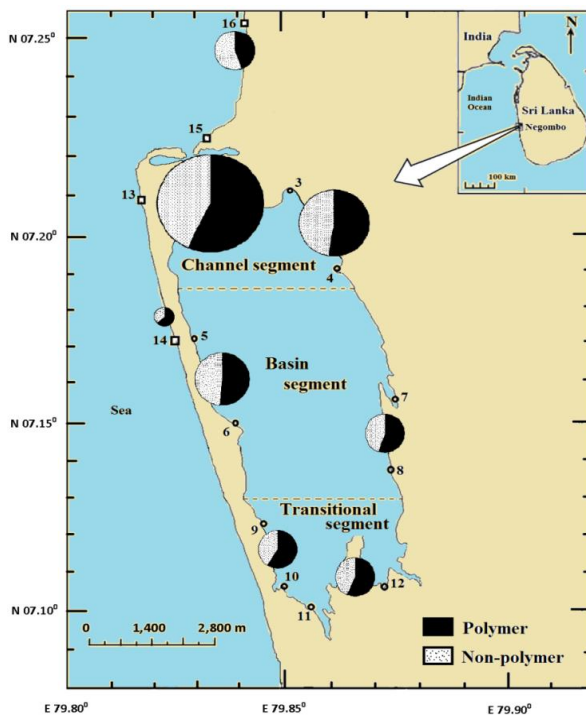


Fig 1: Percentage accumulation rate of debris, with respect to weight, based on polymeric basis from 8 sampling sites in 5 estuarine segments. The size of the pie is proportional to the amount of debris in weight; smallest is 2.56g while largest is 127.52 g.

management systems. Therefore, 16 shoreline survey sampling sites identified within 5 homogeneous segments of Negombo estuary and adjacent coast, based on habitat characteristics were sampled monthly from April to August 2015 in identifying type and accumulation rates of debris. A plankton-net was dragged along 12 identified 100m long stretches in the estuary to collect floating debris. Further, a questionnaire survey was conducted among 100 persons living around the estuary to assess the community awareness on marine debris. Highest debris accumulation, which is more than 50% of polymers, was at channel segment while in the coast it was at the northern area to the estuarine mouth (Fig. 1). Average monthly debris accumulation rate in the shoal of entire estuary was respectively 1.12 items/m² and 44.23g/m² in numbers and weight. According to barcodes present in debris, four times higher weight of debris, had Sri Lankan origin and were plastic products. Average floating debris density in the estuary was 0.013items/m² and highest amounts found in channel segment and by size they belongs to meso category (5-20 mm) plastic type. Most communities live in these areas were well aware on these debris accumulating sites despite to their age, education and occupation. However, debris accumulation rates were well above than what community believes. Community awareness on debris, their accumulation, effects and proposed suggestions to overcome the problem proves people those who are not in the region is the main cause of debris accumulation in Negombo estuary by dumping and directing polluted water inlets to estuary.

Keywords: Marine debris; polymers; shoreline survey

Efficacy of post milking teat dips against mastitis in dairy cows

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Bovine mastitis is the consequence of events starting from contamination of the teat skin with a pathogen and establishment of bacterial growth within milk secretory gland. Declining the microbial population on teat skin decreases the possibility that the udder will become infected with mastitis pathogens. Dipping teats with a germicide after milking has been identified to be an effective method of reducing intra-mammary infections. This fact has resulted in emergence of numerous germicidal products as teat dips though most of their efficacies are not proven by sufficient efficacy data. Thus the study was conducted to test their efficacy to be used in the dairy industry.

Two locally developed post-milking teat dip formulations containing Iodine and Formic acid were evaluated against bovine mastitis in natural exposure trials. A semi-intensively managed Jersey crossbred dairy herd from a commercial farm in Kurunegala district was experimented. A total of 312 quarters from 78 milking cows were initially screened for mastitis using Californian Mastitis Test (CMT) by which the quarters with sub-clinical mastitis were identified. Then split-herd sampling was followed and 45 subclinical mastitis positive milk samples from three groups (one control and two treatment teat dip formulations containing Iodine and Formic acid) were examined for Colony Forming Units (CFU) by standard plate count method. The CMT score reduction pattern was recorded weekly. After 3 weeks of teat dip application under the natural exposure, the germicidal action of two developmental formulations were found to be statistically significant against the control group ($P < 0.05$) in the ability of reducing bacterial colonization in corresponding milk samples. Based on the number of sub-clinical quarters that reduced microbial count, the Iodine-based teat dip and the Formic acid-based teat dip were found to be having respectively 76.9% and 46.6% efficacies in reducing causative pathogens in mastitis milk. Therefore, it could be concluded that Iodine-based and Formic acid-based teat dips are effective as a prophylactic measure against subclinical mastitis in dairy cows.

Keywords: CMT; sub-clinical mastitis; teat dips

Assessing the bacterial contamination of poultry farms and hatcheries located around Wayamba University of Sri Lanka

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Poultry industry contributes around 70% to the livestock sub sector in Sri Lanka and poultry products are popular animal protein sources in average Sri Lankan diet. In recent years the industry faced huge problems due to significant pathogenic contamination, which caused high incidence of disease conditions reducing the quality of the products. Therefore, this study was conducted to assess the bacterial contamination in poultry farms around Wayamba University of Sri Lanka and also to evaluate the biosecurity measures adopted in these farms. For the study 86 samples were collected from poultry litter, dung, hatchery dust, death eggs, liver and heart samples of the dead birds from 16 farms around Wayamba University in North Western Province including broiler farms, layer farms, parent stocks and hatcheries. Samples were collected aseptically to sterilized swabs, sterilized sealed polythene bags and cool boxes. Collected samples were transported to the laboratory of Department of Livestock and Avian Sciences of Wayamba University for microbial analysis. A questionnaire was also used to collect the information on biosecurity measures adopted in each farm. All collected samples were inoculated into nutrient agar and incubated at 37°C for 24 hours. After incubation Gram +ve and Gram -ve organisms were identified using Gram staining. Then series of sub culture were conducted for the identification of species such as *Salmonella* and *Escherichia coli* using Macconkey, Simmoncitrate, TSI, SS and XLD agars. Further, confirmation of salmonella was done using indole, urease and motility tests. The isolated and identified organisms were *Escherichia coli* (93.75%), *Streptococcus* (62.5%), *Staphylococcus aureus* (75%) and every farm was free from *Salmonella*. According to the questionnaire data analysis, there were significant associations ($P<0.05$) between bacterial contamination with application of foot bath, control of the movement of people, vehicle and animal and workers following biosecurity measures. Low bacterial contamination was seen in the farms where above methods were practiced. Considerable amount of farmers (71.42%) provided good quality water with chlorination to prevent *E-coli* contamination. Less percentage of farmers (21.47%) practiced pest and insect control system and footbath in their flocks. Regular screening of these pathogenic microorganisms and maintenance of the rigorous biosecurity programs are the most important practices to eliminate these pathogenic microorganisms from poultry farms.

Keywords: Poultry; biosecurity; *Escherichia coli*; *Streptococcus*; *Staphylococcus aureus*; *Salmonella*

A promising method by PCR for detection of *Escherichia coli* in bovine subclinical mastitis

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Bovine mastitis is known as the most imperative economic problem for dairy producers worldwide. Mastitis mainly exists in two forms; clinical and subclinical and subclinical stage is difficult to detect since the clinical symptoms and abnormalities in milk are not seen. Among the major pathogens involved in mastitis, *Escherichia coli* has been identified as a frequent contaminant of the udder. Currently, culture methods are used to detect the causative pathogens but, it is time consuming and labour intensive. As a solution, PCR based methods ensure rapid and specific identification of pathogens. Therefore, this study was conducted to develop a PCR based method for rapid identification of *Escherichia coli* in bovine subclinical mastitis. *Escherichia coli* pure culture was infected to a LB medium and grown overnight with continuous shaking at the rate of 115 rpm. Cell pellets were separated by centrifugation. Column purified DNA was used as the positive control. DNA was extracted from *Escherichia coli* positive milk samples which were identified using culture methods. PCR assay was performed using 884 bp species specific primers with following conditions. Initial denaturation at 95°C for 2 minutes followed by 35 cycles of 95°C for 45 seconds, annealing at 50°C for 1 minute and final extension at 72°C for 5 minutes. A multiplex PCR was also performed for both *Escherichia coli* and *Staphylococcus aureus* using 884 bp and 229 bp specific primers, respectively using the same conditions as above except for annealing temperature which was 48.1°C. PCR products were analyzed by gel electrophoresis using 1% agarose under the UV transillumination. Positive control of the *Escherichia coli* gave a band in the expected range. However, none of the infected samples gave the expected band. In the multiplex PCR, *Staphylococcus aureus* was amplified prominently and a weakly amplified product was observed for *Escherichia coli*. Absence of bands for *Escherichia coli* positive samples may be due to primer inhibition with the presence of other DNA or insufficient quantity of *Escherichia coli* DNA extracted from cow milk with subclinical mastitis. Therefore, we suggest to conduct a sensitivity test to identify the detectable range of *Escherichia coli* by the selected primer and if it fails, to continue the study with another suitable primer which can contribute to a rapid method of *Escherichia coli* identification.

Keywords: Bovine subclinical mastitis; *Escherichia coli*; milk; PCR; *Staphylococcus aureus*

Subclinical mastitis in dairy cows in Central Province; prevalence, associated risk factors and effect on reproduction

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Subclinical mastitis (SCM), with no visible changes in the udder or in milk is the most common form of mastitis. It causes huge economic losses associated with decreased milk production and milk quality. Central province consists of major dairy farms and high producing dairy cows imported to Sri Lanka recently. Therefore, it is essential to study the prevalence of SCM in these herds. Associated risk factors for SCM and its effects on reproductive parameters have not been studied in detail. Therefore, this research was conducted to determine the prevalence, associated risk factors of SCM and its effect on reproductive performance of dairy cows in Central province. A total of 805 lactating cows in four large scale NLDB (National Livestock Development Board) and seventeen small scale farms in Central Province were selected for this study. California Mastitis Test (CMT) was conducted and infected cows were identified based on the CMT score. Infected milk samples were collected and transported septically to the laboratory. Data about the farms and individual cows were collected using a pre-tested questionnaire. Samples were cultured in nutrient agar and were incubated at 37°C for 24 hours. Grams' staining was used to identify the bacteria such as *Staphylococcus* spp, *Streptococcus* spp. and *E.coli*. associated risk factors for SCM and effect of SCM on reproduction were analyzed using binominal logistic regression. The results showed that, 92 dairy cows (11.4%) were infected with SCM. The most common bacteria found was *Staphylococcus* spp. (56.5%) followed by mixed cultures (22.9%), *Streptococcus* spp. (10.8%) and *E .coli* (9.8%). Higher percentage of infected cows was reported from small scale farms (30.3%) compared to large scale farms (10.6%). The occurrence of SCM was higher in semi-intensive farming systems compared to intensive farming systems ($P<0.001$). The prevalence of SCM was significantly lower in farms which used a disinfectant for cleaning udder after milking ($P<0.05$). From the reproductive parameters considered, cows with SCM had more inseminations per conception ($P<0.0001$). The interval from calving to conception was not significantly different between the normal cows and cows with SCM. The results concluded that *Staphylococcus* spp. are the most common bacteria associated with SCM and farming system and method of cleaning udder were the associated risk factors for SCM in Central Province.

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Keywords: Subclinical mastitis; California mastitis test; dairy herd; risk factors

Determination of concentrations of some selected heavy metals and trace elements in cow milk produced in Kurunegala district in Sri Lanka

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Cow milk plays a primary role in human diets. It can be contaminated by heavy metals and other trace elements mainly through exposure of cows to contaminated feed and water. Though these elements are essential for health, excessive exposure can be hazardous. The concentrations of heavy metals and trace elements in cow milk of Sri Lanka have not widely studied. Therefore, the main objective of this study was to study the levels of heavy metals and trace elements in fresh cow milk in Kurunegala district. Fresh cow milk samples were collected from the milk collecting centers in 25 veterinary divisions of Kurunegala district and preserved in deep freezer at -18 °C. Milk samples were digested by optimized microwave digestion method using HNO₃. The concentrations of Copper (Cu), Zinc (Zn), Chromium (Cr), Cadmium (Cd), Lead (Pb) and Manganese (Mn) were determined by graphite furnace unit of Flame Atomic Absorption Spectrophotometer. The mean higher and lower concentrations of Cu were found in Wariyapola and Galgamuwa veterinary divisions as 10.35 (SD 1.24) ppb and 2.59 (SD 1.12) ppb respectively. The mean higher and lower concentrations of Zn were 146.70 (SD 85.9) ppb and 40.54 (SD 4.88) ppb in Katupotha and Giribawa divisions, respectively. The highest concentration of Cr was found in Nikaweratiya division (10.81 ppb SD 0.31) and the lowest concentration was found in Giribawa division (7.08 ppb SD 0.57). The mean higher and lower concentrations of Cd in milk samples were 40.70 (SD 32.8) ppb and 4.60 (SD 0.54) ppb which were collected in Ibbagamuwa and Wariyapola veterinary divisions respectively. The concentrations of Pb in cow milk were found in between 0.46 (SD 0.21) - 13.46 (SD 6.35) ppb and the lowest and highest mean values were observed in Kurunegala and Polpithigama divisions. The mean higher and lower concentrations of Mn in said samples were 11.65 (SD 5.25) ppb and 4.44 (SD 1.38) ppb which were collected in Narammala and Giribawa veterinary divisions, respectively. These values were below the reported permissible levels of Cu, Zn, Cr, Cd, Pb and Mn in literature in cow milk. At 95% confidence level, concentrations of Cu, Cr and Pb were not significantly different among 25 veterinary divisions while Zn, Cd and Mn concentrations indicated a statistically significant difference among 25 veterinary divisions. Therefore, the results conclude that the concentration of Cu, Zn, Cr, Cd, Pb and Mn in cow milk were lower than permissible limits and cow milk in Kurunegala district is safe to consume under current situation.

Keywords: Cow milk; heavy metals; trace elements; Kurunegala district

The impact of consumer awareness on dairy products purchasing behavior of supermarket customers in Central Province, Sri Lanka

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The Sri Lankan dairy system is a demand driven one. Therefore, the behavior of the milk and milk products in the market has a direct impact on the dairy production and the livestock practices in the country. When making an effective purchasing decision, the level of awareness which the consumer has about the dairy product is very important. This study was performed to determine the impact of consumer awareness on dairy product purchasing behavior of the supermarket customers in Central province, Sri Lanka. The sample was selected from 5% of the daily customer basis of 20 supermarkets in the Central province by using two stage cluster sampling and the total sample size was 425 customers. The survey was conducted using a pretested questionnaire and interviews of the individual respondents. Consumer awareness was studied under four independent variables as the awareness on nutritional information, awareness on quality standards, awareness packaging material and awareness on production process. According to the results, the majority of the customers were aware about the nutritional information, packaging material and the production process while the majority of them were neutrally aware about the quality standards of the dairy product. Also the results showed that, only the awareness on nutritional information and awareness on quality standards were significantly associated with the dairy products purchasing behavior ($P < 0.05$) though the relationships were weak (Cramer's $V = 0.1-0.2$). At the same time, the educational levels of the supermarket customers were significantly associated with all the aspects of consumer awareness ($P < 0.05$) and the relationships were very strong (Cramer's $V = 0.4-0.5$). According to that, the consumer awareness on nutritional information and the consumer awareness on quality standards have a weak impact on the dairy products purchasing behavior of the supermarket customers in central province, Sri Lanka and their educational background has a very strong impact on the consumer awareness level they have.

Keywords: Consumer awareness; Central Province; dairy products; purchasing behavior; supermarket customers

Development of a local cheese and optimization of organoleptic properties

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Cheese is one of the oldest and most widely used dairy products which has immense popularity stems from its taste, versatility and nutritional package. Unripened and ripened are the most common forms of cheese. Among them most small scale farm holders involve in production of unripened cheese. Therefore, this study was aimed to formulate a local spread cheese incorporated with garlic and ginger flavours and to assess the organoleptic and physiochemical properties. Local spread cheese was prepared using fresh cow's milk, garlic, ginger, lime, whipping cream and salt. Product developments followed by first sensory evaluations were carried out to determine the best flavour combination and levels of flavours that needed to be incorporated. Final sensory evaluation was conducted to find out the consumer preference for developed cheese compared to regular spread cheese. Physiochemical and proximate analysis were conducted for both plain and flavored spread cheese that was stored at 4°C pH was determined for 14 successive days and titrable acidity was determined for 10 days with a one day interval. The results of the first sensory evaluations revealed that 1% garlic, 0.5% ginger is the best concentration required for the new product. The results revealed that there was no significant difference for the consumer preference between two products. Results revealed that there was no significant difference between two products for the fluctuation of pH. A significant ($P<0.05$) decrease in pH was observed after 7th day of storage for both samples. Moreover, there was no significant difference between two products for titrable acidity changes. However, the values of titrable acidity significantly ($P<0.05$) increased after 6th day of storage for both samples. Moisture, fat, protein and ash contents were 66.73 (SD 0.23), 2.54 (SD 0.01)%, 13.67 (SD 0.02)%, 1.87 (SD 0.01)% for plain cheese and 66.83 (SD 0.07)%, 2.54 (SD 0.01)%, 13.82 (SD 0.08)%, 1.89 (SD 0.01)% for flavored cheese, respectively. Proximate composition parameters were not significantly different between flavored and non flavored cheese. Therefore, the results suggested that a local cheese can be developed with optimum consumer preference by incorporating garlic and ginger flavors. Future studies are needed to investigate the microbial composition to extend the shelf life of the product.

Keywords: Local cheese; flavours; organoleptic; physiochemical

Combined effect of blending different kinds of milk on sensory attributes of set yoghurt

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Yogurt is one of the fermented dairy products which is produced by the action of lactic acid bacteria. Though the milk is main raw material in the production of yoghurt, in this study yoghurt was prepared by blending different kinds of milk. Production of the best preferred and nutritionally sound quality yoghurt by blending different milk types was the main objective of this study. Each pair of cow: buffalo milk, cow: goat milk and goat: buffalo milk were blended at the ratios of 1:0, 1:1, 1:3, 3:1 and 0:1. Yoghurts were prepared using those blended milk to evaluate the sensory, chemical properties and to perform cost analysis. Sensory test was conducted using 30 untrained panelists and were asked to score the products in terms of color, taste, odor, appearance, texture and overall acceptability using five point hedonic scales. pH and titratable acidity were measured up to four weeks of storage life. pH of each treatment was decreased during the storage life for each product and titratable acidity was increased during the storage life for each product. The significant ($P < 0.05$) pH change occurred after two weeks of storage life for yoghurt prepared from goat milk alone and it was three weeks for all other types of yoghurt. Results showed that there were significant differences ($P < 0.05$) among each treatment with regard to moisture content, fat content, protein content and ash content. Findings of cost analysis revealed that there was not much difference in price between cow milk yoghurt and yoghurt prepared from all ratios of cow: buffalo milk blend. When incorporating more goat milk, price was two to three times higher than cow milk yoghurt. Overall consumer preference was significantly ($P < 0.05$) differed among the yoghurts prepared from cow: buffalo milk blend and goat: buffalo milk blend. Finally the yoghurt prepared by cow: buffalo milk at 1:3 ratio and goat: buffalo milk at 1:1 ratio were selected as the best ratios according to the consumer preference and nutritional point of view. There was no significant difference in consumer preference among the yoghurts which were prepared from every ratios of goat: cow milk blends. Therefore, yoghurt prepared from goat and cow milk blend at the ratio of 1:3 was found as the best from nutritional point of view and price.

Keywords: Buffalo milk; cow milk; goat milk; consumer preference; yoghurt

Effects of phosphate concentration on moisture retention property of chicken meat

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The poultry meat industry plays a vital role among other meat industries in Sri Lanka. Consumer preference is usually attracted by the supreme quality poultry meat which is having optimum texture and sensory properties such as flavor, colour, juiciness etc. Chilling and freezing procedures often result in loss of attractiveness in meat further leading to retardation of other quality attributes of the product. Thawing, that comes after freezing increases moisture removal from chicken carcasses resulting weight loss. Sodium tripolyphosphates (STPP) offer a range of possibilities when used in poultry meat production such as changing and/or stabilizing of pH value, decreasing cooking loss, improving texture and sensory properties, extending shelf life, etc. An experiment was designed to determine whether the phosphate concentration, live weight and age of chicken can affect the moisture retention properties of chicken meat. This study comprised of three major segments. In first segment, chicken with different average live weights such as 1.4 kg, 1.6 kg, 1.7 kg, 1.8 kg, and 2 kg were subjected to determine moisture retention by measuring the chicken carcass weights before and after transferring them in to the screw chilling machine. In here, the same STPP concentration and 34 days old chicken were used. In second segment, chicken carcasses of 34 days old and 1.7 kg of average live weight, were dipped in the screw chilling machine in different STPP concentrations (0 ppm, 752 ppm, 852 ppm, 902 ppm, 952 ppm, 1002 ppm, 1052 ppm, 1152 ppm) for 30 minutes at -10°C and moisture retention was determined as above. As the final segment, another set of chicken having different ages ranging from 29 days to 35 days with 1.7 kg of average live weight were subjected to find out the relationship between age and moisture retention of chicken. Phosphate concentration in meat samples was determined using UV-Visible spectrometry (Model no: G10S UV-Vis) to confirm whether meat contains phosphates within recommended limits. Data analysis revealed that the phosphate concentration and live weight of chicken significantly affect the moisture retention properties of carcass ($P < 0.05$). It also concluded that the optimum STPP concentration was 952 ppm and most desirable live weight was 1.7 kg for higher moisture retention properties. In accordance to the results it can be concluded that there was no any significant difference between age and moisture retention properties ($P < 0.0001$). The maximum concentration of phosphate was 0.17% found in meat sample which was within the recommended limits (0.5%, USDA recommendations).

Keywords: Carcass; moisture; poultry; retention; sodium tripolyphosphate (STPP)

Production, marketing and reproductive characteristics of dairy farms in Polonnaruwa district

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In Sri Lanka, average monthly milk production of cow and buffalo milk is 22742700 L and 5082600 L, respectively in 2014 (1). At present only 42% of the requirement of milk is fulfilled locally. Polonnaruwa district contributes around 4.5% to the total milk production of the country. The production, marketing and reproductive characteristics of dairy cattle and buffaloes have not been reported in the veterinary surgeon's (VS) divisions in detail. Therefore, this study was conducted to assess the production, marketing and reproductive performances of dairy farms in Polonnaruwa district. The data was collected from seven VS divisions, Medirigiriya, Minneriya, Lankapura, Aralaganwila, Polonnaruwa, Bakamuunaand and Welikanda using pre-tested structured questionnaire. Reproductive data were collected from history sheets. 10 small scale farms and 10 large scale farms were included from each VS division. Data were presented as descriptive statistics and percentages. Data of breeding, milking practices and diseases were analyzed using hierarchical cluster analysis. Semi intensive farming system was the main farming system (93.6%) in the study area. Integrated farming with crops was practiced by most of the farmers (88.6%). Mean daily cow milk production of small scale and large scale farms were 11.4 L and 37.3 L, respectively. The means for daily milk yield of Sahiwal, Jersey, Friesian, AFS, Murrah and Nilliravi were 5.23 L, 5.61 L, 8.83 L, 6.53 L, 5.74 L, and 6.21 L, respectively. Daily milk production of Friesian cows was higher (8.83 L) than other cattle breeds ($P < 0.05$). Majority of the farmers sold their milk to collecting centers of Milco (44.9%) and Nestle (39.9%). About 68% of the farmers stated that they do not have any issue related to marketing of milk. Among the farmers who had marketing problems, the major problem was unable to meet acceptable quality standards when selling milk. The mean days from calving to conception of Sahiwal, Jersey, Friesian, AFS, Murrah and Nilliravi were 134, 121, 122, 124, 115 and 118 days, respectively. Age at first calving of Sahiwal was higher (1406 days) than other cattle breeds. The means for birth weight of Murrah and Nilliravi were 25.9 Kg and 27.5 Kg. The means for age at first calving of Murrah and Nilliravi buffaloes were 1608 and 1615 days. Availability of sufficient water sources was identified as a major potential for dairy farming in these areas. High feed cost and limited grass lands were the major constraints for dairy farms in Polonnaruwa district.

(1) Department of Census and Statistics of Sri Lanka (2014), National Livestock Statistics [online] Available from: <http://www.Statistics.gov.lk/agriculture/Livestock/Livestock Statistics.html> (accessed 11/09/2015)

Keywords: Dairy farms; marketing; production; reproductive characteristics; Polonnaruwa

Effect of poultry by-product meal on broiler performance and carcass quality

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Poultry by-product meal is one of the important sources of animal protein used to feed domestic animals, alternatively to meat meal, blood meal, feather meal and fish meal. It is made by combining the by-products from poultry slaughterhouses and poultry processing plants. This study is an attempt to explore the possibilities of better utilization of poultry by-product meal as an animal protein supplement in poultry diets. Experimental- broiler starter rations and finisher rations were formulated with different level of commercially available poultry by-product meal, replacing common protein supplements in each diet. The rate of inclusion of poultry by-product meal in the experimental ratios in each treatment were, 0% (control), 4% (T1), 8 % (T2) and 12 % (T3). Hubbard F-50 un-sexed day-old broiler chicks (n=48) were randomly assigned into four dietary treatments managed under deep litter system. Each starter and finisher diet was offered to birds for 42 days according to the recommended feeding regime. Broiler performance parameters were determined weekly basis and economic feasibility and carcass quality parameters were determined at the end of rearing period. Costs and benefits were calculated for each treatment, respectively proximate composition of the commercial poultry by-product meal was, crude protein = 82.2 %, ether extract = 11.2 %, ash = 5.1 %, dry matter = 93.2 %, metabolizable energy = 2030 kCal kg⁻¹, Ca =15.0 % g/kg DM and P =6.1 g/kg DM. Significant difference ($P<0.05$) was observed among performance parameters (FCR and average body weight) and Carcass quality parameters (carcass recovery percentage and percentage of most expensive cuts) between control and dietary treatments. Slight enhancement (not significant) of the means in T1, T2 and T3 were observed in each performance and carcass quality parameter accordingly. Result showed that poultry by-product meal can be used to enhance the performances and carcass quality of broilers with an economic advantage.

Keywords: Broiler diet; poultry by product meal; hypromeal; poultry industry

Effect of high protein diets on broiler performance and profit

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Poultry meat is an important source of high quality protein, minerals and vitamins to balance the human diet. Protein as a macronutrient and the most expensive feed ingredient, (an ideal broiler diet maximize the production at the least production cost). This study was conducted to assess the effectiveness of high protein diets on broiler performance and the cost effectiveness in the experimental level. Commercial, proximately analyzed feed ingredients; fish meal, maize, rice polish, rice, coconut poonac, soybean meal, animal fat, dicalciumphosphate, broiler premix, salt, L lysine and methionine were used to formulate the experimental diets. Three experimental diets were formulated for the starter phase with crude protein (CP) ratios, 24%, 26% and 22% as the control (T₁, T₂ and T₃ respectively). Birds from each treatment of the starter phase divided into two distinct categories in the finisher phase allocating different CP levels. The two categories of T₁ were allocated with 22% (T₁₁) and 18% (T₁₂) crude protein levels. The two categories of T₂ were allocated with 24% (T₂₁) and 18% (T₂₂) crude protein levels. Sixty Hubbard F-50 un-sexed day-old broiler chicks were randomly assigned to dietary treatments with twelve replicates, and reared in a deep litter-intensive system for four weeks in the starter phase and two weeks in the finisher phase. Each starter and finisher diet was offered to birds according to the recommended feeding regime.

As Broiler performance parameters, Feed Conversion Ratio (FCR), Weight Gain, Growth and the Broiler Performance Index (BPI) were determined weekly basis. Economic feasibility and carcass quality were determined at the end of rearing period. Significant differences ($P < 0.05$) for the growth and FCR among treatments were observed in 5th and 6th weeks of rearing while weight gain was significantly different among treatments in 1st and 5th weeks. The best weight gain had been attributed to 26% CP level in the first weeks while the birds which got 24% CP in starter phase and 22% CP in finisher phase served for the best outcome in weight gain in 5th weeks, FCR and weight in 5th and 6th weeks, BPI value, edible meat content and the commercially important meat content. Diets with 24% CP in starter phase and 18% CP in finisher phase gave the best feasibility in relation to cost analysis. Results showed that high protein diets can be used to enhance the performances and carcass quality of broilers with an economic advantage.

Keywords: Broiler diet; broiler meat; high protein; poultry; profit

Nutritional composition of chemically treated rice straw

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The dairy sub sector is the most prioritized sector for livestock development and targeted to achieve 50% self-sufficiency by 2015. One of the major constraints to dairy development in Sri Lanka is seasonal availability of forage, limited grass lands and high feed cost. Being the most abundant, rice straw has a tremendous potential to guarantee the continuous supply of feed for dairy sector. The objectives of the present study were to establish a method of chemical treatment to wash off undesired factors from rice straw to increase palatability and to evaluate the nutritive values of treated rice straw. Rice straw was soaked in a mixture of a commercially available liquid detergent in the presence of 150 mM CaO and 100 mM H₂O₂ for 48 hours. Then the treated straw was washed two times in 300 L of portable water and dried under direct sunlight. Both treated and untreated rice straw samples were collected, ground and analyzed for proximate composition using standard methods of AOAC and for silica content (SLS 626: 1983). The data were analyzed using two sample *t*-test.

The results of the proximate analysis showed that the concentration of tested parameters in the treated and untreated rice straw, respectively on percent dry matter basis were: dry matter (92.24 SD 0.40, 91.98 SD 0.45), ash (14.76 SD 0.98, 12.83 SD 0.65), crude fiber (40.01 SD 0.86, 36.52 SD 0.94), ether extract (0.88 SD 0.03, 1.72 SD 0.19) and crude protein (5.99 SD 0.56, 6.87 SD 0.08). The results indicated that dry matter content was not different significantly between treated and untreated straw. Ash and crude fiber were significantly higher ($P < 0.05$) in treated rice straw when compared with untreated rice straw. But ether extract and crude protein were significantly lower ($P < 0.05$) in treated rice straw than untreated rice straw. The results of the silica estimation indicated that the treated rice straw has lower content (4.8%) than untreated rice straw (5.6%). From the results it can be concluded that this treatment method could be used as a potential method to improve the nutritive value of rice straw. Furthermore, chemical analysis for cellulose, hemicellulose and lignin needs to be conducted to ensure the digestibility of treated rice straw.

Keywords: Chemical treatment; proximate analysis; rice straw; silica content

The effect of rice straw treated with a detergent wash on milk yield and milk quality parameters of lactating cows

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Sri Lanka gives high priority to increase the milk production and 50% self-sufficiency within 2015. But the reality puts on show that it is difficult to achieve because of the scarcity for good quality feed year around. Rice straw which is abundant and affordable in Sri Lanka could be an alternative feed during off season. The high amount of silica (12–16 %) and lignin are the major limiting factors that reduce the digestibility and palatability. Chemical, physical and biological treatments can be applied to overcome these undesirable compounds where chemical treatment is more applicable in farm level. Therefore, this study was conducted to determine the effect of chemically treated rice straw in lactating cows. Rice straw was soaked in a mixture of a commercially available liquid detergent in the presence of 150 mM CaO and 100 mM H₂O₂ for 48 hours. After 48 hours of reaction, strands were thoroughly washed twice in clean water (300 L) and dried in direct sunlight. Once it was completely dried, chopped into approximate length, ground and finally made into pellets of total mixed ration (TMR) that comprised maize, rice polish, wheat bran, soy bean and coconut poonac. In the same way, untreated rice straw also was made into TMR. Both diets were undergone for the nutritional composition analysis. Treated pellets (treatment 1) and untreated pellets (treatment 2) were fed to a healthy Jersey cow (one treatment followed another after a wash off period of 9 days) and milk samples were collected every day for total milk yield, milk fat and milk solid non-fat analysis. The samples were compared with the normal milk collected before the animals were placed on these diets (control) using paired *t* test. Treated rice straw diet contained less fiber content than the untreated rice straw diet (32.15 SD 1.46 < 39.25 SD 0.51). The result showed that treatment 1 was significantly different from the control in milk fat and milk solid non-fat and both parameters were kept on decreasing ($P < 0.05$) throughout the treatment. The milk yield was increased during treatment 2 and there was no any significant difference between control and treatment 1. Based on these findings, it could be concluded that the detergent wash which resulted in a significant reduction in fibre content might have negatively impacted on the milk fat and for this reason this method of treatment cannot be recommended for lactating cows.

Keywords: Detergent wash; milk fat; milk solid non-fat; total mixed ration

Determination of mineral contents in commercially available layer feeds in North-Western province of Sri Lanka

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Poultry industry is the fastest growing livestock sub-sector at present and it contributes around 70 percent to the livestock sector in Sri Lanka. Layer industry which comes under poultry sector is vital since the egg has been identified as the cheapest source of animal protein that is essential for the growth and development of human beings. The layer industry in Sri Lanka utilizes a number of commercial and self-formulated feed types because performances of birds are directly proportionate to the quality of feeds. Almost all these feed types are balanced with energy, protein, and fat, but the contents of macro and trace minerals which determine the quality and quantity of egg production may often fluctuate. Therefore, this study was designed to assess the precise contents of different minerals in commercially available layer feeds, used in North-Western province of Sri Lanka. Frequently used four different layer feed types which related to four commercial brands were selected from the province and triplicates from each feed types were taken to determine the exact mineral contents. Concentrations of calcium, magnesium, zinc, manganese and iron were determined by Ice 3500 Atomic Absorption Spectrometry and phosphorous by UV-Visible spectrometry (Model no: G10S UV-Vis). One sample t-test was employed to compare the mean mineral concentrations with corresponding recommendation levels. At 95 % confidence level, 50 % of commercially available layer feeds consisted of recommended calcium and phosphorous contents while only 18.75 % and 12.5 % feeds contained required amounts of manganese and zinc, respectively. Furthermore, all feed types contained excess amounts of magnesium and iron when compared to birds' requirements. The results indicated that there should be an improvement and adjustment of minerals in all types of commercial layer feeds used in North-Western province of Sri Lanka to enhance the egg production.

Keywords: Poultry; layers; feed; minerals; spectrometry

Effect of low cost high protein diet on performances of weaning and growing pigs

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The feed cost represents 65-75 % of the variable costs of pork production. Increased costs of grain and protein supplements have forced pork producers to seek alternatives. Poultry by-product meal is a cheaply available animal protein source which is palatable and with high quality feed ingredients potentially suitable for swine diet. This study was conducted to determine the effect of low cost high protein diet on performances of weaning and growing pigs by using poultry by-product meal. Six weeks old (Body weight 7-8 kg) Landrace weaning pigs (n=6) of both sexes were selected for the experiment. The experiment was conducted for a period of 15 weeks providing standard management practices. Piglets were randomly assigned to 03 different groups as two treatment groups (24%, 22% and 20% crude protein in the diet and 18%, 16% and 14% crude protein in the diet with poultry by-product meal) and a control group 18%, 16% and 14% crude protein in the diet (without poultry by-product meal). The experimental animals were fed based on their body weight following the NRC, 1998 recommendations. The body parameters; body weight, length, heart girth and height were measured. Average daily feed intake, average daily gain, FCR and feed costs were calculated as well.

Table: Summary of the results obtained for three different treatments

	Body weight stage								
	10kg-20kg			20kg-35kg			35kg-60kg		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Crude Protein %	18	18	24	16	16	22	14	14	20
Performance Parameters									
Average Weight Gain, kg	12.20	11.15	12.85	13.35	9.00	15.35	18.50	13.50	20.00
Average Daily Feed Intake, g	685	620	710	1155	1000	1255	1755	1240	1855
Average Daily Gain, g	350	320	370	535	360	615	620	450	670
FCR	1.96	1.94	1.92	2.16	2.77	2.04	2.83	2.75	2.77
Feed Cost, Rs/kg	70.75	59.16	64.75	67.15	57.95	63.15	61.85	56.15	60.80

FCR – Feed Conversion Ratio, T1-Standard diet without poultry by-product, T2-Standard diet with poultry by-product, T3-High protein diet with poultry by-product.

Two sample t-tests were carried out to analyze average weight gain and body parameters. Summary of the results is given in the Table. There was a significant difference between treatments and control group of pigs for body weight gain, heart girth gain, height gain and between two treatment groups of pigs after 65 days period ($P < 0.05$), but no significant difference was recorded for length gain. The study concludes that the high protein swine diet containing 10% - 26% of poultry by-product meal can be used without negative effects in growth performances of pigs. High protein swine diet gives better performance with relatively low cost.

Keywords: Feed cost; growth performance; poultry by-product; swine; swine diet

Major drawback points of small scale and medium scale dairy farming in Kurunegala district

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Kurunegala district is one of the major milk producing districts in Sri Lanka which contributes around 15% to the national milk production. A significant contribution to the total district milk production comes from small and medium scale dairy farmers but, the annual contribution of the district to the national fresh milk production has been decreasing for past few years. Therefore, the main objective of this study was to find out major drawback points of dairy farming in Kurunegala district. The data were collected from 67 small scale farmers and 8 medium scale farmers in 17 veterinary regions of Kurunegala district using an interview administrated questionnaire. According to the results, 25% of small scale farmers were unable to identify the cattle breed that they reared. Out of the total, 45% and 37% of farmers of small scale and medium scale were getting low price (58 – 60 LKR/ Litre), respectively and nobody was getting more than 63 rupees/ Litre of milk. Among the interviewed farmers only 1% of small scale and 0% medium scale farmers were processing dairy products. Among small scale farmers 12%, 7% and 0% of farmers demanded veterinary instructions to improve the milk quality, farm development and farm management, respectively. Sixty one percent and 60% of small scale farmers of the district had not participated in any dairy related training programs and had not taken any dairy supporting facility given from government or other organizations, respectively. Therefore, as a conclusion lack of knowledge about their cattle breed, dairy training and supporting programs and unprofitable milking practices were the main drawback points among small scale dairy farmers. Not receiving proper veterinary services and dairy related instructions by the responsible organizations were the main drawback points among medium scale farmers. Getting low price per litre of milk, less awareness about the production of value added milk products, lack of knowledge on common cattle diseases and prevention strategies and proper cattle feed management practices were the main drawback points commonly shared by both small and medium scale farmers in Kurunegala district.

Keywords: Dairy farming; constrains; Kurunegala district

The study of feeding and defecating pattern of sheep in restricted grasslands

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Livestock subsector under the agriculture plays a significant role in the country in providing animal protein to the community. Livestock subsector contributes around 1.2% to the national GDP. Sheep (*Ovisaries*) is a small ruminant domestically reared especially for meat and wool. They are reared in farms under extensive, semi intensive and intensive systems. The economical way of rearing sheep is the extensive system or the free range system. Sheep spend more time on the pasture and feed by both grazing and browsing depending on the availability in different locations. The feeding and defecating in open lands under free range system make animals vulnerable to gastro-intestinal nematode infections which result in poor health of the animals and subsequently a loss to the farmer. Sheep are less susceptible to nematode infections compared to goat. The study was carried out to determine the feeding pattern and defecating behavior of sheep feeding in a restricted area of grassland within the Wayamba University premises, Makandura, North Western Province of Sri Lanka. GPS (Global Positioning System) was used to track the sheep herd by attaching a GPS collar to the leading animal out of 24 animals in the herd. The GPS tracking system passively recorded the location, velocity and the direction of moving in each minute for the whole day. The sheep herd was allowed to move and behave freely and the frequencies of behaviors such as grazing, browsing, regurgitation, walking, defecation, urination, etc. were individually observed and recorded. The diurnal peak feeding and defecating periods were found from 11:00 a.m. to 1:00 p.m. and 9:00 a.m. to 10:00 a.m., respectively. The locations of feeding and defecating were different since they mostly defecated while walking.

Keywords: Sheep; feeding behavior; parasitic nematode; patterns of moving; GPS tracking

The effect of organic, inorganic and liquid sheep manure on growth, yield and nutritive value of hybrid Napier CO-3 grass

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Less availability of high quality green forages attributes to low productivity of national dairy herd of Sri Lanka. Growing grass and fodder to suit the appropriate production system is an efficient and economical solution for this problem. CO-3 is placed in a higher category, especially on tillering capacity, green forage yield, regeneration capacity, leaf to stem ratio, high crude protein content, resistance to pests and diseases and free from adverse factors along with other fodder varieties grown in the country. An experiment was designed to determine the effect of organic sheep manure, inorganic fertilizers and liquid sheep manure on growth, yield and nutritive value of CO-3. Study consisted of three treatments; sheep manure (T1), recommended inorganic fertilizers (T2) and liquid sheep manure (T3) which was prepared using bucket fermentation method and each treatment consisted of three replicates and those were assigned according to randomized complete block design. First harvest was obtained 40 days after plant establishment and numbers of leaves (NL), leaf area (LA), tillering capacity (TC), fresh weight (FW) and dry weight (DW) were recorded and second harvest was obtained 30 days after first harvest and the same set of data were recorded. Results were analysed using standard SPSS 16 software. For proximate analysis AOAC, 2000 standard methods were used. Results revealed that the plants treated with T1 recorded highest NL, LA, TC, FW and DW and were statistically significant at first and second harvest of CO-3 ($P < 0.05$) and it was also found that T1 was statistically significant from T2 and T3. Although T3 was recorded higher, almost all growth parameters than the T2 it was not statistically significant. In addition, the highest crude protein content was recorded in T1 (18.33 SD 1.61) and was lowest in T2 (10.82 SD 1.14) and the values were statistically significant ($P < 0.05$). Apart from this, other proximate composition crude fibre, crude fat, ash, moisture content and dry matter were not statistically significant between treatments. In accordance with the results, it was found that the organic fertilizer is the best fertilizer for CO-3 in terms of growth parameters and crude protein content.

Keywords: Hybrid Napier CO-3; fertilizer; growth parameters; proximate composition

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