



ABSTRACTS

“Capacity Enhancement for a Food Secured Tomorrow”

Undergraduate Research Symposium - 2016

September 28, 2016



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



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Fourth Undergraduate Research Symposium

Faculty of Livestock, Fisheries and Nutrition

Wayamba University of Sri Lanka

2016

“Food Security Through Food Wastage Footprint”

28 September 2016

Third Undergraduate Research Symposium

**Faculty of Livestock, Fisheries and Nutrition
Wayamba University of Sri Lanka
2016**

'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 2016

**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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Evaluation of nutrition content in school text book and documentary drama

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Content criteria	Grade						School
	6	7	8	9	10	11	
Five nutrient groups, water and functions	B	B	-	B	B	-	
Variety of foods from each food group	A	B	-	B	B	-	
Recommended daily servings from each food group	A	A	-	-	B	-	
Body mass index score for measuring health	B	-	-	-	B	B	
Healthy snack	A	A	-	B	-	-	
Importance/benefits of eating vegetables	A	A	-	A	A	-	
Importance/benefits of eating fruits	A	A	-	A	A	-	
Importance/benefits of eating dairy products	A	A	-	A	A	-	
Importance/benefits of eating meat and beans	A	A	-	A	A	-	
Importance/benefits of eating breakfast	-	-	-	A	-	-	
Importance/benefits of drinking plenty of water	A	A	-	-	-	-	
Proper hand washing	A	-	-	A	-	-	
Causes, symptoms their effects of under nutrition	A	-	-	-	A	A	
Causes, symptoms their effects of over nutrition	A	-	-	-	A	A	
Prevention method of over nutrition	-	-	-	-	-	B	
Diets linked to disease	-	A	-	-	-	-	
Importance/benefits of eating whole grains	A	A	-	-	A	-	
Nutrients important for adolescent and adult health	-	-	-	A	B	B	
Micronutrient deficiencies	A	-	-	-	A	B	
Size of servings from each food group	A	A	-	-	A	-	
Food preparation and cooking skills	-	B	B	-	B	-	
Types of malnutrition	A	-	-	-	A	B	
Foodchoices from different cultures	B	B	-	B	B	A	
Nutrition practices for pregnant woman and her baby	-	-	-	A	B	B	

education plays a major role in developing nutrition knowledge and skills of the students. Therefore, school nutrition and health curricular should contain appropriate content and teachers should have suitable tools to deliver the contents. The aims of this study were to evaluate school textbooks containing nutrition syllabi in grade 6 to 11 and to evaluate short documentary dramas produced as educational tools. A content analysis was carried out to evaluate the nutrition content of the textbooks of Health and physical education, Practical and technical skills, Science and Home Science subjects using 24 criteria (Table). Perceptions on nutrition content of textbooks and use of educational tools were obtained from school teachers. Two short documentary dramas on "anemia" and "good food habits for school children" previously produced by Department of Applied Nutrition were evaluated. The results of the content analysis are given in the Table. Of the teachers, 51% agreed that nutrition content in textbooks is sufficient. Further 47% teachers strongly agreed that there is a necessity of having additional educational tools to teach nutrition lessons whereas, 40% teachers prefer to use videos as an educational tool. Short documentary dramas were accepted as suitable and effective teaching tools for grades 7 to 10. The study concluded that nutrition content of the textbooks is mainly knowledge based. Teachers are not provided with appropriate educational tools to be used in teaching nutrition. Therefore, the short documentary dramas evaluated in this study could be used as additional educational tools for children.

Key words: Content analysis; Criteria; Nutrition; Short documentary drama

Note: Knowledge based= A, Skilled based= B

Dietary patterns and glyceimic control levels among a sample of non-critically ill type 2 diabetic patients

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Diet plays an important role in glyceimic control among type 2 diabetic patients. A cross sectional study was conducted to find out dietary patterns and glyceimic control levels among a sample of 100 diabetic patients (33 male and 67 female). Type 2 diabetic patients without critically ill conditions and those who were admitted and attended to diabetic clinics of Bingiriya district hospital and Dr Neville Fernando Teaching Hospital during the data collection time period were selected for the study. Pretested interviewer administered general questionnaire was used to obtain information on socio demographic characteristics, fasting blood glucose level, life style, and health related characteristics. Pretested Food Frequency Questionnaire (FFQ) was used to obtain information's on dietary patterns. A 24 hour dietary recall was used to obtain information on nutrient intakes. American Diabetes Association (ADA) recommended fasting blood glucose level for type 2 diabetic patients was used to classify the study sample as glyceimic controllers and glyceimic non controllers(1). Dietary patterns were determined according to average contribution from different nutrients for total energy intake per day and those values were compared with recommended Percentages of ADA⁽¹⁾. Nutrient intakes were analyzed using Food base 2000 software which has been modified using composition of Sri Lankan mixed dishes. Most of the subjects were educated up to GCE O/L (grade 6-11) and Majority had their monthly income between Rs 20000-34999. According to ADA recommendation there were 47% glyceimic controllers and 53% of glyceimic non-controllers. Mean fasting blood glucose level of the study sample was 143.2mg/dl. There were 15 smokers and 21 alcohol consumers in the study sample and all of them were male. There were 28 meal skippers and most of them skipped their dinner. Of the subjects, 83% consumed rice for all three meals of the day and 62% were daily fruit consumers. Mean total energy intake of the study sample was 1284.5kcal/day. For this total energy intake, contribution from carbohydrate (62.7%) was greater than the recommended level (55%-60%), but contribution from protein (12.8%) was lower than the recommendation (15%-20%). However, contribution from fat (24.6%) was within the recommended level (<35%). Based on the Chi square analysis, among different dietary patterns, different types of fruits consumption, fish consumption, fatty food consumption and green leaves consumption had significant association with glyceimic control ($P < 0.05$). It can be concluded that there were more non glyceimic controllers than the glyceimic controllers in the study sample and current dietary patterns were not appropriate to achieve glyceimic control goals.

American Diabetes Association (ADA) Diabetes Guidelines. (2016), 1–46.

Keywords: Dietary practices; glyceimic control; nutrient intakes; non-critically ill, type 2 diabetes mellitus

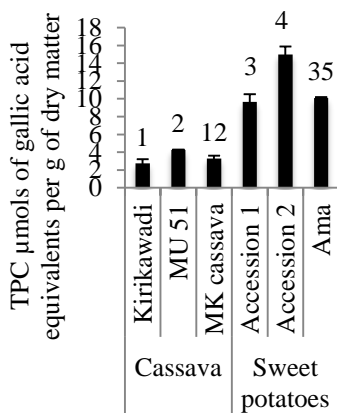
Determination of antioxidants of cassava and sweet potato varieties

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Cassava (*Manihotesculenta*) and sweet potatoes (*Ipomoea batatas*) play a major role in human nutrition providing energy in the form of carbohydrate among starchy roots. Nowadays it has been made considerable effort in determination of antioxidants of those starchy roots due to insufficient studies. The objectives of this study were to determine nutrient and non-nutrient antioxidants of selected cassava and sweet potato varieties and to assess the boiling and peeling effect on antioxidants. Three varieties of cassava named *Kirikawadi*, MK cassava, and MU51 and sweet potatoes named *Ama*, Accession1, and Accession2 were used in the current study. Cassava samples were prepared as flesh with peel, flesh without peel, peel 1 (outer), peel2 (inner) and boiled flesh. Sweet potatoes samples were prepared similarly except peel2. Total phenolic content (TPC), total flavonoid content (TFC), reducing power, DPPH (2,2- diphenyl – 1 pecrylhazylyl) radical scavenging activity (DRSA), and total carotenoids content, beta carotene content and ascorbic acid



content were determined. The graph shows the TPC of flesh of selected starchy roots without peel. Antioxidant activity in terms of reducing power of MU51 peel 2 was the highest among cassava while Accession 2 boiled had the highest reducing power among sweet potatoes. DRSA of MU51 peel 2 was the highest among cassava and *Ama* boiled had the highest among sweet potatoes. Total carotenoids content ranged from 1.34 to 9.19 of cassava while 22.14 to 54.54 of sweet potatoes per g of starchy root dry weight basis. Ascorbic acid content was higher in cassava compared to sweet potatoes. Antioxidant activity was highly correlated with TPC ($P < 0.01$). MU 51 peel2 represented high antioxidant potential among cassava types. The results indicated that having a dark color flesh

possess a high antioxidant potential agrees with the results of previous study which found that the purple fleshed sweet potato genotypes showed superior in the scavenging DPPH radical effects as compared to other genotypes (1). Therefore, these results indicated that both variety and processing methods influence on antioxidants of selected cassava and sweet potatoes varieties.

Bellail, A., Shaltout, O.E., Youssef, M.M. & Gama, A.M.E. (2012). Effect of Home-Cooking Methods on Phenolic Composition and Antioxidant Activity of Sweetpotato (*Ipomoea batatas* (L.) Lam.) Cultivars Grown in Egypt. *Food and Nutrition Sciences*, 3(April), pp.490-499.

Keywords: *Ipomoea batatas*; *Manihotesculenta*; processing; reducing power; TPC

Agro-biodiversity and household food and nutrition security in Niunhella in Kegalle district

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Agro-biodiversity in a particular area facilitates people to add more variety of food groups in their consumption. The aim of the present study was to evaluate the agro biodiversity utilization for household food and nutrition security in Niunhella rural village situated in Kegalle district. One hundred households were selected based on availability of home garden or cultivated land with agricultural crops. Food consumption pattern and dietary practices were assessed by food frequency questionnaire and household 24 hour recall. Food security status was determined by USDA food security core module (1).

The prevalence of food security, food insecurity without hunger, food insecurity with moderate hunger and food insecurity with severe hunger percentages were 79%,18%,3% and 0%, respectively. The table shows food varieties consumed by whole study sample in a single day. It represents the utilization of agro-biodiversity in a particular sample. Highest number of varieties consumed by the households was vegetables (23 varieties) followed by green leaves (18 varieties), fruits (11 varieties) and cereals (3 varieties). Only 2 varieties of starchy foods and 3 varieties of pulses were consumed by the households. Green leaves were the mostly consumed food group from home garden (81.5%) followed by fruits (61.5%) and starchy foods (12.5%).

In conclusion,79% of households studied in Niunhella were food secured. Home garden supplies mainly fruits and green leaves for the consumption of households in the village. Therefore, home gardens play major role in their nutrition security. Agro-biodiversity utilization is mostly done through home garden.

Acknowledgement: Biodiversity for Food and Nutrition Project of Department of Agriculture for financial assistance. Prof DKNP Pushpakumara, Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Agriculture Instructor, Ruwanwellafor field arrangements.

Bickel, G.W., Cook, J., Hamilton, W., Mark, N., and Price, C., (2000) Measuring food security in the United States guide to measuring household food security, USDA., USA., Food and Nutrition service.

Keywords: Agro biodiversity; dietary diversity; household food security

Development of nutrition interventions for primary school children

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Providing nutrition education for school children is an investment for country's future. Nutrition inadequacy in this period negatively affects their growth, maturation and educational performances. The prevalence of thinness, stunting, and overweight among primary school children in Sri Lanka was 8.9%, 28.3% and 3.1% respectively. Further, the majority of school children follow unhealthy food habits (1). This emphasizes the necessity of implementing appropriate and effective nutrition interventions. Therefore, this cross sectional study aimed to develop nutrition interventions for primary school children by addressing their nutritional problems.

Permission for the study was obtained from the authorities and the persons, and written consent was obtained from the guardians of the children age between 6-10 years, studying in Sri Rewatha Rathanapala Vidyalaya, Kuliyaipitiya after briefing about the study. Pre-tested self-administered general questionnaire, nutrition knowledge assessment questionnaire, food frequency questionnaire were used to collect socio-demographic, nutritional knowledge and dietary data, respectively. In addition to that observations of children's mid-day meal and available foods in their canteen were used to gather dietary information. Anthropometric measurements (height, weight) were collected by following standard techniques and nutritional status of the children was determined using Anthroplus software. Different nutrition interventions were developed as suitable for different age groups, to disseminate the nutritional knowledge by addressing the identified nutrition related problems among them. Effectiveness of the developed nutrition interventions was evaluated. According to the results 25%, 15%, 27% and 4% of the sample were underweight, stunted, thinness and overweight, respectively and also unhealthy life style practices such as low consumption of fruits, vegetables and high consumption of fast foods were identified. By addressing those problems appropriate nutrition interventions (Table 1) were developed by incorporating attractive pictures and simple Sinhala language, to improve the attractiveness and understandability.

Table.1: Developed nutrition interventions for primary school children age between 6 to 10 years

Intervention	Age group	Nutritional message
Story book	Grade 1	Importance of healthy eating, physical activity and bad effects of fast foods consumption
Video	Grade 2	Nutritional values and health benefits of fruits
Food cards	Grade 3	Familiarization of different food types, their nutritional values
Nutritional game(puzzle)	Grade 4	Nutritional values and health benefits of different food types
Awareness programs	Grade 5 Parents	Identification of different food groups, Nutrition related health problems, Importance of having a balanced diet, Nutritious food preparation

Effectiveness of the tools was evaluated by comparing the level of nutritional knowledge of children before and after the interventions. Developed nutrition interventions were found as good and

effective approaches to disseminate the nutritional knowledge and to improve healthy eating and behavioral practices among primary school children.

(1) Jayatissa R, Gunathilaka MM, Fernando D N (2012) National nutrition and micronutrient survey part I: Anaemia among children aged 6-59 months. Ministry of Health with UNICEF, 30-50.

Keywords: Awareness program; dietary habits; nutrition education; nutrition interventions; primary school children

Dietary fiber and total carbohydrate content of selected underutilized fruits in Sri Lanka

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This study was carried with an objective of analyzing the dietary fiber and total carbohydrates of selected Sri Lankan underutilized fruits. Sixteen selected underutilized fruits varieties were collected from local markets and home gardens in North Western Province. The edible portions of three independent samples of fruits were analyzed for their total dietary fiber (TDF) by enzymatic gravimetric method and total carbohydrate (TCHO) by phenol sulphuric acid method.

Table: Total dietary fiber (TDF) and total carbohydrate contents of selected locally available underutilized fruits in Sri Lanka (g /100g edible portion of fruit pulp)

Common Name	Botanical Name	TDF		TCHO	
		Mean	SD	Mean	SD
Biling	<i>Averrhoabilimbi</i>	1.77	0.02	2.51	0.10
Soursop	<i>Annona muricata</i>	2.06	0.01	8.34	0.22
Rose apple	<i>Syzygiumjambos</i>	2.06	0.01	2.71	0.08
Pummelo	<i>Citrus grandis</i>	2.10	0.18	4.20	0.09
Star fruit	<i>Averrhoa carambola</i>	2.28	0.02	4.91	0.21
Star gooseberry	<i>Phyllanthusacidus</i>	2.61	0.03	2.79	0.04
Mandarin	<i>Citrus raticulate</i>	3.01	0.04	4.39	0.24
Bael	<i>Aeglemarmelos</i>	3.70	0.21	25.49	0.42
Jew plum	<i>Sondiasdulcis</i>	3.71	0.17	6.95	0.76
Nelli	<i>Phullanthusemblica</i>	5.07	0.00	5.42	0.22
Lovi	<i>Flacourtiainermis</i>	5.76	0.17	4.40	0.31
Guava	<i>Psidiumguajava</i>	6.12	0.00	6.13	0.19
Jamson	<i>Synsepalumdulcificum</i>	8.31	0.07	5.81	0.32
Governor's plum	<i>Flacourtiaindica</i>	10.89	0.23	10.23	0.31
Ceylon olive	<i>Elaeocarpus serratus</i>	11.65	0.04	15.04	0.37
Ceylon date	<i>Phoenix pusilla</i>	20.77	0.14	26.88	0.57

he highest TDF content was found in Ceylon date and lowest was found in Biling (Table). The Ceylon olive and governor's plum showed the second and third highest TDF values, respectively. Ceylon date contained the highest total carbohydrate content followed by Bael, Ceylon olive and Governor's plum. Lowest carbohydrate content was found in Biling. In conclusion, Ceylon date reported the highest TDF and carbohydrate content among the analyzed fruit varieties while Biling recorded the lowest in both.

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Keywords: Enzymatic gravimetric method; phenol sulphuric method; underutilized fruits; total dietary fiber; total carbohydrate

Past dietary pattern and current nutritional status of the patients with Alzheimer's disease

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Epidemiological studies suggest that past dietary intake, medical history, and lifestyle behaviours may influence the development of Alzheimer's disease (AD). Further, AD patients may have high risk of malnutrition. This descriptive study aimed to investigate the past dietary pattern, medical history, lifestyle behaviours, and to assess current nutritional status of AD patients. Based on Mini Mental State Examination (MMSE) score, 28 patients (14 females and 14 males) with mild to moderate cognitive impairment and their caregivers were recruited from a care centre in Colombo. Interviewer administered lifestyle, and health related questionnaire, food frequency questionnaire (FFQ), and mini nutritional assessment (MNA) were used to investigate the past lifestyle behaviours and medical history, past dietary intake, and current nutritional status, respectively. Among AD patients, 21% smoked for more than 10 years, and 11% consumed alcohol more than 3 times per week during their midlife (35-55 y). Further, only 14% of patients had continued their education after G.C.E Advanced level. Less than 40% of AD patients were reported as having at least diabetes, high cholesterol, hypertension, cardiovascular disease, or depression. Table shows the past dietary pattern by the patients during their midlife (35-55y) and a comparison between their consumption of major food groups and the daily recommended level in terms of serving sizes.

Food groups	Daily recommended level (1)	Compliance n%	
Cereal, cereal based products, and yams	6-11 servings	19	68
Vegetables	3-5 servings	11	39
Fruits	2-3 servings	10	36
Legumes and animal sources	3-4 servings	15	53
Milk and milk products	1-2 servings	24	86
Nuts and oil seeds (except coconut)	2-4 servings	1	4
Oils and sugar	less frequently	10	36

According to MNA, 50% of AD patients were found to be at risk of malnutrition at present. It is concluded that, consumption of vegetables, fruits, legumes, nuts, fats, and sugar were inappropriate by majority of AD patients during their midlife when compared with recommendation for healthy life and presently 50% of them are at risk of malnutrition among studied subjects.

Jayatissa, R, Wickramasinghe, P, Mahamithawa, S, & Withana, C. (2011) Food based dietary guidelines for Sri Lankans. 2nd Ed. Nutrition Division, Ministry of Health, Sri Lanka.

Keywords: Alzheimer's disease, dietary pattern, mini nutritional assessment (MNA), nutritional status

Food habits and health well-being of teenagers facing national examinations in Sri Lanka: A case in a national school in Kurunegala district

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A number of physiological, psychological and nutritional changes are taken place during teenage period(1).Examinations are a major factor that affects their food habits, health, nutritional status and psychology of teenagers. A case study was conducted to assess the food habits of teenagers who were facing national level competitive examinations and to assess their nutritional status and psychological well-being. Using self-administered, pre tested questionnaire data were collected from randomly selected 140 students facing G.C.E.O/L (n 86) and G.C.E.A/L (n 54) examinations in a National School in Kurunegala district. Practice of food habits among study sample is shown in the table. Scores were given for answers of emotional feeling questions and if any student scored more than mean score value, that student was considered as having good psychological status. If any student scored less than mean value, that student was considered as in having bad psychological status. Majority of the subjects (72%) were in normal BMI category whereas 18%,6%,3% and 1% were wasted, severely wasted, over weight and obese, respectively. There was a significant relationship between nutritional status with skipping meal ($P=0.001$), eating out($P=0.001$) and sweets consumption ($P=0.041$). Results showed that, 88% of students were

Habit	Practice of food habit (%)	Practicing frequency of food habits (%)			
		1-2 per week	3-4 per week	5-6 per week	Daily
Eating out	97	57	34	7	2
Skipping meal	75	56	20	21	3
Carbonated beverages	71	51	21	24	3
Short eats	57	21	28	48	4
Biscuit	45	10	19	32	40
Fruit	27	53	26	16	5
Milk	73	47	23	13	17
Vegetable	100	0	0	0	100
Sweets	42	12	18	37	33
Watching TV while eating	45	3	5	60	32

having negative feelings rarely while 96% of students were having positive feeling frequently. Proportion of students who had emotional feeling scores above the mean value was 60%. In conclusion, unhealthy food habits are more prominent in the study sample. The frequencies of healthy foods (fruits and milk) consumption were lower than that of unhealthy food choices such as short-eats and sweets. Majority of the population were in good nutritional status (72%) and good psychological status (60%).

Clark, T. C., Fleming, T., Bullen, P., et al. (2013). *Youth'12 Overview: The health and wellbeing of New Zealand secondary schoolstudents in 2012*. Auckland, New Zealand: The University of Auckland

Keywords: Examinations; nutritional status; psychological status; teenagers

Level of physical activity, blood pressure and nutritional status of university students

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Public health should be improved to reduce mortality and prolong life expectancy of population. Adult stage is a good time to improve health behaviours. University is a critical time of transition when students develop and integrate their health related behaviours into their lives. Therefore universities are potentially important targets for the promotion of healthy lifestyles. The undergraduates have issues on physical inactivity, poor eating habits, psychological distress and depression. A study was carried out to determine the nutritional status, physical activity level and blood pressure level of undergraduates and to assess the relationship between physical activity, blood pressure and nutritional status. Descriptive cross sectional study was conducted with 68 males and 162 females of Wayamba University of Sri Lanka by multi stratified sampling method. Pre-tested self-administered general questionnaire and International Physical Activity Questionnaire were used to collect the information. Anthropometric measurements; height, weight and systolic, diastolic blood pressure were obtained.

Category	Percentage of undergraduates (%)
Nutritional status	
Underweight	17.4
Normal	54.3
Overweight	17.0
Obese	11.3
Blood pressure level	
Hypotension	22.2
Normal	74.8
Pre hypertension	2.6
Hypertension	0.4
Physical activity level	
Low	13.9
Moderate	46.5
Vigorous	39.6

Table shows the percentage of students from each category of nutritional status, blood pressure level and physical activity level. Systolic and diastolic blood pressure values were positively associated with anthropometric measures, height, weight, BMI and weight: height ($P < 0.01$). Age did not show a significant relationship with either systolic blood pressure or diastolic blood pressure as university students did not have a higher deviation on age (age range 21 to 26). BMI of each physical activity level (low, moderate, vigorous) was significantly different ($P < 0.05$). There was a trend of increasing overweight and obesity from 1st year to 4th year. Third and final year students had higher percentage of moderate or vigorous physical activity level. Also there was a trend of decreasing low physical

activity level from 1st year to 4th year. First year students had low blood pressure compare to other years. Higher percentage of underweight students had high physical activity level and obese students had lower percentage of high physical activity level.

In conclusion, about half of the students in this selected sample had malnutrition. The majority of undergraduates had normal blood pressure and moderate or vigorous physical activity level.

Keywords: Anthropometric; BMI; diastolic; systolic; undergraduates

Situational analysis of nutrition, health and psychological well-being of adolescents in a rural community

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Adolescence is a significant period of rapid physical, psychological, and social development. Analyzing their nutrition, health and psychological well-being is important, as they contribute for optimal childhood health and intellectual development. This study aimed to analyze the nutrition, health and psychological wellbeing of adolescents and to identify the association among different variables related to wellbeing of adolescents in Vakarai in Batticaloa district. Two hundred and ten adolescents (male-90, female-120) aged between 15 to 19 years were selected from Vakarai. A pre tested interviewer-administered questionnaire was used to gather information. Anthropometry (height and weight) was measured.

Results showed that among the study group 13%, 24% and 1% of the adolescents were severely thinness, thinness and overweight, respectively according to BMI for age z-score (1). According to height for age z-score, 20% of the adolescents were stunted (1). In the present study, 25% of adolescents were in good psychological status whereas 25% of them were not in favourable status according to their score for psychological well-being questions. According to adolescents' scores for health well-being, more than half of the adolescents were in good health status. There was a significant association between gender ($P = < 0.0001$) and educational level of adolescents ($P < 0.041$) with nutritional status of adolescents. In this study, males had more chance to get undernourished compared to female. Nutrition status of adolescents improved with increasing educational level in this study population. There was a significant association between monthly income ($P = < 0.0001$) with psychological well-being of adolescents. Adolescents who had low monthly income had higher likelihood to have bad psychological status compared to adolescents who had high monthly income. There was a significant association between snacking pattern ($P = < 0.0001$) and health well-being of adolescents. Snacking during noon, evening and morning and noon associated with health well-being of adolescents. Compared to adolescents who did not snack, adolescents who had habit of snacking had higher chance to get bad health status.

In conclusion, most of adolescents were in normal nutrition status and considerable amount of them were severely thinness and stunted. Most of the adolescents were in moderate psychological status and majority of the adolescents were in good health.

World Health Organization (2010). COUNTRY PROFILE INDICATORS Interpretation Guide. Geneva: World Health Organization.

Keywords: Health; nutritional status; psychological status; Vakarai

Utilization of food resources in village tanks by the communities in North Western Province

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Fishing in inland water has become an important economic activity and it provides animal protein to families. Inland fishery has a positive effect on household food and nutritional security. The aims of this study were to evaluate the frequency of fish consumption and other food resources from village tanks and investigate the contribution of tank fish to protein intake of communities in North Western Province. A cross sectional study was conducted in 120 households (HH), where the adult men were engaging in fishing activity during April-July 2016. HH were selected from 15 villages in selected four Divisional Secretariats (Polpithigama, Galgamuwa, Nikaweratiya and Anamaduwa). United States Department of Agriculture (USDA) food security core module was used to assess HH food security. Dietary intake of HH were assessed using interviewer administered single household 24-hour dietary recall and a food frequency questionnaire. All HHs were reported as food secured. About 85% of the HHs consumed different fish species and 32% has consumed fresh water fish. The study showed that all the selected HHs had consumed tank fish in every 2-3 days. Moreover, dietary diversity score (DDS) was low (DDS < 8 out of 12) in majority of HHs. Nutrient adequacy ratio calculated from 24-hour recall and the majority of HHs achieved adequate level of energy and protein to meet their Recommended Dietary Allowance (RDA) whereas, majority of HHs did not achieve adequate level of micronutrients, especially vitamin C, vitamin A and calcium. The contribution of protein intake from tank fish was reported as 30% and more than 50% of households preferred to consume Nile tilapia (*Oreochromis niloticus*) and snakehead (*Channa argus*). More than 50% of households had consumed kekatiya (*Aponogeton crispus*) and lotus (*Nelumbo nucifera*) seed, stem and root were also consumed frequently. In conclusion, tank fish and other tank food resources were frequently consumed by the village community studied and tank fish has considerably contributed to their total protein intake.

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Keywords: Dietary intake; dietary diversity score; household food security; inland fisheries

Knowledge, attitudes and practices related to functional food usage of housewives

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Food is an essential part of our lives, and consumer interest in foods that may provide benefits beyond basic nutrition, or “functional foods,” is thriving. However, limited studies showed that knowledge on various dimensions behind functional food is lacking among Sri Lankans(1). Hence, assessment of knowledge, attitudes, and practices (KAPs) of functional food usage among Sri Lankan housewives is essential due to their active participation for decision making regarding food choices. A cross sectional descriptive study was conducted to assess the level of KAPs of functional food usage by housewives in a selected study population in Sri Lanka. Data were collected using a pretested interviewer administered questionnaire with three hundred (n=300) willingly participated housewives in sixteen Gramaniladhari divisions in Rathnapura, Balangoda, Katharagama, and Pannala areas in Sri Lanka. Individuals were assessed by providing scores for knowledge, attitudes and practices sections of the questionnaire. Then percentage scores obtained by the individuals were assessed as “adequate level” ($\geq 50\%$) or “inadequate level” ($< 50\%$).

In relation to mean scores shown in table, study subjects had inadequate knowledge but adequate attitudes and practices. Mean score of overall KAPs showed that adequate overall KAPs among housewives in study population. Around 99% of housewives knew that certain foods can give health benefits beyond basic nutrition. Dietary fiber was most well-known food component, while carotenoid was the least known from given food components. Majority (98%) identified diabetes as a disease which can be managed by usage healthy food. Greater part of participants believed that ability of giving health benefits can be destroyed by heating and knew about health benefits

	Mean score (%)	SD	Rank
Knowledge	46.2	23.2	Inadequate
Attitudes	76.7	16.3	Adequate
Practices	80.3	12.5	Adequate
Overall KAPs	56.6	18.6	Adequate

of spices. More than half of participants (57%) grew fruits and vegetables at home. Almost all buyers concerned about healthiness of food when buying. Commonly used specific functional foods to maintain

healthiness were curry leaves (*Murraya koenigii*), green leafy porridge, the **bu leaves** (*Costusspeciosus*) and garlic (*Allium sativum*). The commonest barrier to selecting functional food was adding various chemicals to food. Television is the most quoted (54%) source of information about functional food. Majority (99%) interested in learning more about functional foods. Perception of fortified food usage was generally positive among participants. Significant associations were observed between age, education level, family income and occupation with knowledge and attitudes. Significant association with practices was only found with educational level. There was a positive interrelationship among KAPs.

In conclusion, inadequate knowledge score among participants demands nutrition education programmes about functional food specially through television to be implemented for them to gain adequate knowledge, plus adequate attitudes and practices than current status.

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Keywords: Diabetes; dietary fiber; functional food; health benefits; Sri Lanka

Consumer perception on iron fortified rice: A community study in Kalpitiya divisional secretariat division

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Fortification of staple food has been considered as one of the most cost-effective solutions to address multiple micronutrient deficiencies. Iron fortification of rice may be the best solution to combat iron deficiency anemia, which has been proven effective at large scale. Therefore, the government of Sri Lanka has planned to introduce fortified rice into the market in future. This study was carried out to assess the rice consumption pattern, buying behavior of consumers, consumer perception on iron fortified rice and the nutritional knowledge level regarding iron. The data were gathered by using an interviewer administered questionnaire with 100 convenient samples of households situated in Kalpitiya divisional secretariat division in Puttalam district.

The findings suggested that the nutritional value of rice was the most influencing factor when buying rice. "White naadu" is the commonly consuming rice type of the studied community and the major reason for it was the health benefit of it. Price is the main influencing factor which will determine the purchase of fortified rice. Consumers will only accept the extra amount for rice within Rs 5-10 per kilogram. Majority of the people (89%) did not know about the availability of fortified products in the market and introduction of iron fortified rice. Consumers' nutritional knowledge related to iron was low. Overall 91% of the respondents were willing to accept iron fortified rice as a solution for anemia, whereas only 19% of them were ready to accept iron fortification of rice at present. Remaining 81% of respondents require more information on fortified rice from most reliable source and they believe that the reliable source should be the medical practitioner. Further, consumers also have some future concerns related to sensory attributes of fortified rice next to the nutritional value.

In conclusion, the results suggested that majority of the respondents are willing to accept iron fortified rice without changing their buying behavior and consumption pattern. However they need more nutritional knowledge related to iron and iron fortified rice before making decisions on purchasing and consuming fortified rice.

Keywords: Acceptability; consumers perception; iron-fortified rice; iron deficiency; nutritional knowledge

Compilation and development of an electronic nutritional composition database for commonly consumed Sri Lankan foods

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Nutritional composition of Sri Lankan foods and recipes are not updated. Computer based software are more convenient and useful for the users of food composition data (FCD). Compilation of nutritional composition values of commonly consumed foods and recipes is needed to develop comprehensive food composition database. Aims of the present study were to compile nutritional composition data of Sri Lankan foods from published literature and carrying out recipe calculations, and to update NutriBase software (CyberSoft, USA) which contained United States Department of Agriculture (USDA) and Canadian food composition data. Five hundred and ninety two foods (single foods and mixed dishes) were selected in consultation of experts in nutrition. Food composition data of 188 foods were borrowed from UK(1), 190 foods from Indian(2) and 76 foods from ASEAN FCDs and 138 foods from published data from laboratory analysis of nutritional compositions. Further, 18 new food recipes were prepared in the dietetic laboratory according to a standard recipe book. Recipe compositions of mixed dishes were analyzed using Food base 2000 (Institute of Brain Chemistry and Human Nutrition, UK). Quality of the data was checked using scrutinizing criteria of International Network of Food Data System (INFOODS). Nutritional composition of commonly consumed 408 food items including 135 cereal and cereal based products, 70 fruits, 25 pulses and legumes, 44 roots and tubers, 21 condiments and spices, 33 vegetables, 15 nuts and oil seeds, 35 leafy vegetables, 20 meat and meat products, 10 milk and milk products were compiled and included into NutriBase. Also, energy, macro(including classes of fatty acids) and micronutrients of 184 mixed dishes including 25 cereal based dishes, 80 vegetable based dishes, 22 fish and sea food based dishes, 7 poultry based dishes, 15 pulses and nut based dishes, 17 mixed dishes and 18 sweets were included into NutriBase. In summary, NutriBase software has been updated with the composition of commonly consumed Sri Lankan foods obtained from published data and recipe calculations.

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Gopalan, C., Ramasastri, B.V. & Balasubramanian, S.C. (2012). Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research (ICMR), Hyderabad- 500007, India.

Keywords: Compilation; food composition database; nutritional composition; recipe calculation

Nutrition knowledge, attitudes, and practices on food habits of national level athletes in Sri Lanka

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Nutrition knowledge, attitudes, and practices are needed to meet energy demand, maintaining body mass and body fat at appropriate levels in national level athletes. The purpose of this study was to estimate the level of nutrition knowledge, attitudes and practices (KAPs) on food habits and to evaluate the relationship between gender, age, education level, and receiving of nutrition advice on KAPs of national level athletes in Sri Lanka. A cross sectional descriptive study was conducted using pre tested interviewer administered KAP questionnaire. Eighty athletes who were engaging in badminton, boxing, weight lifting, taekwondo, volleyball, netball, and track and field in Sri Lanka were recruited.

Based on the used scoring system (1), nearly a half of the subjects (44%) showed good level of knowledge and only 61% of subjects had excellent ($\geq 80\%$) attitudes regarding food habits (Table). But nearly one-fourth (24%) of subjects demonstrated excellent ($\geq 80\%$) nutritional practices. Study population had satisfactory level (50-59%) of nutrition knowledge with a mean score of 57.9% for

Score level	Percentage of athletes (%)		
	Knowledge	Attitudes	Practices
Excellent ≥ 80	9	61	24
Very good 70 - 79	11	14	19
Good 60 - 69	44	18	21
Satisfactory 50 - 59	20	5	15
Regular 40 - 49	14	1	16
Poor 30 - 39	3	1	3
Very poor 20 - 29	-	-	3
Bad < 20	-	-	-

of athletes and approximately half (44%) of subjects used dietary supplements and also there was a significant association between gender and knowledge, education level and attitudes. Study identified that, there was very good level of attitudes, but gaps in nutrition knowledge and practices on dietary habits of athletes in study population. Thus suggest developing strategies in counseling and educating of athletes to improve their performance with adequate nutrition.

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Nazni, P. & Vimala S. (2010). Nutrition knowledge, attitude and practice of college sportsmen. *Asian Journal of Sport Medicine*. 11 (2), 93-100.

Keywords: Dietary habits; sports performance; skipping meals; supplement

Household food security and associated dietary and socio-economic determinants in estate and rural communities

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Household food insecurity is associated with level of under nutrition status of children in Sri Lanka. This study assessed the household food security status and associated socio-economic and dietary determinants on household food security in estate and rural communities. Households having at least 1 child aged between 2-6 yr from estate (n 479) and rural (n 279) communities were selected in Nuwara Eliya and Batticaloa districts, respectively and the study was conducted in March-July 2016. Food security status of the households was assessed by using USDA food security core module (1). Household Dietary Diversity Score (HDDS), Food Variety Score (FVS) and Food Consumption Score (2).

Prevalence of food insecurity was 62.6% in estate communities and 62.8% in rural communities. Education level of mother (OR = 2.6), household income level (OR = 3.7), household expenditure (OR = 2.6) and family size (OR = 1.5), mother's FVS (OR = 3.6) were significantly associated ($P < 0.05$) with the household food security status in estate community. Household income (OR = 1.9), expenditure (OR = 1.8), family size (OR = 1.2) and DDS (OR = 1.9) were significantly associated on food security status in rural community ($P < 0.05$). Most of the mothers and children consumed 3-5 food items/day in estate communities and 5-10 food items/day in rural communities. FCS was in acceptable range (> 35) in both rural (98.2%) and estate (99.7%) communities. Fifty three percent of estate households reported HDDS ≥ 8 whereas, 46.7% of rural households had HDDS ≥ 8 . Higher household income, better education level of the mother, family size, household expenditure and mother's FVS were associated with household food security status in estate communities whereas higher household income, family size, household expenditure and HDDS were associated with household food security status in rural communities.

Authors acknowledge the financial support of National Science Foundation of Sri Lanka Bickel, G., Nord, M., Price, C., Hamilton, W. and Cook, J. (2000) Measuring food security in the United States. Guide to measuring household food security. 3rd ed. Food and Nutrition Service, Office of Analysis, Nutrition and Evaluation, Alexandria VA: U.S. Department of Agriculture.

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Keywords: Dietary diversity; food variety score; food consumption score, household food security

Caregiver’s knowledge, attitude and practices related to early childhood nutrition: a case in Panadura MOH area

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Early childhood nutrition plays an important role in growth and development of children. Breastfeeding contributes a major part of child nutrition. However, despite strong evidences in support of breastfeeding and early childhood feeding practices, prevalence of these practices have remained poor worldwide due to poor attention of caregivers(1).Hence the objective of this study was to assess the caregiver’s knowledge, attitude and practices related to early childhood nutrition. A cross sectional descriptive study was carried out among randomly selected 100 caregivers(n=100) of 2-5 years old children in Panadura MOH area. Pre-tested interviewer administered questionnaires were used to collect socio-demographic data, knowledge, attitude and practices (KAP) towards early childhood nutrition, dietary information and household food security. The findings revealed that 91%, 8% and 1% of households were food secure, food insecure without hunger and food insecure with moderate hunger, respectively. Majority of caregivers (93%) had fulfilled minimum dietary diversity score (MDDs) and mean dietary diversity score of caregivers was 6.7. Of the total 100caregivers, 65% practiced exclusive breastfeeding (EBF). Only 38% of women had the knowledge that breastfeeding should continue up to two years or more, but 94% of mothers had continued breastfeeding up to two years or more. Of the caregivers,61% practiced complementary feeding (CF) starting from 6 months, while considerable proportion (32%) had introduced CF before 6 months. There were significant correlations between caregiver’s knowledge, attitude and practices ($r > 0.30$; $P < 0.05$).According to percentage of “correct answers”, “desired/positive attitudes” and “optimal practices” of the survey, the population was

Factor	Need of nutrition education strategies for caregivers %			Mean score % (SD)	Category
	A-Urgent (<70%)	B-Should be considered (70-89%)	C-Not needed (≥ 90%)		
Knowledge	15	40	45	85(±13)	B
Attitude	13	45	42	83(±12)	B
Practice	6	40	54	89(±11)	B

categorized into three categories as shown in the table. According to the mean values of scores, the study population was in the category B (nutritional education strategies should be considered). Considerable amount

of mothers (15%, 13%, and 6%) were in the category A(nutrition education strategy is urgent) according to their percentage of scores. In conclusion, the nutrition education strategies should be considered for the study population according to their KAPs related to early childhood nutrition. About half of caregivers had inadequate level of KAPs. Majority (91%) of households were food secure and 93% of caregivers had fulfilled MDDs.

Vijayalakshmi, P., Susheela, T., & Mythili, D. (2015). Knowledge, attitudes, and breast feeding practices of postnatal mothers: A cross sectional survey. *International Journal of Health Sciences*, 9(4), 364–374.

Keywords: Breast feeding; complementary feeding; minimum dietary diversity score(MDDs)

Hydration status and fluid intake pattern of national level athletes in Sri Lanka

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Sport is one of contributors to the economic development of Sri Lanka. Hypohydration of 2% of body mass can compromise sport performance (1). Severe dehydration can lead to even death of athletes by creating heat shock. There is no published research on assessment of hydration status and fluid intake pattern of Sri Lankan athletes. This study was aimed to assess the hydration status and fluid intake pattern and to investigate the contributory factors on hydration status of national level athletes in Sri Lanka. A cross-sectional, descriptive study was conducted with a selected sample of 70 national level athletes including boxing, badminton, weightlifting, volleyball, netball, track & field and taekwondo. Interviewer administered questionnaire, qualitative fluid frequency questionnaire and 24-hour fluid recall were used to collect information. One spontaneously voided urine sample was collected from each participant and specific gravity and urine colour were measured in triplicate.

Mean total fluid and water intake of athletes were 4.1L (SD 2.0) and 3.3L (SD1.8) per day, respectively. Athletes consumed different types of fluid before, during and after the event. Percentage of athletes consumed water before, during and after event were 73%, 88% and 90%, respectively. Other than water, tea (12%) and *Jeewani* (Oral hydration liquid) (7%) were used before the event and during the event and only 7% consumed sports drinks. Mean fluid intake before, during and after the event were 0.5L (SD 0.3), 1.5L (SD0.8) and 1.0L (SD 0.8), respectively. The amount of fluid intake showed negative association with hydration status. A greater frequency of athletes consumed fluid 3.1-4L per day. Majority of athletes (55.7%) were minimally dehydrated, 15.7% of athletes appeared significantly hypohydrated, 28.6% athletes were well hydrated and no any athletes were seriously dehydrated. A considerable percentage (17.9%) of athletes consumed sport drinks more than three times per day. Sports type ($P=0.001$), age ($P=0.001$), gender ($P=0.001$), frequency of urination ($P=0.006$) and alcohol consumption ($P=0.03$) were significantly associated with hydration status. In conclusion, hydration status of Sri Lankan national level athletes is not up to the standard. High consumption of sport drinks can cause undesirable health effects in later life of athletes. Fluid intake pattern of Sri Lankan national level athletes needs to be modified to improve their hydration status.

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Volpe, S.L., Poule, K.A., Bland, E.G. (2009) Estimation of prepractice hydration status of National Collegiate Athletic Association Division I Athletes. *Journal of Athletic Training*, 44(6):624–629.

Keywords: Dehydration; hypohydration; sports; urine color; urine specific gravity.

Prevalence of established risk factors of breast cancer among apparently healthy women in two ethnic groups

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Breast cancer is the most common gynecological cancer in the world. Over 508,000 women died worldwide due to breast cancer in 2011 (1). Death rate due to breast cancer is increasing particularly in developing countries like Sri Lanka. Recognizing risk factors and their prevalence among local communities are important for preventive measures. The main objective of the study was to determine the prevalence of established risk factors of breast cancer among apparently healthy women in two ethnic groups. A cross sectional study was conducted using 100 Sinhalese and 150 Tamils who were conveniently recruited within the age range of 25-70 years. A pre tested general questionnaire and a food frequency questionnaire were used to collect information. Further, physical activity level of individuals was determined by using General Practice Physical Activity Questionnaire (GPPAQ). Lifetime risk of breast cancer with respect to reproductive and hereditary characteristics of apparently healthy women was assessed by using Gail risk assessment tool (2).

High consumption of meat (84.0%), processed meat (33.0%), cheese (30.0%) and high frequency consumption of butter/margarine (46.0%) and egg (74.0%) were identified as dietary risk factors common among Sinhalese. Among Tamils, high consumption of meat (76.0%) and low frequency consumption of cruciferous vegetables (50.0%) and soya meat (60.7%) were observed to be common dietary risk factors. Reproductive risk factors such as young age at menarche, higher BMI and low parity were highly prevalent among Sinhalese whereas majority of Tamils had shorter durations of breast feeding. In the study sample, 77.0% of Sinhalese and 67.3% of Tamils were identified as inactive. Further, 21.0% of Sinhalese and 10.0% of Tamils were exposed to passive smoking. Based on Gail risk assessment tool, majority of the subjects showed a lower risk for breast cancer compared to an average woman of the same age. Among the women with high risk, majority was Tamils.

Number of considered dietary risk factors was higher among Sinhalese than Tamils. Tamils indicated a comparatively higher risk for breast cancer related to reproductive and hereditary factors than Sinhalese. However, more research is needed on risk factors of breast cancer in different communities to investigate the identified trends.

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National Institute of Health (2011) Breast cancer risk assessment tool [online] Available from: <http://www.cancer.gov/bcrisktool/> [accessed on 05/06/2016].

Keywords: Gail risk assessment tool; general practice physical activity questionnaire; Sinhalese; Sri Lanka; Tamils

Development and evaluation of nutrition intervention tools for pregnancy and complementary feeding

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Proper nutrition during pregnancy and infancy ensures better growth and development of infants. There is a great doubt about the effectiveness of nutrition interventions conducted in Sri Lanka as currently Sri Lanka represents a low birth weight rate of 17% and preschool children’s stunting, wasting and under-weight prevalence of 5.7%, 10.3% and 20.2%, respectively among infants at complementary feeding age(1). Therefore, developing novel nutrition interventions and evaluating their effectiveness are of current importance in Sri Lanka. The aims of this study were to develop two hand-brochures on nutrition during pregnancy and complementary feeding and to evaluate their effectiveness as nutrition intervention tools. The study was conducted in two phases. First phase was the development of intervention tools and the second phase was the evaluation of developed tools. Among different intervention tools, hand-brochure was selected for this study as it is easy to develop, inexpensive, freely distributed and can include more information. Two separate hand-brochures on nutrition during pregnancy and complementary feeding were developed incorporating information gathered by referring currently available nutritional information at Maternal and Child Health Clinics (MCH) and discussing with health-care professionals deal with pregnancy and infancy. The evaluation of the tools was done as a quasi-experimental study using fifty pregnant women and fifty-seven mothers of complementary feeding infants. A pre-intervention nutrition knowledge assessment was conducted using a knowledge assessing questionnaire. A post-intervention knowledge assessment was conducted four weeks after distributing hand-brochures using the same knowledge assessing questionnaire. The subjects who scored between 20-14, 10-13 and 0-9 for the knowledge assessing questionnaire during pre and post intervention knowledge assessments were categorized as to have “good”, “moderate”, and “weak” knowledge levels respectively (2). Mean scores of pre and post-intervention knowledge assessments were compared using dependent sample t-tests.

The hand brochures were developed in A4 size with three folds (6 sides). Pictorial format and simple language were used. Post-intervention mean scores of pregnant-women and mothers of infants showed a significant improvement of knowledge ($P < 0.05$).

Knowledge levels	Pregnant women				Mothers of infants			
	Pre-intervention		Post-intervention		Pre-intervention		Post-intervention	
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD
Good	10 (20)	10.34 ± 3.6	20 (40)	13.16 ± 3.2	9 (16)	9.96 ± 3.4	21 (37)	12.28 ± 3.5
Moderate	16 (32)		22 (44)		22 (39)		22 (38)	
Weak	24 (48)		8 (16)		26 (45)		14 (25)	

In conclusion, these two newly developed hand-brochures can be used as effective nutrition intervention tools on pregnancy and complementary feeding.

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Keywords: Complementary feeding; evaluating effectiveness; hand-brochures; nutrition knowledge; pregnancy

Determination of energy balance and assessing the nutritional status of national level athletes in Sri Lanka

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Manipulating energy balance has extremely important implications for any athlete and affects not only body weight but also; nutritional status. Changes in the athlete's energy and nutritional status have direct implications on sports performance (1). Therefore, aims of the present study were to determine the energy balance and assess the nutritional status of national level athletes in Sri Lanka and to identify the relationship between anthropometry and body composition with dietary factors. A 24 hour dietary recall for a week day was taken to calculate energy intake and interviewer administered international physical activity questionnaire (IPAQ) was taken to calculate energy expenditure from 68 Sri Lankan national level athletes who were recruited by convenient sampling method. Height, weight, skinfold thickness, waist circumference and hip circumference were measured. Percentage of body water was taken using body analyzer scale.

Results showed that 87% of athletes had negative energy balance. The highest mean negative energy balance of 2167 kcal/d (SD 1001) was observed in male weight lifters and the lowest mean negative energy balance of 156 kcal/d (SD 938) was observed in taekwondo male players. Mean energy intakes per kilogram of body weight of male and female athletes were 37.7 kcal/kg/d (SD 17.6) and 31.4 kcal/kg/d (SD 11.2), respectively which was lower than the recommendation. Majority of athletes had appropriate body fat distribution since athletes are highly physically active. The lowest mean body fat percentage was 13.0% (SD 3.2) and the highest mean fat free mass percentage was 87.0% (SD 3.2) of track athletes.

Table: Pearson correlation coefficients of some anthropometry and body composition values with dietary factors

	BMR	% Body fat
EI/BW	-0.214	-0.260*
EB/BW	-0.412**	-0.191
% E-Fat	0.035	0.252*

** = Significant (P -value < 0.01), * = Significant (P -value < 0.05)

In conclusion, some of athletes participate at national level have appropriate body composition according to respective sport but, majority of them had negative energy balance. Therefore, athletes have to show more interest on maintaining nutritional status and energy balance since it affects athletes' sports performance.

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

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Available at: (<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:energy+balance+in+young+athletes#0>) [accessed on 2016.04.25]

Keywords: Anthropometry; body composition; sports performance

Development and validation of semi quantitative food frequency questionnaire for pregnant women

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Maternal nutrition related health problems remain as one of the major public health problems in Sri Lanka. In Sri Lanka it has been reported that nearly 16 % of infants have low birth weight, nearly 16% of women of reproductive age are malnourished and anemia prevalence among pregnant women is 34% (1). Therefore assessment of maternal diet is important to identify the adequacy of dietary nutrient intake of pregnant women. There are many methods in epidemiological studies to assess the dietary nutrient intake of particular population. Among them Food Frequency Questionnaire (FFQ) is commonly used method to identify dietary patterns. If FFQ can be accessible quantitatively, dietary pattern and dietary nutrients intake can also be assessed. In Sri Lanka, FFQ were developed for adults (2). But there are no any validated FFQ specifically for pregnant women in Sri Lanka. Therefore, this study was conduct to develop and validate a Semi Quantitative Food Frequency Questionnaire (SFFQ) for pregnant women.

Commonly consumed foods among pregnant women were identified by focus group discussions, market visits and household observations including home gardening. After that, those foods were categorized under 13 food groups. Portion sizes in house hold measurements such as tea cup, tea spoon and table spoon; and frequency of consumption such as daily, weekly, monthly, rarely and never options were included in developed SFFQ to get the information about their dietary intake patterns and amount. Further, food photographs also were shown to the pregnant women to estimate the consumed amount of food items. For the validation of this developed SFFQ, 3 day diet-diary (DD) was used. Cross sectional study design was done in Maternal and Child Health clinics (MCH clinics) in Jaffna and Pannala MOH areas. 104 pregnant women were recruited by convenience sampling method.

The developed SFFQ was contained 113 food items under 13 food groups. Results showed that mean daily energy and nutrient (protein, fat, carbohydrate, calcium, iron, zinc and folic acid) intakes obtained from SFFQ was higher than the DD. Pearson Correlation coefficients between energy and nutrient intakes obtained from SFFQs and DDs ranged from 0.360 (protein) to 0.525 (calcium).When adjusting for energy, correlation coefficient values were decreased for most of the selected nutrients except for fat. Cross classification analysis revealed that on average 87% of participants were classified in to the same or adjacent quartile of energy, protein, calcium and folic acid intakes when comparing data obtained from SFFQ and DD. According to the Cohen's weighed kappa values, energy, protein, calcium and folic acid showed relatively fair agreement between these two dietary assessment tools.

In conclusion, this developed SFFQ has adequate validity for assessing energy, protein, calcium and folic acid intakes of pregnant women in this study area.

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Keywords: Dietary nutrient intake; dietary pattern; food frequency questionnaire; pregnant women

Dietary patterns and nutritional status among hospitalized elderly patients

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Hospitalized elderly patients are at high risk of malnutrition due to low appetite and disease condition. A cross sectional study was conducted to assess the nutritional status and dietary patterns of a sample of hospitalized elderly patients. Recently hospitalized elderly patients were recruited according to their willingness to participate the in study from the Bingiriya District Hospital and Dr Neville Fernando Teaching Hospital at Malabe, after getting the ethical approval, and briefing the study to the participants. The Mini Nutrition Assessment (MNA) tool incorporated pre-tested interviewer administered general questionnaire was used to collect socio-demographic and health related characteristics among the study sample. Anthropometric measurements; weight, height/knee height, Mid Upper Arm Circumference (MUAC) and calf circumference were measured following the standard procedures. Pre-tested Food Frequency Questionnaire (FFQ) and a 24-hour dietary recall were used to identify dietary patterns and food consumption servings of the study sample. The MNA scores was used to classify patients as well-nourished (24-30 points), at risk for malnutrition (17-23.5 points), or malnourished (< 17). Dietary patterns were determined according to average daily consumption servings of foods from different food groups and values were compared with recommended servings per day according to Food Base Dietary Guidelines (FBDG) for Sri Lankans.

One hundred hospitalized elderly patients (female 72, male 28) with a mean age of 74 years (SD 5.4) were studied. In the sample, 68% had a monthly income level less than Rs 20,000 and 48% of them were educated up to primary education (Grade 1 – 6). Mean daily intake of cereal and cereal products servings (4.5) was less than the recommended servings per day (6-11). Further, it showed that daily average consumption protein rich food servings (15 servings) from fish, meat, pulses and eggs and their products were lower than the recommended servings per day (3-4 servings). According to the Body Mass Index (BMI) 83.3% of the patients were malnourished. Of the subjects, 83% did not know whether their weight loss happened during the last 3 months period. Based on the chi-square analysis nutritional status of the hospitalized elderly patients was significantly associated with their education levels and the total monthly income ($P < 0.05$). MNA results showed that out of total 86% of hospitalized elderly patients were at risk of malnutrition, while 6% were malnourished and only 8% were at normal nutritional status. Assessment of nutritional status elderly patients at the point of hospitalization would be important in identify those who are in risk of malnourished and initiate necessary interventions to overcome it.

Keywords: Dietary patterns; hospitalized elderly patients; malnutrition, mini nutritional status assessment

Food exchange list for Sri Lankans with type2 diabetes mellitus

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Type2 diabetes mellitus (DM) has become an epidemic in Sri Lanka. Medical Nutrition Therapy is one of the ways to control DM by maintaining appropriate quantity, quality and timing of meals. The aim of this study was to develop a Food Exchange List (FEL) for meal planning and assessment of nutrient intake of Sri Lankan type2 diabetic patients. A cross sectional study was conducted as a baseline survey. Interviewer administered questionnaire was used along with 2days 24hour dietary recalls to obtain information from 55 type2 diabetic patients. Fifty food items with highest consumption frequency were identified and information on their preparation methods was obtained. The selected food items were divided into two groups such as cooked before consumption and consumed as raw. Yielding factors were calculated for cooked foods. One exchange of the foods was quantified in household measurements and in respective metric units. Nutrition facts of selected food items available in market were obtained from food labels. Foods were divided into 7 groups(American Diabetes Association 2003).The energy and macro nutrient contents in one exchange of all selected foods were calculated by using Indian and ASEAN Food Composition Tables, USDA nutrient database and food labels. Median values of macro nutrient content in one exchange of all selected food items with in a food group were obtained. They were considered to be the group representative macro nutrient contents that used to develop FEL. Nutrient intake of 24hour recalls derived from developed FEL and FEL by American Diabetes Association (ADA) was compared with values obtained by food composition database developed for Sri Lankan foods.

Quantifications for mean values of macro nutrients by developed FEL were not significantly different to reference. A perfect association was obtained from Pearson correlation coefficients (r) for developed FEL in all nutrients. Cohen’s weighted Kappa values for developed FEL showed a very good agreement with reference compared to FEL by ADA. In conclusion the energy and macro nutrients quantifications from developed FEL were unacceptable agreement with reference as determined via Bland Altman plots. Developed FEL is a more suitable meal planning tool for Sri Lankans with type 2 diabetes mellitus.

Table: Means, standard deviation (SD), Pearson correlation and weighted Kappa values of energy and macro nutrients intake for Food Exchange Lists with Foodbase2000 software

Nutrients	Developed FEL				FEL by ADA				Foodbase2000	
	Mean	SD	r	Kappa	Mean	SD	r	Kappa	Mean	SD
Energy (kcal)	1526.1	227.3	0.986	0.945	1591.1	249.6	0.858	0.779	1493.6	239.5
CHO (g)	233.9	49.1	0.997	0.952	245.0*	48.3	0.867	0.772	234.3	50.9
Protein(g)	45.6	10.0	0.988	0.822	47.5	12.3	0.730	0.583 ⁺	45.5	10.0
Fat (g)	47.1	8.5	0.941	0.893	46.8	11.3	0.479 ⁺	0.410 ⁺	46.7	8.5

*Significantly different at 95% confidence intervals +Moderate association at 95% confidence intervals

American Diabetes Association, 2003. The Diabetic Exchange List. , pp.1–18. Available at: [http://glycemic.com/DiabeticExchange/The Diabetic Exchange List.pdf](http://glycemic.com/DiabeticExchange/The%20Diabetic%20Exchange%20List.pdf). [Accessed on 30th May 2016].

Keywords: Energy; food exchange list; macronutrients; Sri Lanka; type 2 diabetes mellitus

Analysis of Polycyclic aromatic hydrocarbons to determine the best firewood for smoking fish

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Firewood smoking is one of the traditional preservation techniques, still widely used in processing of maldives' fish, smoked dry fish, garcinia at very primitive level in various parts of Sri Lanka. Modern food industry also use smoking processes to obtain desired flavors in certain products like ham, bacon and sausage. Various types of firewood are being used to generate smoke, which contains at least 100 Polycyclic Aromatic Hydrocarbons (PAH) and their alkylated derivatives. US-EPA and EU listed 16 PAHs as hazardous compounds. Benzo[a]pyrene (Bap) is regarded as a marker of the carcinogenic PAHs in smoke. The maximum acceptable content of B(a)P in smoked food is 0.031 μ g/kg in EU.

This study investigated the PAHs content in smoke of selected fire woods aiming to find out suitable fire woods for food smoking. Nine commonly use, wood variety such as coconut husk, coconut fronds, palmyrah, cinnamon, mango, jack, margosa, portia and weera from northern and southern parts of Sri Lanka were selected for the study. Initially they were dried to assure desired moisture content for burning. A solvent extraction method was adapted at ITI to separate PAHs from smoke. The solvent mixture of acetonitrile, acetone and toluene with a ratio of 6:3:1 was used to trap PAHs within one hour time duration with two replicates. Then the extract was concentrated up to 50 ml. PAHs analysis was performed by Agilent 1260 Infinity Quaternary Gradient HPLC. The different PAHs were separated on an Agilent ZORBAX Eclipse PAH column (4.6mm x 250mm x 5 μ m) by gradient elution with a binary system of acetonitrile-gradient water with subsequent fluorescence and UV detections set at appropriate excitation and emission wavelengths.

According to the analysis, naphthalene, fluorene, phenanthrene, anthracene, benzo(a)anthracene, benzo(a)pyrene and benzo(k)fluoranthene were identified. Among them naphthalene was prominent to all selected woods. Particularly palmyrah, jack and weera have considerable amounts, 198.89ppm, 67.37ppm, and 38.55ppm of naphthalene respectively. According to the EU-EPA probable carcinogenic compounds such as benzo(a)anthracene (1.55ppm), benzo(a)pyrene (1.18ppm) and benzo(k)fluoranthene (0.41ppm) were detected in palmyrah smoke. In conclusion among the nine firewood tested, margosa, mango and portia can be selected as the best fire woods for smoking of fish.

Keywords: Carcinogenicity; polycyclic aromatic hydrocarbons; smoked fish; wood smoke

Comparison of current farm performance in Ambakandawila and Arachchikattuwa sub zones

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Shrimp farming was initiated in northwestern Province of Sri Lanka in mid 1980's. Due to high demand, resulting high prices, high profits, and the breakthrough in culture technology, shrimp culture had expanded rapidly. Shrimp aquaculture industry is mainly concentrated in the northwestern coastal belt and covers an area of around 4500 ha. The economic sustainability of shrimp culture systems depend on the farm management interventions. Recently no studies have been carried out to relate the farm management interventions to the farm performance indicators. Hence the present work is concentrated on investigating the influence of farm management interventions on farm performance in farms distributed in Ambakandawila and Kusala/Kottage sub zones. Study included 196 shrimp ponds in both Ambakandawila (100) and Kusala/Kottage (96) subzones. Details about pond preparation, feed management, water quality management, and other farm management interventions were studied during the culture cycle and after harvesting farm performance indicators were evaluated.

When compare two sub zones (Ambakandawila and Kusala/Kottage sub zones), there is a significance difference ($P < 0.05$) in food conversion ratio (FCR), survival rate (SR), but there is no significant difference ($P > 0.05$) among operational cost per acre (CPA), profit per acre (PPA), and average weight at harvest (AW) (g). Semi intensive ponds which are with stocking densities ≤ 18 PL/m² (average stocking density-15.75 PL/m²) and intensive ponds with stocking density > 18 PL/m² (average stocking density -22.93 PL/m²) there is a significant difference ($P < 0.05$) among AW, CPA and PPA, but there was no significant difference ($P > 0.05$) among FCR, and SR. Intensive ponds in Ambakandawila sub zones show better performances than semi intensive ponds. Intensive ponds in Kusala/Kottage sub zones show better performances than semi intensive ponds. Profitability per unit area is high in farms operated at intensive level irrespective of sub zone.

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Keywords: Economic; farm performance; management; shrimp culture

Design, Construction, and Evaluation of Performance of Solar Powered Paddle Wheel Aerator

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Dissolved oxygen (DO) is one of the most important primary water quality parameters for successful output from aquaculture production. The optimum DO levels improve the aquaculture production while inadequate DO levels lower the production. Lower levels of DO create stress conditions - leading to disease out breaks and high fish mortality. Artificial aeration is essential to maintain the required DO level in culture ponds, specially in night and under cloudy weather. Fish farmers widely use electric powered pond aerators where considerable proportion is used to cover energy cost. Solar energy, which is available throughout the year in tropical countries, could be one of the best solutions to generate required power. In Sri Lanka the annual average of 5.5kWhm^{-2} solar irradiation is available throughout the year with low seasonal variations. Thus, this study is aimed to design and construct a low cost solar powered paddle wheel aerator to reduce the operational energy cost in aquaculture. Performance evaluation and optimization of the aerator setup was also considered during this study. Paddle wheel aerator was designed and constructed using locally available materials. A 12 V DC battery of 90 Ampere was charged by a 50 W capacity solar panel during day time. Paddle wheel aerators were operated by the DC battery during day and night. In order to identify the best type of aerator, aerators were connected with 3, 4 and 5 wings propeller and data were recorded separately. Fresh water fish *Oreochromis niloticus* were stocked in experimental tanks for the evaluation of aerators. The performance evaluation was also done by changing aerator operational depths (2cm, 5cm, 7cm and 10cm). Aerator was installed in different locations in experimental tanks to identify the best locations to maintain proper water circulation. DO and fish growth performance were recorded in aerated and controlled ponds. Results showed that the maximum oxygen transfer of 8ppm was recorded with a high spinning speed of 40 rpm from a five wings aerator. When using the five wings propeller, seven centimeters was found to be the most suitable immerse depth to reach the maximum average surface water velocity of 0.42ms^{-1} . Significantly higher growth rate ($P < 0.05$) was observed in aerated ponds compared to non-aerated ponds. In conclusion, five wing solar powered paddle wheel aerator can be suggested as the suitable aerator for small scale pond aeration. Further research is recommended towards the scaling up activities.

Keywords: Dissolved oxygen, growth rate, oxygen transfer, paddle wheel aerator, solar energy

Fish production in Cauvery basin of Sri Lanka; trends.

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Fisheries sector plays a crucial role in Sri Lanka in the area of food security and livelihood. Cauvery basin is very rich in fishery resources as it contains a wide continental shelf. Jaffna, Kilinochchi, Mullaitivu, and Mannar districts are the fishery districts located in Cauvery basin of Sri Lanka side¹. Commercial fish production of Cauvery basin has been adversely affected by the civil disturbance and natural disaster like tsunami etc. Poaching of resources by Indian fishermen, hydrocarbon exploration activities, coral mining, sand mining, and illegal fishing activities are the treats. The aim of this study is to determine trends in marine fish production and possible reasons and those trends over the period of 1981 to 2015. Trends were determined in the west and northwest coast of Sri Lanka by analyzing pooled secondary data collected from Department of Fisheries and Aquatic Resources for respective districts, National Aquatic Resources Research and Development Agency and Department of Census and Statistics. In addition, SWOT analyzes was conducted with the consultation of key informants. Sequential MK test and linear regression were used to analyze the trends statically.

All districts except Kilinochchi had no significant turning points throughout the period. But significant decreasing trends were observed in 1992, 1995 and 1992 in Jaffna, Mullaitivu and Manner districts respectively. According to analysis, Kilinochchi and Mullaitivu districts exhibited statistically significant increasing trend in small pelagic and big pelagic production. However, Manner district exhibited a statistically significance decreasing trend in small pelagic but no trend was observed for big pelagic and dermasal production. However, increasing trend for shrimp production was observed in Mannar district. Jaffna district exhibited a statistically significance increasing trend in dermasal production. However, no trends for small pelagic, big pelagic and prawn production were observed in Jaffna district. The dermasal fish production exhibited no trend in Kilinochchi district while increasing trends in Mullaitivu district was observed during 2003-2015. The fish production in Cauvery basin was found greatly influenced by restrictions in fishing activity due to civil disturbance and natural disaster (tsunami). After the conflict, fishing activities were improved due to introduction of multiday boats and removal of restriction. As a result, dermsal fish production exhibited an increasing trend in recent years. Shrimps and Small pelagic fish production has decreased due to restrictions in fishing methods (set net and shrimp trap) and removal of old traditional boats. Influence of civil disturbance was identified as the main reasons for significant degreasing trend during 1991 - 2001.

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Keywords: Cauvery basin; civil disturbance; fish production; recent trends

Value addition to invasive South American Sailfin Catfish through product development

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South American Sailfin Catfish (*Pterygoplichthys multiradiatus*) is a wide spread invasive fish in Sri Lanka, which belongs to the family Loricariidae. Almost all fish caught in fishing gear are discarded due to lack of market demand. Developing a consumer preferred products is vital requirement for value addition of this nuisance species. Therefore, this research attempted to produce ambulthiyal (a traditional method of cooking fish in Sri Lanka) and fish chips for deep frying using a mixture of Sailfin Catfish and the Catla calta (Catla). Samples of Sailfin Catfish and Catla were collected respectably from Victoria and Kimbulwana Wewa reservoirs in Sri Lanka. Collected fish samples were preserved in ice immediately after landing and transported to the university laboratory. Aerobic plate count (APC), yeast and mold count (Y&M) and coliform test (CT) were done to check the microbial quality of raw fish samples. Different fish cakes were prepared mincing meat with ice water, Salt, Glucose, Pepper and Corn flour. After preliminary trials fish cakes prepared using 1:0, 4:1, 3:2, and 1:1 proportions of Sailfin Catfish and Catla were subjected to sensory evaluation. Steamed sample of above mixtures were tested by 30 panelists using five point hedonic scale. The best choice was identified using Kruskal-Wallis test for producing ambulthiyal. Fried samples of fish cakes in similar proportions were mixed with past of potato, chili powder and pepper were tested using the same tasting panel and same statistical method to select the best proportion of two fish species for fish chips. Shelf life of the Ambulthiyal was determined by storing fish cake in vacuumed pack conditions with and without mixing a Gacinia, paper and Salt mixture for five weeks. Finally, Ambulthiyal was prepared using two mixtures stored for five weeks and freshly prepared fish cake and Ambulthiyal mixture. Similar tasting panel and statistical test was performed to evaluate the final products. Proximate analyses of final products were done using AOAC standard methods. Acceptable levels of APC (1291cfu/ml and 1073cfu/ml) for the raw meat of Sailfin Catfish and Catla, low value of Y&M and negative result of coliform test ensured the good microbial quality. According to sensory evaluation most acceptable proportion of Sailfin Catfish to Catla was 4:1 for Ambulthiyal and 1:1 for fish chips respectively. Fish cake stored with Ambulthiyal mixture received the highest preference from the tested samples. There were no significant differences in APC before (8.42×10^3) and after (9.06×10^3) five weeks of storage in fish cake mix with Ambulthiyal mixture. Proximate analysis shows the crude protein (15.29%), crude fat (0.98%), crude fiber (0.13%), carbohydrate (1.39%) and moisture (66.5%) in the final product stored with Ambulthiyal mixture. Result revealed that the potential use of Salfin Catfish for consumer preferred product with good nutritional and microbial quality.

Keywords: Microbial quality, proximate analysis, shelf life, fish cake, fish chips

Evaluation of biogas production potentials of fish waste and invasive aquatic plants

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There is an increasing need to replace conventional energy sources with renewable energy sources to save our environment and as a strategy to mitigate climate change. Bio-energy has received increasing attention to be the most probable solution to produce renewable energy. In this context, biogas production through anaerobic digestion, the process, which is formerly known, has a great potential to produce bio-energy as well as a solution for sustainable management of biodegradable wastes. Fish processing sector produces a considerable amount of biodegradable wastes. These wastes are often protein and fat rich materials thus, representing high methane potentials. However, there is a risk of accumulation of ammonia to inhibiting levels due to low C:N ratio. Therefore, co-digestion with more carbohydrate rich materials is needed to obtain stable and efficient anaerobic digestion processes. Water hyacinth (*Eichhornia crassipes*) was used as co-digester, which is known as an aquatic invasive plant with rich in carbohydrates.

In this study, the biogas production potential of different mixtures of water hyacinth and fish waste and the influence of particle size on the performance of anaerobic digestion was tested. Five laboratory scale batch type reactors were set up with different proportions of fish waste and water hyacinth. They were in 1:0, 3:1, 1:1, 1:3, and 0:1 ratios and each setup was prepared with two different particle sizes of feedstock, i.e. 1-2 cm and 4-5 cm. Digestion was carried out for 21 days at room temperature, $32 \pm 2^\circ\text{C}$. Daily gas production was measured by measuring gas pressure using a manometer setup. The reactor containing 100% fish waste produced the maximum volume of gas on the first 3 days as a measured pressure of around $(1.2 - 1.4) \times 10^4 \text{ Nm}^{-2}$ then it started to decrease rapidly. The same production pattern was observed in 75% fish containing reactor. The reactor with 50% fish waste showed a good gas production for 12 days. The measured pressure was around $(1.2 - 1.4) \times 10^4 \text{ Nm}^{-2}$ and then steadily decreased while the 25% fish waste containing reactor produced very low gas volume and decreased quickly within 10 days. With respect to the reactor of 100% plant, during the first few days, a low gas production was recorded and then it steadily increased after few days. This could be due to lignin content of plant tissue, which is an important plant component, but cannot be decomposed under anaerobic conditions at all. The maximum gas production was observed in the sample containing 50% fish waste and 50% water hyacinth. This indicates that this sample combination could give the best C/N ratio of all the samples tested. On the other hand, the optimum level of biogas production was recorded for small particle sizes (1-2 cm) as expected. However, further studies using both batch and continuous feeding reactors for a longer period are needed to support these results.

Keyword: Anaerobic digestion; digester; fish wastes; particle size; Water Hyacinth

Jellyfish: diversity and abundance in northern Sri Lanka

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Jellyfish, gelatinous free-swimming marine invertebrates, sustains worldwide multibillion industries as seafood, pharmaceuticals, aquarium etc. Moreover, jellyfish serves as an excellent bio-indicator of pollution and global warming. In Sri Lanka throughout the year Jellyfish are commonly found at different parts of the country. Heavy jellyfish blooms appeared in southern Sri Lanka during 2007/8 but still no systematic study had been conducted in identifying the available jellyfish species, their stock abundance and economical potentials.

This study was carried for a period of 15 weeks, from February to July 2016, to identify jellyfish species, to estimate their abundance and distribution off northern Sri Lanka with respect to water quality parameters. Samples were collected from three sites (Point Pedro, Kaytes and Kakathivu) using beach seine and scope nets. Gear dimensions and duration of gear operation were used in estimating the abundance. Both live and 5% formalin preserved samples were identified to the lowest possible taxa, using identification keys and guides, at the laboratory at Wayamba University. This study reported 15 jellyfish species which belongs to two orders; Semaestomeae and Rhizostomeae. Out of the two specimens which belong to order Semaestomeae, one specimen was further identified up to genus *Discomedusae*. Thirteen jellyfish specimens were found to be in order Rhizostomeae, Out of them, 11 specimens were further identified into sub order Daktyliophore (1 specimen), two genus: *Cassiopea* (9 specimens) and *Catostylus* (1 specimen), and only one specimen identified upto species level, *Cassiopea andromeda*, is probably the first record from Sri Lanka. The abundance of *Catostylus*, a potentially edible genus, was found to be 5 individuals per 1000 m³ during the study period. Within the period of study, order Semaestomeae was recorded from Kakathivu and Point Pedro while order Rhizostomeae recorded from Kakathivu and Kaytes. The physio-chemical parameters recorded from jellyfish abundant and non-abundant areas revealed narrow ranges of pH and salinity in areas where jellyfish are abundant, but dissolved oxygen and conductivity were varied in a wider range. However, long-term systematic study is essential in understanding the spatiotemporal dynamics of species with respect to seasonal and physiochemical parameters. Species characteristic description and identification process reported in this study will be important in initiating further studies on jellyfish under different aspects.

Keywords: Abundance; *Cassiopea*; *Catostylus*; northern; taxonomy

Proximate Analysis of gonad and diet of *Stomopneustes variolaris* Lamarck, 1816 inhabiting rocky pools off Negombo, Sri Lanka

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Assessing the diet composition of regular echinoids (Phylum: Echinoidea) is difficult due to fine grinding of food by their specialized mouth part known as Aristotle's lantern. Hence, conventional diet composition techniques cannot be adopted. However, being grazers, they can exert influence over producers of rocky shores. Therefore, determining what is being consumed is important. Additionally, the gonads of *S. variolaris* has the potential to be developed as a fishery. Therefore, assessing the nutritional composition of gut content and gonads were done as a preliminary study to validate the approaches. Samples were collected from Morawala area off Negombo and they were categorized into 3 size classes (below 3 cm, 3.1-6 cm, over 6 cm) from March to August 2016. At least six samples were taken during the day time at low tide. The process was repeated three times. During the sampling period. Samples were frozen on site and were immediately dissected to extract gonads and gut content from just below the Aristotle's lantern in the laboratory. Proximate composition of pooled gut samples and single mature gonad samples were conducted. Standard measurements such as weight, test width, colour and maturity status of gonads were also recorded. Mean percentage content of moisture, ash, proteins, lipids and fiber based on wet weight of female gonads were 75.67 (\pm 2.73), 5.73 (\pm 4.02), 44.3 (\pm 17.8), 0.04 (\pm 0.0216) and 0.176 (\pm 0.336) respectively. In the case of male gonads, moisture, ash, proteins, lipids and fiber percent content were 71.80 (\pm 11.50), 10.58 (\pm 5.91), 28.8 (\pm 25.9), 0.046 (\pm 0.0422) and 1.168 (\pm 0.304) respectively. Mean nutritional composition of gut content for pooled samples based on wet weight were 85.34 \pm 1.018 of moisture, 8.23 \pm 9.037 of ash, 0.035 \pm 0.021 of proteins and 0.065 \pm 0.021 of lipids. Low lipid levels in gut content may be an indication of herbivory. However, discrepancies in protein content of gonads needs further investigation on a longer term scale for both sexes for matured gonads. The methods adopted is an appropriate alternative conventional gut content analysis sans knowing what is actually consumed.

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Keywords: Diet; gonad; proximate analysis; Sri Lanka; *Stomopneustes variolaris*.

Trends analysis of commercial Fish production in Mannar basin of Sri Lanka

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Fishery is one of the main industries in Sri Lanka, which provides employment to 650,000 people. Mannar basin is a sedimentary basin and that was involved in producing 49.56% of marine Fish production during the year 2015 in Sri Lanka. Mannar basin consists of seven fishery districts; Galle, Kaluthara, Colombo, Negombo, Chillaw, Puttalam and Mannar. Mannar basin records 40% of marine fishing crafts, 36% of active Fishers & 32% of fishing household. The present study concentrates on the fish production in the Mannar basin of Sri Lanka. To evaluate the trends in the fishery, available data on fish production (year 1981-2015), fishing fleet data, and socioeconomic details about the fishery were collected from the Statistics Unit, Ministry of Fisheries & Aquatic Resources, respective district fisheries offices, and from the Department of Census & Statistics of Sri Lanka. Simple linear regression & Sequential Mann Kendal test were used to analyze data. In addition SWOT analysis was conducted with a simple questionnaire from the key informants in the fishing societies. Results indicate that there was an upward trend in the annual fish production in the Mannar basin from year 1981 to 2000. A downward trend has been detected from year 2000 to 2005 and a significant upward trend from the year 2005 to 2015. Galle district also followed similar pattern. Except for Mannar district, all other districts were displayed upward trends during the period of 1981 to 2015. Except for Mannar district, all the other districts displayed significant turning points during the period of 1981 to 2015. In the case of major commercial groups, large pelagic group in the Puttalam district showed an increasing trend from year 2005 to 2014. In Chillaw district, large pelagic and Dermal groups showed significant increasing trends from year 2005 to 2013 and Shrimps showed an increasing trend from year 2003 to 2009. Small pelagic and the Dermal groups showed increasing trends in year 2003 to 2009 and 2003 to 2011 in Negombo district. In the Manar district increasing trends in production of large pelagic and shrimps were observed from year 2003 to 2008. When consider the Galle district, the large pelagic group showed a downward trend from year 2003 to 2008 and a significant upward trend from year 2008 to 2014. Small pelagic group showed a significant upward trend from year 2003 to 2015. There were no trends observed for the major commercial groups in the Kaluthara and Colombo districts.

Keywords: Fish production; illegal fishing; mannar basin; trends

Present status of aquaculture development in northern province, Sri Lanka

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Northern Province of Sri Lanka comprised of districts of Jaffna, Kilinochchi, Mannar, Mulithivu, and Vavuniya which are blessed with natural water resources and fishery resources. Eighty percentage of population of the Northern Province depend on fish as their main animal protein. In 2014 capture marine fisheries production was 76288 MT and aquaculture inland fish production was 3583MT in the Province. Aquaculture did not contribute significantly to total fish production. But there is a recent growth in aquaculture industry due to improved environment in the Province. There are 130 major and minor inland water reservoirs.

Available information at National Aquaculture Development Authority (NAQDA) Kilinochchi, visit to farms, discussion with farmers & key stake holders provided the basis for the study. Main objective is to evaluate the present situation of aquaculture industry in Northern Province. There are 59,890 individuals involved in fishing activities and 788 people involved in aquaculture activities. The aquaculture production in this Province can be categorized into three major categories; inland aquaculture, Coastal line aquaculture and brackish water culture. Sea cucumber (*Holothuria scabra*) and seaweed (*Kappaphycus alvarezii*) species are cultured along the coastal line culture. Sea cucumber is cultured in pens while seaweed is cultured using bamboo raft and mono line method. Tilapia (*Oreochromis niloticus*) is the dominated species for inland pond culture systems in this Province. Indian carps, freshwater prawn (*Macrobrachium rosenbergii*) were harvested in culture based fisheries from the natural freshwater bodies. Ornamental fish breeding sector is developed at satisfactory level in the Province. Brackish water culture is at its initial stages. Sea bass (*Lates calcarifer*) is one of the major species cultured in ponds while milkfish (*Chanos chanos*) is at initial stages.

A SWOT analysis had been used to analyze the strengths, weaknesses, opportunities, and threats of the aquaculture practices in Northern Province. Additional income, willingness of non-government organizations (NGO's) and aquaculture farmers to work together have identified as potential strengths while direct marketing opportunities in local and export oriented markets, abundance of fresh water and brackish water resource, technical support from NAQDA, financial support from NGO's and Northern Provincial Council are the potential opportunities for the aquaculture development. Lack of knowledge in fingerling production, poor commitments of beneficiaries for construction and spat collection; dependency mentality of community, lack of insurance, low income in some seasons and occupational health hazards have been identified as weaknesses. Predation, unfavorable weather condition, disease, and theft are identified threats which adversely affect this sector.

Keywords: Aquaculture activity; Northern Province; SWOT analysis

Situational analysis of commercial fish production in Eastern Province of Sri Lanka

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Fishing is the second largest livelihood option in the eastern province of Sri Lanka. The eastern province coastline extends up to 507 km and the province covers 32% of the coastline of the country. Moreover, around 3900 ha of brackish water bodies in the region contribute for fishery. Forty percent of the county's fishing villages and 36.2% of the fish landing sites are located in the eastern province and contribute 16% to the total fish production. Coral reef and sand mining, industrial pollution, illegal fishing methods and gears, exploration of offshore oil and gas together with natural disasters are the factors identified to affect fishing industry of the province. The fisheries sector in the province has suffered substantially from the civil unrest and tsunami.

This study was conducted with published secondary data collected from Ministry of Fisheries and Aquatic Resources, and from the National Aquatic Resources Research and Development Agency for a period of 34 years. The main objective was to determine major trends in annual fish production in eastern province of Sri Lanka over the period 1981-2014. According to the study, annual marine fish production of three districts was drastically changed in 2005. However, during 2006 to 2010 Trincomalee and Batticaloa districts showed a positive sign and increasing trend in fish production. But in the Kalmunai district increasing trend was observed up to 2008 after that decreasing trend up to 2010 was evident. There is an increasing trend in demersal and other group fish catches in Batticaloa district during the period of 2003 to 2014. Kalmunai district exhibited three turning points in annual fish production during 2002, 2005, and 2006. Other two districts have exhibited one turning point only. For Batticaloa and Trincomalee districts turning points were observed during 2001, and 2008 respectively. Highest numbers of fishermen were recorded during 2010 in Trincomalee district. After 2010, the number remains at the same level from 2011 to 2014. Number of boats have increased after the tsunami due to financial support extended by government and non-government organizations.. In Batticaloa and Kalmunai districts boat used were mainly Non-motorized traditional boats (NTRB) during the period of 2004 to 2014. For Trincomalee district most prominent boat type was Outboard engine fiberglass boats (OFRP). Impacts of ethnic disturbances and the tsunami were identified as the main reasons for turning points observed during the study.

Keywords: Eastern province; marine fish production; trends; tsunami

Determination of the growth performance of cage reared Giant freshwater prawn (*Macrobrachium rosenbergii*) against different feeds

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The Giant freshwater prawn *Macrobrachium rosenbergii* (de Man 1879) post-larva (0.011 g) obtained from a breeding center were cultured for three months (March- June) in twelve experimental cages with the dimension of 1m (length) × 1m (width) × 1m (depth) in the freshwater ponds of Department of Aquaculture and Fisheries, Wayamba University of Sri Lanka. Four different kinds of feeds were used to feed the prawns as; cattle feed (C.F), broiler feed (B.F), fish feed (Fi.F) and formulated feed (Fo.F) and their protein contents were 16%, 21%, 39% and 45% respectively. Each of the treatments were assigned into three cages as replicates and the feed was dispensed into a separate feeding tray which was submerged very close to the bottom of the cage. The prawns were fed twice a day (morning and evening) with a ration of 10% of their biomass initially and after 8 weeks it was 6%. The growth performances (Length and Weight) of the prawn were monitored fortnightly along with the water quality parameters such as temperature, surface and bottom dissolved oxygen, pH, salinity, turbidity, plankton density ammonia and nitrate. At the end of the experiment, growth performances and the flesh protein contents of the prawns were checked in order to determine the most suitable feed out of four diets used. The results were analyzed using one way ANOVA and graphical models.

According to the results, the mean weight of the prawns fed with fish feed was significantly higher (5.5g) compared to the other prawns fed with cattle feed (5.2g), Formulated feed (4.6g) and Broiler feeds (3.4g). Following a similar trend, crude protein content (dry basis) of the prawns fed with fish feed (76.97%) was significantly greater than the crude protein contents of the prawns fed with cattle feed (75.08%), Formulated feed (73.25%) and Broiler feeds (72.54%). There were no significant differences found for the survival rate of the prawns in different treatments and the water quality parameters of the pond water over time. As per the results, it was found that the greatest growth performances (length and weight increment) and the flesh protein content of the prawns were revealed in fish feed fed treatment irrespective to the highest protein content of formulated diet.

Keywords: Cage culture; growth performances; *Macrobrachium rosenbergii*

Post-harvest losses of selected fisheries off Jaffna and Mannar

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Post-harvest fish loss is one of the economic and food security concerns. Post-harvest fish loss becomes more critical in small-scale fisheries as most of the gears are non-selective and fishers do not adhere to preservation practices. In coastal villages at Mannar and Jaffna in northern Sri Lanka have been fishing for centuries, but fish post-harvest loss has not yet been investigated in developing corrective actions. Therefore, present study quantified the post-harvest losses of marine fish and the fate of fish discards at each stage of market chain in Jaffna and Mannar regions from March to July 2016 with respect to 3 different gears (set-net, trap-net and trawl net). At five landing sites: 3 in Jaffna districts (Kurunandar, Kaakaithivu and Pannai) and 2 in Mannar districts (Pesalai and Anthoniyarpuram), total weight of discards (entire or part) and discarded fish species were recorded at each stage of market chain from hap-hazardly selected market chain actors: fishers, collectors, fish sorters, sellers and consumers. In addition to the recorded data and observations, 60% of market actors were contacted in gathering information on discards, their practices and opinions via questionnaire, group discussions and interviews. For each gear, estimated discards per unit effort (DPUE) were compared after gear standardization.

Significantly high discards (20.4 ± 17.9 kg per operation) were reported from Mannar than Jaffna (10.3 ± 8.9 kg per operation) ($P < 0.05$). Among the six landing sites, Mannar trawler fishery at Pesalai reported the highest mean discard rate (62.3%) followed by Anthoniyarpuram set-net discards (48.2%) which are respectively 35.3 ± 13.8 kg per operation and 5.5 ± 2.5 kg per operation. Of Mannar trawler discards 63.6% was edible fish but not yet reached the marketable-size (Juveniles and fingerlings) while in Jaffna total trawler discards was 21.9% of that 58% were non-marketable-size edible fish. The estimated DPUE at Mannar trawler fishery (0.2kg per unit filtered water volume per operation) was two times higher than the Jaffna trawler fishery discards. Coastal set-net operates at Jaffna reported significantly high DPUE (146.2 kg / m^3 per operation) than set-net operated at Mannar (2.3 kg/ m^3 per operation). While sorting at landing sites highest discard rate (49.6%) were reported from catches comes from shrimp trap (Pannai) fishery of Jaffna followed by Pesalai trawl fishery (35.1%). *Tetradon leopardus* found to be discarding from all fisheries at each landing sites followed by *Scatophagus argus*, *Leiognathus insidiator*. More or less similar levels of discard rates were reported at retailer level (~35%). Mannar consumer level discard rates were higher (32%) than in Jaffna (27%), as the fish head portion is not generally consumed in Mannar. Effects of trawling are more intensive as this study did not consider the by-catches of coral and sea grass. Irresponsible fishing practices, poor handling and preservation practices were observed to be responsible for high post-harvest lost at different stages of market chain hence, awareness programme could be helped to reduce postharvest lost. As such, continuation of this study for a longer period will help in prioritising the issues highlighted in this study for developing corrective actions.

Key words: Discards per unit effort; discards; trawler fishery; set net fishery; post-harvest loss

Investigation of chemical controlling method for yellow grub disease reported from guppy (*Poecilia reticulata*)

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Yellow grub disease is caused by digenean flukes belong to family Clinostomatidae. Among them *Clinostomum marginatum* and *Clinostomum complanatum* have been reported in Sri Lanka twice from wild guppies in western and southern provinces. A similar disease has been reported by some ornamental fish farmers from commercial farms but no studies were reported in Sri Lanka. There is no treatment for controlling the disease except controlling the host species such as snails and birds. Therefore, the present study was attempts to identify the effectiveness and the effective dose of Albendazole to control Yellow grub disease in wild guppy. Infected wild guppies were collected from an urban drainage canal in Seeduwa. One to six numbers of creamy yellow color metacercaria cysts were recorded from their bodies. Collected fish were transferred in to the laboratory tanks for one month acclimatization. Extracted worms were stained by using Aceto alum carmine solution to identify the internal characteristic features to conform the species. Especial feed ration was formulated with 20g of powder fish feed and 80g of fish meal. Albendazole was incorporated to 100g of prepared feed with a ratio of 5mg, 8mg and 10mg respectively. Fish were fed with three experimental doses of Albendazole and control fish were fed without Albendazole. Each treatment consisted with three replicates, which were consisted with six infected fish. During the period of experiment; behavioral changes, water quality, cyst removal and fish mortality were observed. Extracted warms were identified as *Clinostomum marginatum*. Results showed that 61.11% of cysts were removed in the 10mg Albendazole incorporated treatments. Higher fish mortality was reported from same treatment and it was 55.55%. Finally, 50% of the cyst removed fish were survived. There was no significant difference observed in the behavior of fish in treated tanks compared to control. This study concluded that Albendazole have a potential effect on controlling yellow grub disease in guppy fish. The results indicate the possibility of recovery 30% of the infected fish using 10mg Albendazole incorporated in 100g of feed. It may help for the ornamental fish farmers to have partial recovery of their investment. With the support of the reported information of the current study, further studies have to be carried out to identify the effective dose of Albendazole for guppy and other fishes with a lower level of mortality.

Keywords: Metacercaria; *Clinostomum* spp; Yellow grubs

Development of fresh fish incorporated nutritious bun

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Fish provides a good source of high quality protein together with many vitamins and minerals, whereas some fish contain high fat content. As a result of high fat content, absorption of fat soluble vitamins (A, D, E, and K) and essential fatty acids becomes high, all of which are vital for the healthy functioning of the body. Traditionally fish buns are produced mixing fish with a vegetable mixture hence hardly a consumer could enjoy the real quality fish flavor. As such, this study investigated to develop a bun by incorporating fresh fish during dough preparation. Buns were made of wheat flour by incorporating fresh fish flesh of both fresh water fish tilapia (*Oreochromis niloticus*) and marine fish tuna (*Thunnus albacares*). The flesh was incorporated in two forms; ground and chopped forms. Each of these combinations was further developed into two more options "with" and "without" spices. Each of these product options were ranked using a sensory evaluation conducted by 30 non-trained panelists by using simple ranking test. Physico-chemical and proximate characteristics of selected buns were analyzed and compared with control buns which made only with wheat flour. The chopped fish flesh bun with spices gained highest acceptability ranking hence subjected to further analysis. Physico-chemical and proximate characteristics of the selected buns were significantly ($p < 0.05$) different than the control. Microbial analysis revealed that the aerobic plate counts of tuna bun and tilapia bun were 4.1×10^2 -cfu/g and 4.0×10^1 -cfu/g, respectively. Proximate composition of tuna flesh incorporated bun was 52.9% of moisture, 8.2% of fat, 21.5% of protein, 3.1% of ash, 0.84% of crude fiber and 64.2% of carbohydrate. The same for tilapia flesh incorporated bun was 54.19%, 6.2%, 17.3%, 2.7%, 0.86% and 71.7% respectively. Tuna and tilapia buns give 417 kcal/100g and 412 kcal/100g, respectively. Both tuna and tilapia buns showed a difference for saturated fatty acid content and unsaturated fatty acids such as omega-3 and omega-6. Moreover, the ratio between omega-6 and omega-3 was also under the safe level for human consumption. In conclusion, the fresh fish flesh incorporated bun improves the nutritional quality by increasing the protein and unsaturated fatty acid content while reducing the total fat. Therefore, we can recommend to make available protein rich, cheap, value added food products through the incorporation of fresh fish in bakery products in order to raise the fish preference and consumption among different communities.

Keywords: Bun; nutritious; spices; tilapia; tuna

An assessment of physio-chemical and microbial quality of water, ice and effluent water in Meegomuwa fish market

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Access to quality fish partly depends on how fish is handled in fish markets prior to purchase by consumers. Meegomuwa is an important fish supply area in the western province of Sri Lanka. It has two fish markets, and "Podi Lellama" was recently build adjoining the sea with a treatment plant, piped water and in-house ice facilities with the aim of improving post-harvest quality of fish as well as maintaining the quality of surrounding environment. However, regular assessment of water, ice and effluent water that is released from the waste treatment plant directly into sea has not been conducted. As such this study was conducted to investigate the physio-chemical and microbial quality of water, ice and effluent water in new fish market.

Effluent water samples were collected during the period of March to June 2016 from purposely selected locations of the market (six points in sub effluent canals, inlet of treatment plant, outlet of treatment plant, sea- effluent canal juncture). Physio chemical parameters such as pH, conductivity, dissolved oxygen, temperature, salinity, nitrites, nitrates, phosphates, BOD₃ were measured on six occasions. Additionally, potable water available from tap borne water temporarily stored in cement tanks were also collected at six occasions and above mentioned water quality parameters were measured. Three samples each of effluent water, potable water and ice were tested for total coliform and faecal coliform using most probable number technique (MPN). The results indicated that there was no significance difference in nitrite, nitrate and phosphate levels in any of the locations of effluent system in three areas. Ice and both types of water contained faecal coliforms (Table).

Table: MPN values of total coliforms and faecal coliforms in water and ice

Samples	Total coliforms MPN/100 ml	Faecal coliforms MPN/100 ml
Effluent water	≥ 24000 to ≥ 240000	≥ 24000 to ≥ 200000
Tank water	≥ 21330	≥ 17170
Ice	≥ 11125	≥ 9860

According to the Sri Lankan standards for potable water SLS 614 of 1983 water and ice were both not suitable for the processing of fish in terms of total and faecal coliform counts. It can also be concluded that treatment plant is not effective in treating effluent water.

Keywords: Coliforms; nitrates; nitrites; phosphates; physio-chemical parameters

Seaweed bun: an alternative to underutilized seaweeds.

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Seaweed draws an extraordinary wealth of minerals from the sea that can account for up to 36% of its dry mass⁽¹⁾. But in Sri Lanka seaweed consumption is low due to its characteristic strong aroma which was not preferred by many. Therefore, if seaweed products can be developed without strong aroma, the underutilised seaweed resource in the country could be used for a healthy food industry. Therefore this study aims to develop a seaweed incorporated bakery product, a mini-bun, for Sri Lankan consumer and also to analyse the major nutritional and calorific value of the mini-bun with the objective of displaying on bun-pack label to guide consumers. Seaweed (*Kappaphycus alvarezii*), which is the only commercially cultured species in Sri Lanka by now, was used in wet form and dry forms for bun production. Wet seaweed were chopped (<5mm size) and tested in two combinations 20% and 40% with wheat flour for bun preparation while dried seaweed in powder form (250µm size) was used 4% and 8% combinations. With each of the combinations garlic added and pepper-added options were developed. Control bun was developed without adding seaweed. Further fish and seaweed (20% from each) incorporated bun was also developed. Two bun sizes; small (10g and 5cm diameter) and large (33g and 10cm) were developed for identifying a standard based on consumer preference. The physical properties, sensory characteristics and overall quality of buns were ranked by 30 non trained panellists using nine point hedonic scale ranking test. Proximate composition, pH, microbial counts and associated cost for each bun type were determined. Physical characteristics of the bun made out of chopped seaweed were selected better than the buns made out of powdered seaweeds. Due to soft crust, texture, colour and overall acceptability, the larger bun had higher ranking. The chopped seaweed bun added with garlic powder had significantly higher taste and overall preference (P<0.05). Moreover, high nutritional value with respect to high calcium, fiber, vitamin C and low fat and Na/K ratio below 2.0 were found in chopped seaweed-garlic bun and water activity, pH, total titratable acidity and aerobic plate counts were within the accepted ranges of food products. The 40% chopped seaweed-garlic bun provides 412kcal/100g energy and can be produced for a cost of 17 LKR. Further investigation on bun shelf-life, glycemic index and suitable packing materials are important for commercialization of this product.

Rajasulochana, P., Krishnamoorthy, P. & Dhamotharan, R. (2012). Research Article Biochemical investigation on red algae family of *Kappahycus Sp.*, 4(10), pp.4637–4641.

Keywords: *Kappaphycus alvarezii*: Physico-chemical properties; Sensory evaluation

Diversity, distribution and abundance of plankton off southern coast of Sri Lanka

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Plankton plays a vital role in oceanic food webs. Nevertheless, spatial and temporal dynamic of plankton are mainly governed by oceanographic physicochemical factors. In many parts of the world plankton dynamics are used in managing related industries. Southern coast of Sri Lanka is well known for such industries like fishing, whale watching and sport fishing. Yet the dynamics of plankton in the area is still unknown. Thus, the present study tried to set the baseline information on diversity, distribution and abundance of plankton off southern Sri Lanka with respect to some oceanographic parameters. Plankton samples were collected in November 2015 by a systematic plankton survey using research vessel Samudrika. Six line sampling sites, from Dondra coastline towards offshore, encompassing the region 81° 38'E, 82° 02'E and 7° 56'N, 8° 00'N, were sampled taking 3 replicates, which are 5 km apart, at each sampling site. Samples were preserved onboard. Conductivity, temperature, salinity, nitrate and phosphate were recorded. Plankton were identified and counted under compound microscope to estimate total cell abundance, evenness, species richness, Shannon-Wiener and Simpson's diversity indices. Association and degree of similarity of planktonic groups were determined by Detrended correspondence analysis using plankton percentage composition of groups and hierarchical cluster analysis using present-absent data of plankton groups. Pearson correlation was used in determining the relationship between planktons and oceanographic parameters. Total of 217 taxa were identified: 57% phytoplankton and 43% zooplankton. Diatoms were the dominant (69%) phytoplankton while copepods (50%) dominated in zooplankton. Highest abundances were recorded in diatoms and nauplii. A negative correlation was evident in plankton abundance with respect to salinity and distance from coastline for phytoplankton ($P < 0.05$) and zooplankton ($P > 0.05$). The abundance of phytoplankton and zooplankton showed a positive correlation ($P < 0.05$). Diatoms, dinoflagellates, copepods, chaetognaths, crustacean larvae, fish eggs, polychaetes, and cladocerans were low in abundance in offshore areas while other groups did not show any distinct pattern. Clear clustering patterns of some plankton groups were revealed ($P < 0.05$). Even the plankton abundance did not show any significant relationship with Nitrate and Phosphate. Plankton species richness reduced from coastline towards offshore areas. Phytoplankton diversity indices increased from coastline towards offshore areas due to high abundance of *Chaetoceros* sp. For zooplankton, highest diversity indices were recorded from coastal areas. Plankton abundance and species richness were higher in coastal areas than offshore probably be due to lower salinity and food availability. Some of the plankton group associations revealed in this study could be used for developing future predictions of associated species yet continuous long term study is needed in establishing baseline data in understanding the special-temporal dynamics of plankton abundance.

Keywords: Feed availability; phytoplankton; salinity; zooplankton

Management of culture-based fisheries in seasonal reservoirs: issues, weakness and potential improvements

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Culture-based fisheries (CBFs) are form of extensive aquaculture and fisheries enhancement strategy. It has been introduced to seasonal reservoirs in Sri Lanka in early 1980s. However, farmer communities in seasonal reservoirs have not properly adapted to it. The current study was to investigate the factors affecting to the sustainability and the management of CBFs in seasonal reservoirs in North-Western Province. Information on, socio-economic factors, management strategies, weakness and issues of existing management, factors affecting to the sustainability of CBFs, fish production, benefits sharing among community members were collected through an interviewer administered questionnaire survey. Survey was conducted in 15 villages and 204 people were interviewed including members of farmer organization and fisheries management committees. Six main issues were identified in existing co-management system. Among the answers of all interviewees, 50% raised marketing issues, 47% raised lack of fingerlings, 47% raised poor fisheries extension, 40% raise weakness in law enforcement, 38% raised lack of fishing gear and 30% raised fish mortality. Frequency of answers in each reservoirs were grouped in to five arbitrary levels; 0-20%, 20-40%, 40-60%, 60-80% and 80-100%. Marks were assigned to each reservoirs based on a scale 1 to 5. Category of least frequency issue (0-20%) was given 5 marks and highest frequency issue (80-100%) was given 1 mark. Total marks obtained by the reservoirs were plotted against the total income from aquaculture and a significant leaner relationship was obtained ($P < 0.05$, $r = 0.9214$). High income reservoirs reported less frequency of issues while others have high frequency of issues. Relative satisfaction of the existing management was comparatively higher in high income reservoirs. Present study shows the need of effective aquaculture extension for the sustainability of CBFs in seasonal reservoirs. Results show the potential involvement of Department of Agrarian Services and Provincial fisheries Ministry in CBFs management in seasonal reservoirs. There is no difference in satisfaction of the benefit sharing among community members in two groups of reservoirs. It is important to empower the farmer organizations to solve their issues in conflicting situations. Fingerling availability and improved market chain for the fish harvest need to have prior attention for the sustainability of CBFs in seasonal reservoirs. Providing fishing gear on sharing basis may solve the issues of harvesting. Most of the issues identified by the farmers can be answered through effective mechanism of fisheries extension.

Keywords: Co-management, culture-based fisheries, fisheries extension

Investigating the environmental assessments carried out in relation to developments in River Kelani and assessing the impacts of barriers to natural water flow and fish fauna

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Freshwater ecosystems are among the most altered ecosystems due to anthropogenic and natural disturbances¹. Amongst them, river ecosystems have very much been altered in Sri Lanka, mainly due to production of hydro power. In recent years, mini hydro power projects have boomed in all rivers, especially in River Kelani. Eventhough environmental assessments are conducted cumulative impacts to natural water flow and the movement of fish have been adequately addressed. Current study attempted to document all the barriers in River Kelani and identifying the impacts of natural and artificial barriers to fish movements.

All the manmade and natural barriers in River Kelani were documented using “Google Earth®” software. Fish species that show migration over the barriers in River Kelani was identified using an interviewer based questionnaire (n= 30). Environmental assessment reports of mini hydropower projects were screened (n= 32) to get the details of projects such as location of weir, penstocks and fish passage. A weir and a natural barrier (a steep rocky part of river) was selected from Seethawaka Oya to determine the fish diversity and relative abundance across the barriers. Spot and bank counts were used in collecting data. Basic water quality parameters were measured.

The study resulted in compiling all barriers which indicated that water movement is currently disturbed from river mouth upto 1st order streams and most of the disturbance was in middle course of river. Respondents indicated that *Tor khudree* and *Puntius bimaculatus* shows upward migration with rain. No significant changes in temperature, dissolved oxygen and pH were observed across the barriers. However, upstream turbidity was higher when compared with downstream at the weir due to accumulation of debris near the barrier. Also, when compared with upper segment of natural barrier, turbidity was higher in upstream of the weir. There was no significant difference in diversity indices between artificial and natural barrier. None of the IEE have recognised fish movement. Also no fish passes have been recommended. Study recommends continuation of research work.

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Keywords: Fish migration, mini hydropower projects, water quality

Variation of physio-chemical characteristics of virgin coconut oil during the storage

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The chemical characteristics of virgin coconut oil (VCO) are deviated from the standards and sedimentation is observed as part of physical deviations during storage. In this research, free fatty acid (FFA) and peroxide value (PV) variation with different storage temperatures (12°C, 27°C and 40°C) and effect of buffer system (0%, 1% and 2% buffer having lauric acid/lauric salt) to control the chemical or physical deviations were observed. Further, this study examined the causes for sedimentation of VCO over the storage.

The results of this study revealed that FFA value and PV of VCO varies over storage period, storage temperature and with added buffer system ($P < 0.05$). FFA value of VCO significantly increased ($P < 0.05$) with increased storage temperature and with added percentage of buffer. Both FFA value and PV showed an increasing trend over time. Peroxide value of VCO showed significantly higher values at 27°C and 40°C storage temperatures compared to lower storage temperature conditions (12°C). Significantly higher ($P < 0.05$) peroxide value is shown VCO samples added with 2% buffer system compared to control (0%) and 1% buffer system. In identification of the causes of sedimentation of VCO over the time, experiments were conducted to ensure the microbial contribution towards sedimentation. In the microbial analysis of sediment part and supernatant oil, no any fungal colonies were detected. In detecting the effect of temperature towards sedimentation, refrigerated samples developed sedimentation one day after the refrigeration indicating that it is due to a soluble compound within the oil. In detecting the effect of acid towards sedimentation, 20 mL oil samples ($n = 10$) were added with glacial acetic acid (0 to 9 drops) and amount of sedimentation is increased with added glacial acetic acid indicating the effect of pH towards the sedimentation. Samples of VCO filtered with a 0.45 μm filter followed by refrigeration for one day did not show any sedimentation.

In conclusion, sedimentation of VCO is not due to any microbial (fungal) colonization, yet it could be due to colloidal effect of soluble proteins of VCO. Winterization and filtration with micron filter prior to packaging can be utilized to avoid sedimentation effect of VCO over the storage. Since buffers contribute for FFA value and PV, it cannot be utilized to control them during the storage.

Keywords: Buffers, free fatty acid, peroxide value, sedimentation, virgin coconut oil

Improvement of traditional wet method to produce good quality virgin coconut oil

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Virgin coconut oil (VCO) is a product obtained from fresh coconut kernel without allowing the kernel to undergo chemical or microbiological changes under control conditions. The demand for VCO has increased since last 3-4 years. Sri Lanka exported 14,000 MT of VCO in 2015. The process of VCO production needs improvements to meet the demand of individual buyers in the global market. Traditional Wet Method (TWM) is a popular method of producing coconut oil in small scale. Countries like Thailand, Indonesia and Philippines produce VCO using Modified Kitchen Method (MKM) which is very similar to TWM. However, the yield of VCO obtained from MKM is very low compared to currently available dry processing method. Therefore, this study was conducted to improve the process parameters of TWM and thereby increase the yield of VCO.

Matured fresh coconuts were de-husked and split manually. Coconut kernel was scraped. Coconut milk was extracted by mixing scraped coconut with water (1:1, 1:2, 1:0) at two different temperatures (30°C and 60°C). Coconut cream was separated from coconut milk including control treatment with two different coconut cream separation treatments. Separated coconut cream was heated at two different temperatures (60°C and 80°C) for 10 minutes and control temperature at 60°C until completion of oil separation. Extracted VCO was filtered and dried in order to remove moisture and residues. The oil yield, oil recovery percentage, physico-chemical characteristics; moisture percentage, free fatty acid, color, relative density, refractive index, and peroxide value of produced VCO samples were evaluated in order to select the best treatments.

The best mixing ratio was (1 scraped coconut: 2 water) at 60°C. Coconut cream separation was facilitated when coconut milk was allowed to settle for 3h and with subsequent refrigeration for overnight. Oil separation was maximized on heating of coconut cream at 80°C for 10 minutes and control temperature at 60°C. The improved TWM was yielded 26.8-27.8 kg of VCO per 100kg of coconut kernel and oil yield incensement was 40.89% - 46.47% compare with MKM. The VCO obtained from improved TWM was conformed to the Sri Lankan standard of VCO with moisture 0.09 %, free fatty acid 0.032%, color 0.7, relative density 0.921, refractive index 1.4494 and peroxide value 0.99 meq/kg. There were no significant difference ($p > 0.05$) in oil yield and physico-chemical parameters between VCO samples obtained from improved TWM and currently available dry method.

Keywords: Dry method; Quality of VCO; Oil yield; Virgin coconut oil; Wet method

Effects of preform weight changes on performance of high carbonated soft drink bottles

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KIK cola™ is one of the fizzy soft drinks recently launched to the Sri Lankan market by Ceylon Cold Store PLC with an intense level of carbonation (4.6 ± 0.1 volumes). The product was made available in two bottle sizes; 300 mL and 1000 mL, made from polyethylene terephthalate (PET). Currently higher weight (44 g) preforms are being used to produce above PET bottles. Thus, the company has to bear higher cost while causing a larger impact on the environment. These impacts could be minimized by reducing the weight of preforms used in the production process. Thus, the research was carried out to investigate the suitability of low weight (35 g) preforms as an alternative to high weights (44 g) during the production of KIK Cola™ packaging while identifying the differences between low and high weight unfilled bottles. The height, weight, selected bottle diameters (upper bumper, upper panel, mid panel, lower panel, lower bumper, and upper grip), base clearance, brimful capacity, bottle thickness (shoulder, panel, and bottom) of unfilled bottles were measured. In order to analyze the final products, 400 filled bottles which consisted of 200 filled bottles from each weight category were selected and stored at two different temperatures; 26 ± 2 °C and 37 ± 2 °C, which represented the room and market temperature conditions respectively. Overall height, carbonation level, brix value, titratable acidity, base clearance and all the relevant diameters were measured twice a month for a period of ten weeks. Sensory evaluation (color, flavor, fizziness and overall acceptability) of filled bottles was conducted using twenty semi trained panelists based on five point hedonic scale at 2nd, 6th and 10th weeks. It was observed that, there was a significant difference in material distribution of two different types of unfilled bottles. After the 6th week, there was a significant difference ($p < 0.05$) in carbonation loss between low weight and high weight bottles at 37 ± 2 °C while no significant difference ($p > 0.05$) was observed at 26 ± 2 °C in both bottle types during the ten weeks period. The results revealed that low weight (35 g) preforms could be used at market conditions (37 ± 2 °C), for maximum of six weeks. Low weight preforms could be replaced with high weight preforms at room (26 ± 2 °C) storage, for minimum of ten weeks.

This study was funded by Ceylon Cold Stores PLC, Sri Lanka

Keywords: Carbonation level; Organoleptic properties; PET (Polyethylene terephthalate) bottles; Preforms

Development of dietary fiber rich multi legumes flake mix

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Consumption of dietary fiber rich food has shown many health benefits against a range of disorders including obesity, type 2 diabetes mellitus and colon cancer. Dietary fiber is composed of two; soluble dietary fiber(SDF) and insoluble dietary fiber (IDF). Legumes are rich source of total dietary fiber (TDF)and resistant starch(RS).In addition to that legume starch has low digestibility. This study was carried out to develop dietary fiber rich multi flake mix with low glycemic index from selected locally available legume varieties. Accordingly,11 legume varieties such as green gram (MI 5, MI 6), Cowpea (Waruni, MICP1,Bombay,Dhawala ANKCP1), soybean (PB1, MISB1) and horse gram (ANK black, ANK brown) were analyzed for their chemical composition prior to prepare multi legumes flake mix. Among all legume seeds, TDF content was ranged between21.41% to 13.10%. A variety with higher TDF from each legume type wereANK black 21.41(SD1.32) %, MISB 1 18.75(SD0.00) %, ANKCP 1 16.07(SD0.67) %, MI 515.33(SD0.77) %. Results for RS content demonstrated significantly higher amount in ANK black 10.54(SD 0.68) % followed by ANKCP 1 9.61(SD0.27) %,MI 5 5.95(SD 0.44) % and MISB 1 0.09(SD 0.01) %. A variety with lower predicted glycemic index (pGI) value from each legume type wereANK black39.77(SD 0.64) %, ANKCP 1 41.35(SD0.65) %, MI 5 41.53(SD 0.35) % and MISB 1 41.38 (SD 0.41) %.The RS content of legumes had an inverse correlation with pGI (-0.698; P<0.05).Moisture, crude protein, crude fat, total ash contents had range values of 11.99 – 6.81%, 37.18 – 20.67%, 22.02 – 1.25%, 6.34 – 3.43% and respectively. After considering above data, legumes were selected and multi flake mix was prepared in 3 different formulae (F1, F2, and F3) by using sorghum (50%) as the base. Different legume proportions of soybean:horse gram: cowpea and mung bean in those formulae were F1 - 5%, 20%, 15%, 10%, F2 – 10%, 5%, 15%, 20% and F3 – 5%, 15%, 20%, 10% respectively. Sensory evaluation was carried out with 3flavors; coconut milk + spices, coconut milk + sugar, milk powder + sugar for F1 formula. The taste and overall acceptability of three flavorswere significantly differentat (p<0.05) and the spicy flavor had the highest meanscore. Subsequently the three formulae were prepared in spicy flavor and those were analyzed for chemical composition and pGI value. Among the 3 formulae,F1 had the highest TDF 13.84(SD 0.08) %, highest RS 4.07(SD 4.07) % and the lowest pGI 33.52(SD 0.11) %.Therefore, F1 formulation can be considered as the best formula for the preparation of dietary fiber rich multi legumes flake mix.

Keywords: Legumes; multi legumes flake mix; predicted glycemic index; resistant starch; total dietary fiber

Development of finger millet based probiotic beverage using *Lactobacillus casei*431[®]

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Probiotic beverage as functional food promotes health by reducing risk of chronic diseases. Traditionally probiotic foods are made with dairy products. High cholesterol content in dairy products and increased popularity of vegetarianism lead to develop demand for nondairy probiotic products. Cereals confer nutrient and health benefits as rich sources of dietary fibers, resistant starches and oligosaccharides that can be acted as substrates for probiotics. Finger millet comprised with high nutritional value especially with its great mineral content (Ca, K, Fe, P and Mg). Dietary fibers and phenolic compounds with minerals contribute to health benefits such as antidiabetic, antiulcerative, increment of hemoglobin status in children⁽¹⁾. *Lactobacillus casei*431[®] is a probiotic microorganism which is internationally introduced into fruits and vegetable beverages due to its great activity and survivability. The main aim of this study was to develop a finger millet based probiotic beverage as a novel product acquiring significant health benefits from both finger millet and the probiotic. Finger millet (*Eleusine coracana*) was roasted, ground, and boiled (at 78°C for 10 minutes). Subsequently *L. casei*431[®] was inoculated as the probiotic and incubated at 37°C for 2 h, 4 h, and 6 h. The beverage was formulated with the addition of sucrose, fresh cow milk, and cocoa powder and refrigerated at (5 ± 1 °C). Sensory evaluation was carried out using ranking test with 30 non trained panelists to select best fermented time for overall acceptability. Highest acceptability was achieved by the sample fermented for 4 h. The viability of *L. casei*431[®], and physicochemical characteristics (pH, titratable acidity, brix, reducing/non-reducing sugars) were determined weekly during refrigerated storage (5 ± 1 °C) for a period of six weeks. The standard to be considered as a functional food, viable probiotic count should be greater than 10⁸ CFU/mL, and it was enumerated in the beverage on completion of 4 h fermentation and at the end of the shelf life. pH was decreased from 7.10 (SD 0.01) to 5.05 (SD 0.00) and titratable acidity was increased significantly (p < 0.05) during storage due to the lactic acid production by probiotic. Reducing and non-reducing sugars were decreased significantly (p < 0.05) because of usage by probiotics while amount of dietary fibers were not shown any significant difference (p < 0.05) during shelf life. The proximate composition of the product was 89.53% (SD 0.11) moisture, 8.27% (SD 0.14) carbohydrate, 1.80% (SD 0.07) protein, 0.08% (SD 0.03) crude fat and 0.55% (SD 0.12) ash. This study concludes that finger millet based probiotic beverage can be developed with *L. casei*431[®] and it could be serve as a ready to drink functional beverage by keeping under refrigerated (5 ± 1 °C) storage up to 5 weeks. Shukla, A., Lalith A., Sharma.V., Vats. S. and Alam. A. (2015). PEARL AND FINGER MILLETS : THE HOPE OF FOOD SECURITY. *Applied Research journal*, 1(2), pp.59–66.

Keywords: Finger millet; functional foods; phenolics; probiotics; prebiotics

Red color development of brown colored Yellowfin tuna (*Thunnusalbacares*) and Bigeye tuna (*Thunnusobesus*) loins

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Bright red color of tuna meat is an important factor used in the evaluation of meat quality, and strongly influences the consumer's purchasing decision (1). However, desirably red tuna meat undergoes discolorations and develops an undesirable brown color, which results from oxidation of ferrous myoglobin derivatives (deoxymyoglobin, deoMb and oxymyoglobin, oxyMb) to ferric met-myoglobin (metMb) due to storage over a period of time and continued exposure to oxygen (2).

The present study was undertaken to assess the effect of curing salts (NaNO₂ and NaCl) and antioxidants (sodium ascorbate and sodium erythorbate) on red color development of brown colored (Grade #3 tuna) Yellowfin tuna (*Thunnusalbacares*) and Bigeye tuna (*Thunnusobesus*) loins in the chilled (0°C to 4°C) storage conditions. Loin samples (approximately 1.50 kg) were injected with 10 000 ppm NaNO₂ and immediately dipped in curing solutions which composed of 300 ppm NaNO₂, 0.2% sodium ascorbate or 0.2% sodium erythorbate, 1% regular or analytical grade NaCl, and chilled distilled water. Dipped samples were taken out according to dipping periods (2, 3.5 and 5 hours) and kept for 5 minutes in chilled condition to drain excess water and loins were vacuum packed. Vacuum packed loins were stored at 0-4°C for 5 days and, center and surface area of loins were analyzed for redness (r%), residual nitrite and nitrate, pH, total volatile base nitrogen (TVB-N), microbiological and sensory attributes in every 5 days for two weeks. Statistical results showed that there were no significant changes ($P > 0.05$) of redness (r%) with tested fish species, salt types and antioxidants during the study period. The redness of center and surface area of treated tuna loins was significantly increased ($P < 0.05$) with increased dipping period (2, 3.5 and 5 hours). Redness of center and surface area were highest in 5 hour dipped samples and were increased, from 69.97 (SD 5.19) to 76.67 (SD 2.47) and 71.61 (SD 4.61) to 77.37 (SD 2.32) respectively within 15 days. Total plate counts lied below 3.05 log cfu/g during storage time which was below the maximum acceptable levels (5.7 log cfu/g). Observed pH values between the center and surface area of flesh during the chilled storage were not significantly different ($P > 0.05$). In conclusion, 5 hour dipping period along with curing solution and chilled storage developed a desired red color (Grade #2⁺ tuna) for tuna loins. Residual nitrite content in center area of tuna was not significantly changes ($P > 0.05$) with species, salt types, antioxidants and dipping time during the study period. The residual nitrite content of surface area was significantly decreased ($P < 0.05$) during the dipping, yet species and salt type did not significantly affect ($P > 0.05$) the residual nitrite content during 15 days of storage.

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Keywords:Ascorbate and erythorbate, chilled storage, nitrite curing, nitrosylmyoglobin, tuna

Effect of repeatedly used coconut oil on physiochemical and sensory properties of deep fried foods

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The physical, chemical and sensory properties of foods are changed when deep fried in repeatedly used oil. Frying involves heat and mass transfer in between food and oil. Coconut oil is one of the major cooking oil used in deep frying and it contains high amount of saturated fatty acids. Deep frying is carried out at very high temperatures (162°C-196°C) in the presence of air and water, and under this condition, chemical process, such as oxidation, polymerization, and hydrolysis, occur resulting change in physical and chemical properties of both frying oil and food. The study was focused on evaluating changes in physiochemical and sensory properties of deep fried foods occur due to used coconut oil repeatedly. In addition, the number of frying cycles that coconut oil can be used, was determined. Potato chips, lentils (Masoor), and fish (*Sardinella gibbosa*) were used as food samples. Deep frying in coconut oil was continued for six frying cycles for each food product. Fried foods were analyzed for moisture content, free fatty acid(FFA) value, peroxide value, pH, and absorbed oil amount. The acceptability of colour, smell, taste, and texture of fried foods was evaluated by using an affective test.

In deep frying, potato chips had lost about 50% of moisture, whereas the average moisture loss of lentils and fish were 28% and 29%, respectively. Lentils and fish had comparatively high amount of FFA after 3rd frying cycle(1.04% and 2.22% as lauric acid respectively at 6th frying cycle). The peroxide value of potato chips was 6 times higher at 6th frying cycle compared to fresh potato chips, whereas peroxide values of lentils and fish increased and again decreased slowly. The average increment of fat level in fried potato chips, lentils, and fish were 20%, 19%, and 60%, respectively, with compared to fresh foods. However, the changes in pH of each food were insignificant ($p \leq 0.05$) throughout the frying cycles. Sensory analysis revealed there was no effect of repeatedly used oil on colour, smell, taste, and texture of both potato and lentils. Repeatedly used oil had no impact on colour and texture of fried fish. Nevertheless, after 3rd frying cycle, the taste and smell of fish had an effect in using of oil repeatedly. In conclusion, repeatedly used coconut oil has influence on food's physiochemical properties and sensory attributes, depending on the type of food and number of frying cycle.

Key words: Coconut oil; free fatty acid value; peroxide value; repeatedly used oil

Extraction and characterization of gelatin from the skin of scavenger fish (*Pterygoplichthys*)

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The scavenger fish (*Pterygoplichthys*) is an invasive species identified in the inland reservoirs of many regions of Sri Lanka. It is considered as a threatening species with significant negative impacts on commercial fisheries due to its higher population and unutilized nature. Excluding head of the scavenger fish, muscle and skin including scales are accounting 24% and 30% respectively. There is an increasing demand of fish gelatin due to Bovine Spongiform Encephalopathy disease and cultural concern as restrictions to mammalian gelatin. The study was aimed to extract gelatin using the skin of the scavenger fish and characterization for its physiochemical, rheological and functional properties. The fresh skin were initially treated with 0.23% (w/v) sodium hydroxide at solid/solvent ratio of 1:10 (b/v) followed by 0.2% (w/v) sulphuric acid at solid/solvent ratio of 1: 6 (b/v) and then 1% (w/v) citric acid at solid/solvent ratio of 1:3 (b/v). Each treatment was carried out for 2h followed by washing with excess water. Treated skin were heated (1:5 b/v) in 54°C water bath followed by filtration and drying to obtain gelatin powder. The average yield of the gelatin powder was 4.22% (SD 0.39). Extracted gelatin included 83.16% (SD 2.08) of protein, 2.97% (SD 2.04) of fat, and 6.52% (SD 2.66) of ash. The concentrations of heavy metals such as Cd, As, and Pb were below the standard levels. The pH of the gelatin was 5.45 (SD 0.01) and the isoelectric point was between 7.0 to 9.0, therefore it can be considered as type A gelatin. The viscosity was 1070cP at 20°C. The gel strength of scavenger fish skin gelatin and bovine gelatin were similar ($p > 0.05$). Gelling temperature and melting temperature were 12.5°C (SD 0.3) and 25.8°C (SD 0.2) respectively while the melting point was 26.0°C (SD 0.6). As the functional properties, water holding capacity, emulsifying capacity, foaming ability and foaming stability of scavenger fish skin gelatin and bovine gelatin were similar ($p > 0.05$), while the fat binding capacity and emulsifying stability of scavenger fish skin gelatin were lower compared to bovine gelatin ($p < 0.05$). The SEM structure of gelatin showed as it had compactly packed, denser strand with small voids (Figure 1). It can be concluded that the scavenger fish skin is a prospective source to produce gelatin with desirable rheological and functional properties which may be useful in various food and pharmaceutical applications.

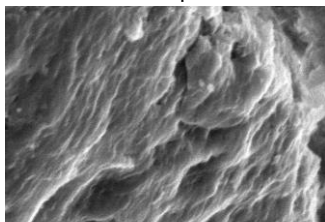


Figure 1. Image of Scanning Electron Microscopy (SEM) of *Pterygoplichthys* skin

Keywords: Fish gelatin, functional properties, scavenger fish skin, type A gelatin,

Assessment of present postharvest losses of *Katsuwonuspelamis*(Skipjack tuna) landed from multi-day boats at Negombo fish landing site

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Sri Lanka is one of the oldest and most important tuna producing islands in the Indian Ocean. *Katsuwonuspelamis*(Skipjack tuna) is the most abundant and fast-growing commercial tuna species. Negombo landing site, which is situated in Western province, is one of the major sites for anchoring of multi-day boats (MDBs) in Sri Lanka. In 2000 it was reported that postharvest quality loss (PHQL) and commercial postharvest loss (CPHL) of skipjack tuna was 40%, and 15% , respectively (1).In this study present levels of PHQL and CPHL of skipjack tuna landed from MDBs at Negombo landing site were assessed by using questionnaire based survey with the use of 35 MDBs from April to July of 2016. During this study, 65 skipjack tuna fish samples which belong to different quality categories were analyzed for spoilage bacterial count using iron agar media, total volatile base nitrogen (TVB-N) by steam distillation method, and histamine content by rapid colorimetric method.

Considering fish storage time during fishing trip of MDBs, PHQL were assessed in three storage time categories: as <10 days, 10-19 days, and > 20 days. PHQL of skipjack tuna stored in multi-day boats for <10, 10-19, >20 days were 37 [SD 4], 43 [SD 3], and 45 [SD 1] %, respectively. CPHL of skipjack tuna stored for <10, 10-19, >20 days in MDBs were 17 [SD 3], 21 [SD 2], and 21 [SD 4] %, respectively. In Negombo landing site fish landings from MDBs consist 27.9%, 32.1%, 30.4% and 9.6% commercial grade I, II, III & IV respectively. In Negombo landing site total bacterial count of skipjack tuna catches from MDBs were in the range of 4.87 log₁₀CFU/g - 6.41 log₁₀CFU/g, spoilage bacterial counts were in the range of 4.74 log₁₀CFU/g - 5.64 log₁₀CFU/g. TVB-N content was in the range of 15.6 mg/100g - 20.9 mg/100g, and it increased (P<0.04) with the lower quality commercial grades. Lowest TVB-N (15.6 mg/100g [SD 3.02]) value observed in commercial grade I and it was significantly lower (P<0.002) compared to commercial grade IV (20.9 mg/100g [SD 1.91]). Histamine content was in the range of 11.55ppm - 173.4 ppm and lowest histamine content was observed in commercial grade I (11.55 ppm [SD 9.41]), which is significantly lower (P<0.01) compared to commercial grade II (52.89 ppm [SD 32.2]) and III (173.4 ppm [SD 124]). PHQL and CPHL increase with the days of storing of fish during the trip duration. Tuna landed from Negombo landing site did not exceed standard level of total bacterial count (7.0 log₁₀CFU/g), standard level of TVB-N content (35 g/100 g) and illness causing histamine content (200 ppm) in all the four commercial grades indicating the suitability for human consumption.

Key words: Multi-day boats, Negombo, Post-harvest loss, Skipjack tuna

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Comparison of physical and chemical characteristics Indian and Sri Lankan turmeric (*Curcuma longa*)

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Turmeric derives from the rhizome of the *Curcuma longa* plant and extensively used as a food colorant and preservative agent. It has been reported to have anti-oxidant, anti-inflammatory, anti-mutagenic and anti-cancer properties. The major active compounds of turmeric rhizome are curcuminoids responsible for the yellow color of turmeric.^[1] India is the major producer of turmeric. Currently the turmeric production is common in Sri Lanka and other Asian countries. Research on Indian turmeric is abundant while very few studies are conducted on Sri Lankan turmeric. The aim of this study was to evaluate the physical and chemical characteristics of Indian & Sri Lankan turmeric and assess the differences.

Indian turmeric samples "Madras" and "Allepy" were collected from importers at wholesale market and local samples were collected from Department of Export Agriculture Matale. Curcumin content was tested using ethanol extraction followed by spectrophotometric analysis at 425nm wave length. Oleoresin content, total ash, ash insoluble in HCL were analyzed using AOAC (1990) methods while moisture content and the oil content were analyzed using Dean and Starke method and distillation method respectively. Further the color values of each turmeric sample were measured in colorimetric values and the relationship between curcumin content and lab value of turmeric was plotted. All data were analyzed using SPSS software and the mean values were compared. Curcumin content in Sri Lankan turmeric samples was higher (2.42 ± 0.5) while the Indian samples showed low curcumin values (4.48 ± 0.25). Sri Lankan turmeric and Indian turmeric showed levels of 3.4 ± 0.4 and 3.22 ± 0.47 (oil content), 24.09 ± 3.2 and 23.65 ± 9.1 (oleoresin content) and 8.28 ± 1.0 and 7.9 ± 0.14 (total ash) respectively. Ash insoluble in HCL showed similar values closer to 0.94 ± 0.12 in both Indian and Sri Lankan turmeric. A weak linear relationship between color of the turmeric and curcumin content was found with correlation coefficient of $R^2 = 0.529$ for Sri Lankan sample and $R^2 = 0.552$ for Indian turmeric respectively. It can be concluded that Sri Lankan turmeric have higher curcumin content compared to Indian turmeric. Further there is a weak linear relationship between curcumin content and the color of the turmeric.

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Keywords: Curcumin; lab value; oleoresin; spectrophotometry

Effect of different precooking and dehydration techniques on selected chemical properties of palmyrah (*Borassusflabellifer*L.) tuber flour

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Palmyrah palm (*Borassusflabellifer*L.) is widely spread in the arid tropics of North-East Sri Lanka. Its tuber is an important source of starch in the villages of Jaffna Peninsula. Palmyrah tuber flour is used to prepare different food products such as porridge, pittu, biscuits and palmosha. The fresh tubers have a limited shelf life due to its high moisture content thus preventing long distance transportation. Use of proper precooking and dehydration techniques in tuber flour preparation can improve its quality and shelf life. Therefore, the research was conducted to determine the effect of different precooking and dehydration techniques on selected chemical properties of palmyrah tuber flour and select the most suitable combination in palmyrah tuber flour preparation.

Four months old tubers belonging to the variety of black skin fruit of palmyrah were selected for the research. The effect of three precooking techniques; autoclaving for 30 minutes, steaming for 45 minutes and boiling for 30 minutes followed by two dehydration conditions; sun drying for 7 days and oven drying at 85°C for 4 hours were evaluated during the experiment. The pretreated sample was sliced into even size pieces (3mm). Dried slices were ground to a particle size of 0.297mm, sieved and packed in high density polyethylene bags and were stored at room temperature. Proximate composition, crude fiber, total starch, resistant starch, total sugar and reducing sugar contents of the developed tuber flour types were measured.

The results indicated that drying methods have not shown any significant effect ($P < 0.05$) on crude fiber and crude protein content. The flour obtained by steaming and oven drying had the highest carbohydrate 87.31% (SD 0.26) content. Significantly high crude fiber content was recorded in steamed and oven dried tuber flour. In the case of starches and sugars, autoclaved and oven dried flour had the highest resistant starch 1.37mg (SD 0.13) and the lowest reducing sugar 0.047g (SD 0.23) contents. Both flours obtained by boiling and sun drying or boiling and oven drying resulted flour with high total sugar and values were 1.99g (SD 0.01) and 1.96g (SD 0.02) respectively. All precooking methods resulted nearly same total starch content 1.74mg (SD 0.02). The study confirmed that autoclaving followed by oven drying at 85 °C for 4 hours is the most suitable precooking and dehydration combination to be used in palmyrah tuber flour production.

Keywords: Dehydration; palmyrah tuber flour; precooking; reducing sugar; resistant starch

Effectiveness of a thin edible coating to extend the post-harvest shelf life of giant guava (*Psidiumguajava*L)

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Guava (*Psidiumguajava*L) is a climacteric fruit that ripens rapidly and is highly perishable. Post-harvest loss of giant guava in Sri Lanka is about 46% and its shelf-life ranges from 3 to 4 days at room temperature ($31^{\circ}\text{C} \pm 2^{\circ}\text{C}$). Locally grown guava is marketed without receiving any treatment for shelf life extension, thus causing wilting and shriveling of fruits due to higher moisture loss. The study was conducted to evaluate the effectiveness of a thin edible coating that developed as water based coating mixture with tamarind seed powder, emulsifier (tween 80, 0.5% v/v), beeswax and sunflower oil to extend the shelf life of giant guava at room temperature. Tamarind seed powder used as an antimicrobial agent. Initial experiment was conducted to find out best amounts of tamarind seed powder and beeswax to prepare the coating mixture by assessing the appearance and taste of coated guava. Out of three tamarind seed powder concentrations (0.05%, 0.1%, 0.15% w/v) and three beeswax concentrations (1%, 2%, 3% w/v), tamarind seed powder 0.05% (w/v) and beeswax 1% (w/v) was selected as the best combination which resulted an even coating with highest sensory acceptability. The effectiveness of the coating mixtures prepared with three levels of sunflower oil (3.5%, 4.5%, 5.5% v/v), tamarind seed powder 0.05% (w/v), beeswax 1% (w/v) and tween 80, 0.5% v/v were tested for guava by evaluating the physiochemical (weight, height and width loss percentage, pH, titratable acidity, total soluble solids, moisture content, phenolic content), microbiological (yeast and mold count) and sensorial qualities. Sunflower oil 5.5% (v/v) treatment had shown minimum weight loss (21.57%) and maximum sensory acceptability, as it is act as good barrier for moisture and air. Shelf life of coated guava extended up to 9 days while uncoated guava had only 3 days shelf life with highest (35.74%) weight loss. Increasing the dipping time enhance the coating effectiveness as the thickness of coating is increased. Out of the three dipping times (2s, 4s, and 6s) 6 seconds dipped guava had shown good keeping quality up to 13 days in room temperature. Coating had reduced weight loss and shrinkage of guava due to moisture barrier properties of beeswax and sunflower oil. Results revealed that the best combination for the water based coating mixture to extend the shelf life of guava is 0.05% (w/v) tamarind seed powder, 1% (w/v) beeswax, 5.5% (v/v) sunflower oil, 0.5% v/v tween 80 emulsifier with 6s dipping time. Furthermore, it was found that when coated guava kept at supermarket storage temperature (25°C) the shelf life could be increased up to 21 days with significantly high consumer preference ($p < 0.05$). Results concluded that it is possible to produce low cost thin edible coating with the combination of tamarind seed powder, beeswax and sunflower oil to preserve giant guava without damaging sensory appeal and quality.

Keywords: Beeswax; Edible coating; Guava; Shelf life; Sunflower oil

Effect of additives and storage conditions on shelf life of cake determined by accelerated shelf life study

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Storage conditions and additives are important parameters affecting the shelf life of cake. This study aimed finding the effect of preservatives, humectants, acidulants and storage temperature towards the shelf life, water activity/moisture content and microbial counts. Cake samples were formulated by adding potassium sorbate (0 ppm, 500 ppm, 1000 ppm) as preservative, glycerol (0 mL/kg, 10 mL/kg) as humectant, acetic acid (0 mL/kg, 12 mL/kg) as acidulant and stored at different temperatures (29°C, 34°C and 40°C) for 12 weeks after packed in sealed polyethylene bags. Every two weeks the moisture content, water activity, yeast and mold count, and total plate count of cake samples were measured. Yeast and mold count (100 cfu/g) was used as the cutoff value for the accelerated shelf life evaluation (Arrhenius equation) and respective time taken at different temperatures to reach the above cutoff were converted to equivalent values of 32°C for the comparison.

Shelf life of cake significantly reduced ($P < 0.0$) with the increased temperature. Shelf life values equivalent at 32°C were 79, 78 and 79 days for used storage temperatures (29°C, 34°C and 40°C respectively) and they were not significantly different ($P < 0.309$) showing the validity of used model. Shelf life as determined by yeast and mold count did not have significant effect with potassium sorbate ($P < 0.176$) levels, glycerol ($P < 0.058$) levels or with acetic acid ($P < 0.258$) levels. Water activity significantly reduced with the addition of both potassium sorbate ($P < 0.0$) and glycerol ($P < 0.0$) showing the water binding effect of above compounds towards food preservation. Shelf life of the cake had an interactive effect from potassium sorbate \times acetic acid ($P < 0.043$). Water activity of cake had an interactive effect from glycerol \times acetic acid ($P < 0.012$).

In the aspects of sensory preferences, cakes added with moderate level of potassium sorbate (500 ppm) is preferred by the panelists. Cakes stored at 40°C developed a hard texture over the storage period. Glycerol added cakes were resistant to water evaporation and developed watery texture.

Keywords: Accelerated shelf life; cake; extended shelflife; food additives

Development of a fermented functional beverage with cow milk and brown rice

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Dairy foods are considered to have an important impact on human health and nutrition as they are main types of food matrices supplemented with probiotic bacteria and contain bio functional components. Cereal grains also can be used as carriers for probiotic microorganisms because they are containing significant amounts of biologically active ingredients which may be served as prebiotics. Also they are excellent sources of phytochemicals which defined as bioactive non-nutrient plant compounds that have been linked to reducing the risk of major chronic diseases. Addition of cereals to probiotic dairy foods can improve its nutritional and functional properties. Thus, this study aimed at investigating the suitability of brown rice "Kaluheenati" in developing dairy based fermented functional beverage.

Optimum formula was formulated using following variables: pretreatment of brown rice (soaking, roasting, cooking), amount of pretreated brown rice (30g, 60g, 100g), amount of cow milk (30mL, 60mL, 100mL) and the fermentation time (6hrs, 8hrs, 24hrs). The beverage was fermented with a commercial probiotic starter culture (ABT 2) which containing *Streptococcus thermophilus* ST-20Y, *Lactobacillus acidophilus* LA-5 and *Bifidobacterium* BB-12. The optimum formulation was selected by sensory evaluation according to the scores of appearance, aroma, taste, texture and overall acceptability. Physicochemical properties (pH and titratable acidity), total viable cell count of Lactic acid bacteria, yeast/mold count, proximate composition, total phenolic content, total flavonoid content and DPPH radical scavenging activity of beverage were determined. Shelf life was determined at refrigerated temperature by observing changes in pH, titratable acidity, total viable cell count of Lactic acid bacteria and yeast/mold count. The beverage which contained 37.5% (W/V) of cooked brown rice extraction and 62.5% (V/V) full cream cow milk was considered as the optimum formulation on the basis of sensory properties. It was contained 81.23 (SD 0.01)% moisture, 4.58 (SD 0.34)% crude protein, 3.45 (SD 0.02)% crude fat, 0.44 (SD 0.01)% crude fiber, 12.31 (SD 0.11)% total carbohydrates and 0.35 (SD 0.02)% total ash. The pH and titratable acidity of the beverage was 4.24 (SD 0.01) and 63.38 (SD 0.11) respectively. Total viable cell count of Lactic acid bacteria was ranging from 2×10^9 (SD 0.02) to 1.06×10^9 (SD 0.13) cfu/mL, was higher than prescribed range of 10^6 to 10^8 cfu/mL at the end of the storage period. Total phenolic content of beverage was 402.77 (SD 0.01) mg gallic acid equivalents/100g and total flavonoid content was 246.27 (SD 0.02) mg rutin equivalents/100g. DPPH radical scavenging activity of the fermented beverage was 57.62 (SD 0.02) %. The shelf-life of the beverage was estimated to be 20 days under refrigerated storage without any preservatives. According to the results it was concluded that brown rice and full cream cow milk can be used together to produce dairy based fermented functional beverages.

Key words: Brown rice; cow milk; fermentation; functional beverage; *kaluheenati*

Evaluation of several methods to inhibit the fermentation of palmyrah (*Borassus flabellifer*.L) sap

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Palmyrah sap contains well balanced nutrients and easily fermented by air borne microbes during collection. Traditionally “quick lime” is added to arrest fermentation though which has some limitations. The present study was carried out to evaluate alternative methods to inhibit the fermentation. Addition of plant materials (*Launaeacoramandelic*a, *Syzygiumcumini* dried bark, *Syzygiumcumini* dried seed, *Allium sativum*, *Allium cepa* and leaves of *Anacardiumoccidentale*), addition of food grade alkaline compounds(Sodium bicarbonate and Sodium carbonate), usage of palmyrah leaf bucket and application of cooler system were evaluated as methods to inhibit fermentation. Six plant materials were evaluated and two plant materials were screened for further analysis.Total phenol, flavonoids and tannin content were analyzed for screened plant materials and *Vateriaacumintabarks*. Lime added sap and the sap without any additives were positive and negative control respectively. The sap was collected for 24 hours, and physio chemical parameters (total soluble solids[TSS], pH, titrable acidity, alcohol % and reducing sugar) were evaluated to select the best method. The best method was subjected to microbial, sensory and nutritional analysis. Among the plant materials tested, *Launaeacoramandelic*a and *Syzygiumcumini* barks showed lower tritrable acidity, higher pH and alcohol was not detected. Aqueous extract of *Launaeacoramandelic*ashowed higher total phenol, flavonoids and tannin content and *Syzygiumcumini*showed similar results compared with *Vateriaacuminta*. High titrable acidity, alcohol content and low pH were observed in sap collected from addition of alkaline compounds and usage of palmyrah leaf bucket methods. The table shows physio chemical properties of sap collected from cooler system with compared to controls. The sap collected from cooler system showed comparable result with sap collected with lime.

Treatment	TSS		pH		Titrable acidity(mol/l)		Reducing sugar (g/100 mL)		Alcohol(%)	
	Mea n	SE	Mea n	SE	Mea n	SE	Mean	SE	Mea n	SE
Sap without any additives	8.30	0.33	3.55	0.34	0.11	0.004	47.23	2.23	1.38	0.05
Lime	12.10	0.38	11.42	0.39	0.006	0.006	8.15	2.57	0.00	0.00
Cooler (with ice)	14.25	0.32	5.64	0.32	0.008	0.005	8.16	2.13	0.05	0.05
Cooler control (without ice)	12.22	0.30	4.52	0.31	0.037	0.005	28.66	2.05	0.41	0.05

The indicated means are adjusted means by the covariates (volume).

Overall the usage of cooler system showed a promising result as a fermentation inhibition method compared with other tested methods.

Keywords: Cooler system, fermentation, *Launaeacoramandelic*a, palmyrah sap, *Syzygiumcumini*and quick lime

Analysis of selected heavy metals in rice in Kandy district, Sri Lanka

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Rice (*Oryza sativa*) has become the staple food in Sri Lanka from centuries ago. The cultivation of rice is deeply enmeshed with the tradition and novel technologies of the country. Sri Lanka currently produces 2.7 million tons of rice annually and satisfies more than 95% of the domestic requirement. Kandy is one of the districts with agriculture based food consumption pattern. In recent years, some claims have arisen as rice consumed in Sri Lanka is contaminated with some toxic heavy metals due to anthropogenic activities. Arsenic and cadmium accumulation in rice has found as a causative factor for chronic kidney disease due to unknown etiology (1). In order to investigate if the rice in Kandy district is safe in terms of heavy metal, locally cultivated and commercial rice in Kandy district were analyzed for heavy metals. Samba raw, samba steamed, nadu raw and nadu steamed rice from seven commercial rice brands were collected from Kandy market as commercial rice while paddy rice from seven stations in Kandy district were collected as local rice. In addition, traditional rice varieties and imported rice available in Kandy market were analyzed. A total of 41 samples of commercial, local, traditional and imported rice were investigated for heavy metals (As, Cd, Pb, Hg, and Se) by using inductively coupled plasma spectrophotometry.

Metal concentrations were significantly different ($p < 0.05$) for selected rice brands. Commercial rice which is distributed from Polonnaruwa district showed highest metal concentration for As, Pb, Cd and Hg. Significant difference ($p < 0.05$) was found within two rice varieties: samba and nadu for As, Cd and within raw and steamed rice for Cd. Samba variety has shown higher content of As but the content of Cd was lower than Nadu variety. Concentration of As, Pb, Cd and Hg in commercial rice was in the range of 16.6-77.6, 110.8-164.3, 46.1-94.2 and 21.3-58.3 μgKg^{-1} while it was 15.8-53.8, 87.3-109.8, 6.83-78.9 and 17.9-42.4 μgKg^{-1} in locally cultivated rice respectively. Significant difference ($p < 0.05$) was found for Pb and Cd levels within commercial and local rice with higher levels in commercial rice. Notably higher mean concentration of As and Cd was reported for imported rice. Considerably higher levels of Se was detected in traditional rice varieties whereas it was not detected in other analyzed rice samples. According to the FAO/WHO recommendation, none of the estimated daily intake of heavy metal in rice in Kandy district have exceeded the tolerable daily intake. It is worthwhile to note that local and commercial rice in Kandy district have heavy metal concentrations within permissible limits for production of safe rice for human consumption.

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Jayasumana, C. et al., 2015. Presence of arsenic in Sri Lankan rice. *Int.J. Food Contam.*, 2, p.1

Keywords: Daily intake; heavy metals; imported rice; rice; Sri Lanka

Development of a sauce using *Gymnemasyvestre* leaves

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Plant derived products have attracted huge attention due to their diverse range of biological and therapeutic properties. *Gymnemasyvestre* is an underutilized dicotyledonous medicinal herb belonging to the family Asclepiadaceae which is known as “Masbadda” in Sinhala and “Chirukurinja” in Tamil which possesses phytochemicals that with anti-diabetic and anti-obesity properties. Development of a sauce from *G. sylvestre* leaves is an effective way of delivering the health benefits to its potential consumers. This research was conducted in four stages. In the first stage four formulations of sauce were developed by changing the leaf extract concentrations (LEC) as 50, 60, 70 and 80% (w/w). In the second stage two formulations of sauce were developed by changing the thickening agents as sweet potato and pumpkin. Finally, formulation of the sauce was designed by adjusting the % of the ingredients and characteristics of sauce were evaluated. The chemical composition (pH, moisture, protein, carbohydrate, fat, ash, fiber, polyphenolics and antioxidants) of the sauce were determined. Sensory evaluation was carried out using a five-point hedonic scale followed by the simple ranking test. Microbial tests (total plate count, yeast and mould) were evaluated at weekly intervals. Shelf life of sauce with preservative (Sodium benzoate) and without preservative were evaluated during six weeks of storage. The sensory evaluation revealed that there was a significant difference ($p < 0.05$) among four sauce formulations. LEC with 60% scored the highest median score. There was no significant difference ($p > 0.05$) among the two sauce formulations but the sauce with sweet potato as thickening agent scored the highest median score. The most acceptable composition of the sauce was with 60% LEC, 17.2% water, 4.8% vinegar, 3.2% sweet potato, 2.6% chilli, 2.0% sugar, 2.0% cinnamon, 2.0% cardamom, 1.8% ginger, 1.8% garlic, 1.2% onion, 1.2% salt, 0.1% citric acid and 0.1% sodium benzoate. Total soluble solids, pH, titratable acidity and water activity of the sauce was 25^o, 4.52 (SD 0.01), 0.81% (SD 0.11) of acetic acid equivalents and 0.77 (SD 0.02) respectively. Final product contains 73.54% (SD 1.68) moisture, 19.92% (SD 2.59) carbohydrate, 2.98% (SD 0.44) ash, 2.61% (SD 0.58) protein, 0.88% (SD 0.05) fiber and 0.05% (SD 0.01) fat. The total flavonoid content was 243.67 (SD 8.57) μ moles of rutin equivalent, total phenolic content was 65.44 (SD 0.51) μ moles of gallic acid equivalent and inhibition of DPPH % of total antioxidant capacity was 43.70 (SD 0.72). Sauce with 1000 ppm sodium benzoate had minimum six weeks of shelf life. The results showed that there is a potential in formulation of a sauce from *G. sylvestre* leaves as functional food rich in phytochemicals.

Keywords: Anti-diabetic, anti-obesity, functional food, *Gymnemasyvestre*

Prebiotics extracted from banana (*Anamalu*) peel in improving the functional properties in mixed berry stirred yoghurt

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Probiotics enriched dairy products are considered to improve intestinal health. Probiotics can enhance the growth of probiotics making the product more stable. Banana peel, a waste product rich in prebiotic properties shows potential in improving the functionality of probiotic yoghurts. This study was undertaken to find the possibility of using banana peel extracted prebiotics in developing a synbiotic yoghurt. Anamalu (*Musa acuminata sub spGros Michel AAA*) banana peel was used to extract prebiotics (hot solvent extraction) and analyzed for physicochemical properties. The presence of inulin in the prebiotic extraction was tested using FT-IR Spectrum analysis. Mixed berry stirred yoghurt was prepared using different concentrations of extracted prebiotics at levels of 1.5%, 2% and 2.5% (w/w) and inoculated with a 10^6 cfu g of probiotic *Lactobacillus acidophilus*. A Control sample was maintained without prebiotics. Physico-chemical, microbiological and sensory properties were analyzed for a shelf life period of 30 days. Prebiotic extraction showed levels of 0.275, 6.53, 2.89%, 3.46% and 0.965% for water activity, pH, ash, crude protein and crude fat respectively. Final product with 2% prebiotics was found to confirm with the standards set with 23.5% total solids, 3.10% fat, 27% brix value. Sensory tests confirmed that addition of prebiotics had no significant difference ($p > 0.05$) in relation to accepted sensory properties. The levels of coliforms, yeast and mold were within safety levels by the 30th day. Results revealed that the counts of *Lactobacillus acidophilus* increased from 10^6 to 10^9 cfu g⁻¹ in the prebiotic added yoghurt during incubation while slight reduction of the probiotic count by the end of the shelf life was noticed. The results suggested that the addition of 2% inulin improved viability of *Lactobacillus acidophilus* in mixed berry stirred synbiotic yoghurt with optimum organoleptic and physicochemical characteristics.

Keywords: Anamalu banana peel, inulin, synbiotic yoghurt

Validation of Thiobarbituric acid (TBA) method and comparison of selected methods on assessing freshness quality of Indian mackerel (*Rastrelligerkanagurta*)

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Sea foods are an important part of a balanced diet and contribute to a good nutritional status to human health. Raw seafood is a highly perishable commodity. As the high quality products increase the demand through improving its value, the freshness and total quality should be maintained at the level of satisfying the customer perceptions. Quality of fish refers to the aesthetic appearance and freshness or degree of spoilage which the fish has undergone. Total volatile base nitrogen (TVBN) method is a widely used commercial method, however, thiobarbituric acid (TBA) method has employed in laboratory to overcome the limitations of TVBN method in assessing freshness quality of seafood. This study was designed to demonstrate that the TBA method is suitable for its intended purpose and to evaluate the method performance of TBA & TVBN on assessing freshness quality of fish. Thiobarbituric acid reactive substances (TBARS) were analyzed in seafood by using UV-Visible spectroscopy. The developed method was validated as per ICH, IUPAC and EURACHEM guidelines with respect to linearity, limit of detection, limit of quantification, recovery, repeatability and uncertainty. Indian mackerel (*Rastrelligerkanagurta*) was used as experimental sample. Whole Indian mackerel was placed in a refrigerator at 4°C for six days. Sampling was done in 48 hours interval, and quality changes were assessed by using sensory (Torry scheme), TBA and TVBN method. Results indicated that the limit of detection and limit of quantification were 0.1µmol/L and 0.4µmol/L, respectively and repeatability at 100% level (3.0µmol/L) was with 1.58% RSD. The method was linear with concentration range of 0.3-6.5µmol/L with the correlation coefficient greater than 0.999 and percentage expanded uncertainty was within + 5.18% (k=2; 95% confident interval). The percentage recoveries for malondialdehyde (MDA) were calculated in three concentration level as 80, 100 and 120%; it was observed from 85.95 to 86.98%. The sensory evaluated shelf life of Indian mackerel is limited for five days of storage at 4°C and rejected on 6th day. TBARS and TVBN values were 14.33nmol/g and 39.47mg/100g, respectively. Sensory, TBA and TVBN methods value were shown high correlation co-efficient with storage time, and values were 0.996, 0.983 and 0.958, respectively. The study revealed that TBA method is suitable for measuring MDA in seafood sample, and sensory, TBA and TVBN method are suitable criteria to assess the freshness quality of Indian mackerel at chilled storage.

Keywords: Freshness quality; *Rastrelligerkanagurta*; TBARS; total volatile base nitrogen; validation.

Effect of maturity, temperature, packaging and ethylene on quality of banana (*Musa acuminata*)

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Banana (*Musa acuminata*) is the most important fruit in Sri Lanka as it is the part of regional diet and contributes to economic returns. Even though, about 30 % of post-harvest losses were reported to banana in Sri Lanka¹. Seeni, kolikkoottu, embul and embon are very popular banana varieties in Sri Lanka. Seeni banana is used for this study which is small in size, cheap and unique because of its rubbery texture and taste.

The study was conducted to find out the effect of maturity stage, temperature, packaging and ethylene on the final quality of banana. Two maturity stage (120 days:M1 and 100 days:M2), three levels of temperature (12°C, 22°C, and 32°C), two levels of packed condition (LDPE packed: P and un packed: nP) and two level of ethylene treatment (ethylene treated and un treated) were used. Treatments were transferred to un packed room temperature condition after one week and treated with ethylene. Changes during the ripening were assessed at 32°C and 22°C. Physico chemical parameters were assessed and sensory evaluation was performed at fully ripe stage. The effect of maturity stage, temperature, and packaging were analyzed by the factorial design. The effect of ethylene was examined by paired t test. During ripening weight loss, pulp to peel ratio and TSS increased steadily from harvest to fully ripe stage. Titrable acidity increased from harvest to ripe stage and reduced slightly from ripe stage to fully ripe stage. pH showed a drop from harvest stage to ripe stage and slightly increased from ripe stage to fully ripe stage. Bananas showed a characteristic pattern of starch loss.

Table1: Treatments account lowest and highest value at fully ripe stage

Parameters	Weight loss	Diameter Reduction	Pulp to peel ratio	TSS	pH	Titration acidity
Lowest	M2 12 P (14.67%)	M1 12 P (3.55%)	M1 12 P (1.57±.08)	M1 22 P(15.8±.34)	M2 22 P (4.78±.05)	M1 12 P (0.3±.01)
Highest	M1 22 nP (37.66%)	M2 22 nP (17.85%)	M2 32 np (6.01±.01)	M2 22 nP (20.2±.69)	M1 32 P(4.98±.03)	M1 22 nP (0.21±.02)

Maturity, temperature and packaging significantly affected weight, volume, diameter, and pulp to peel ratio. Maturity and packaging affected TSS, maturity and temperature affected pH and packaging only affected titration acidity at p=0.05. Considering the sensory scores, 120 days matured banana, stored in 22°C and 12°C has high eating qualities. Packaging improves the eating qualities at 22°C and 12°C while it negatively affects in bananas stored at 32°C. Ethylene lowers the weight loss, improves color, smell, appearance and overall acceptability. The highest overall acceptability is accounted by 120 days matured 22°C stored and LDPE packed banana when ethylene treated among all treatments.

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Keywords: Physicochemical properties; Post harvest; Ripening; Seeni

Development of a synbiotic ice cream substituted with coconut milk

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Ice cream is a delicious, wholesome, nutritious frozen dairy product, popular among all segments of the society because of its taste and cool sensation. Growing interest of consumers in therapeutic products has led to the incorporation of different components to produce novelty products. Frozen storage can reduce probiotic survival thereby reducing the expected health benefits of such products. Incorporation of probiotic cultures and prebiotics results in synbiotic ice creams where prebiotics provide substrates to probiotics thereby enhancing their survival. The purpose of this research is to develop a synbiotic ice cream with partial substitution of cow's milk with coconut milk and to study the effect of prebiotics in enhancing the survivability of probiotics. Three different levels coconut milk; 40%, 50% and 60% (w/w) was used in substitution with cow's milk in developing the ice cream. Prebiotics extracted from "Anamalu" banana peel (ethanol extraction) and arrow root (continuous washing procedure) was used in developing the ice cream at levels of 3%, 5%, 7% and 10% (w/w). Probiotic culture (2×10^{10} cfu/g) was inoculated and incubated in 12% (w/v) skim milk for 16 hours and 10% (v/v) was added to each ice cream mixture. Physicochemical, microbiological and sensory properties were analyzed using standard methods. pH, titrable acidity, total soluble solids, protein content, fat content was tested throughout the storage period of 15 days. 40% substitution of coconut milk was found best organoleptically while prebiotics extractions of both banana and arrowroot at levels of 7% (w/w) were selected the most acceptable. Survivability of probiotics were higher in banana peel incorporated synbiotic ice cream (2.29×10^{12} cfu/g) than arrow root extract incorporated synbiotic ice cream (2.22×10^{10} cfu/g) at the end of the 15th day while the control sample showed a count of 1.73×10^9 cfu/g. Banana peel extraction added ice-cream was selected best based on organoleptic properties. Protein, fat, calcium and sodium levels of the final product was 2.38 (g/100ml), 13.36 (g/100ml) and 87.5mg and 44.8 mg respectively with 28% of over-run. It can be concluded that a synbiotic ice cream can be successfully prepared with 40% coconut milk, 60% fresh milk at a 7% prebiotic incorporation where the survivability of probiotic *L. acidophilus* was highest at a minimum change in sensory properties. Further storage studies are required to ensure the stability of the said properties.

Keywords: Prebiotics; probiotics; synbiotic ice cream

Determination of physiochemical properties and antifungal activity of Sri Lankan bee honey

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Bee honey is the natural sweet substance produced by honey bees from the nectar of blossoms or from secretions on living plants. Properties and composition of bee honey depend on its geographical and floral origin, harvesting season, environmental factors and beekeeping practices. Recent studies have demonstrated that honey serves as a source of natural antioxidants with good antimicrobial properties. Investigation of physiochemical properties, antioxidant and antimicrobial capacity helps to determine the quality of natural bee honey, while facilitating to expand the Sri Lankan bee honey exportation. Research dealing with melissopalynological, physiochemical, antioxidant and antifungal capacity of Sri Lankan natural bee honey are limited. Hence, the research was conducted to determine the properties of different natural bee honey types available in Sri Lanka and to assess their quality. Wild honey, red gum honey and rubber honey samples belonging to the honey harvesting period of 2015 were used for the research. pH, free acidity, refractive index, total soluble solid, reducing sugar content, diastase activity and total phenolic content were determined following the methods given by the International Honey Commission. Melissopalynological analysis was conducted by identifying the pollen structures using the Harmonized methods. The agar well diffusion assay was used to determine the antifungal activity against the following human fungal pathogens: *Candida albicans* ATCC 10231, *Aspergillus niger* ATCC 1015 and *Fusarium oxysporum*. The result revealed from the research are given in the table.

Variety	Wild honey	Red gum honey	Rubber honey	
pH	3.90 ± 0.194	4.35 ± 0.189	4.10 ± 0.22	
Ash content %	0.3456 ± 0.123	0.4414 ± 0.154	0.2845 ± 0.084	
Free acidity (mmol/Kg)	32.048 ± 4.28	24.65 ± 2.47	27.87 ± 4.77	
Refractive index	1.4809 ± 0.007	1.4839 ± 0.004	1.4789 ± 0.001	
Total soluble solid (Brix)	76.18 ± 2.78	77.12 ± 1.78	75.3 ± 0.56	
Reducing sugar %	64.55 ± 1.69	63.70 ± 2.15	65.68 ± 2.14	
Diastase activity (Schade Units/g)	12.626 ± 3.32	8.89 ± 1.40	7.90 ± 2.07	
Total phenolic content (GAE /100 g honey)	454.9 ± 15.42	499.4 ± 13.10	481.7 ± 11.81	
Pollens content (Family)	Fabaceae, Rutaceae,	Meliaceae, Sapotaceae,	Myrtaceae, Musaceae,	Euphorbiaceae, Arecaceae,

The result was analyzed using SPSS and it was given that three type of bee honey were significantly different ($P < 0.005$) in pH, free acidity, diastase activity and total phenolic content. According to the agar well diffusion method growth of *C. albicans* ATCC 10231 and *A. niger* ATCC 1015 were inhibited by three honey types used for the assay, however *F. oxysporum* were not inhibited by any honey type. As the conclusion physiochemical properties of three types of Sri Lankan bee honey are fall within the international standard limits and good in antifungal activity against *C. albicans* ATCC 10231 and *A. niger* ATCC 1015.

Keywords: Antifungal; antioxidant; bee honey; physiochemical

Extraction and characterization of pectin from waste materials of Pumpkin (*Curcubita maxima*)

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Pectin is a complex hetero polysaccharide mainly found in the primary cell wall of dicotyledonous plants and it is extensively employed as a gelling agent, thickener, stabilizer and emulsifier in food industry. Apple pomace and citrus fruits are utilized as conventional raw materials for industrial pectin production. Annual global pectin consumption has been drastically exceeded 45,000 tons and it is necessary to investigate alternative sources of pectin. Notably, there is about 10%-20% of vegetable waste produced daily at Dambulla economic center in Sri Lanka¹. Therefore, it is feasible to utilize bio-degradable vegetable waste for pectin extraction and it will minimize environmental issues and contribute for value addition. This study was designed to extract and characterize pectin from waste of *Curcubita maxima*. In addition, effect of pretreatments, acid type, extraction time and temperature on the yield of pectin was evaluated and suitability of extracted pectin was evaluated in food product development. Pectin was extracted using citric and hydrochloric acid separately from core, peel and whole fruit of *Curcubita maxima* by the method of acid hydrolysis. Subsequently, extracted pectin was isolated from acid solution through ethanol precipitation. Furthermore the core, peel and whole fruit were subjected to four types of pretreatments; unblanched fresh, blanched fresh, unblanched dried and blanched dried prior to the extraction. Extracted pectin was dried at $40 \pm 1^\circ\text{C}$ overnight. Physiochemical and functional properties of dried pectin were evaluated and pectin was used in processing of jam.

Yield of pectin from the whole fruit of *Curcubita maxima* ranged from 7.30 (SD 0.07) – 11.04 (SD 0.01) % on dry weight basis. The highest yield was recorded for the unblanched fresh pumpkin peel extracted using 0.1 N hydrochloric acid at $80 \pm 5^\circ\text{C}$, 1.25 pH for 1 hour. It was found that there is a significant effect of extraction time, pretreatments and temperature on the yield of pectin. According to the results, water holding capacity, oil holding capacity and emulsifying activity index of extracted pectin were 2.5 g/g of pectin (SD 0.456), 1.76 g/g of pectin (SD 0.10) and 0.29 (SD 0.01) respectively. In addition the degree of esterification, equivalent weight, methoxy content and galacturonic acid content of extracted pectin were 67.64% (SD 0.89%), 978.35 (SD 69.88), 6.55% (SD 0.37%) and 66.46% (SD 1.19%) respectively. Sensory analysis revealed that there is no significant difference in textural properties such as spreadability, surface texture and chewiness of two types of jam prepared using pumpkin and commercial pectin. Pectin extracted from pumpkin can be categorized as high methoxy pectin and higher pectin yield indicated that pumpkin is an alternative raw material for pectin extraction.

[1]United Nation Environment Program (2008) *Report of Waste Quantification and Characterization*. Matale: Sri Lanka, pp.3-15.

Keywords: Acid hydrolysis; pectin; physiochemical properties; vegetable waste

Optimized and accelerated method for developing pineapple vinegar from peel for commercialization

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Pineapple (*Ananascomosus*L) is a popular fruit among Sri Lankans and considerable amount of whole fruit is notutilized (41%) as it is removed with peel during processing. Present study was conducted to optimized protocol of developing pineapple vinegar from peel for commercialization. Obtained peel (Mauritius) was washed, blanched, and blended, and juice was taken after the filtration through cotton cloth. Alcohol fermentation was done with 0.27% baker's yeast (*Saccccharomycescerevisiae*) and 0.18 g/L of ammonium phosphate at 29°C. In order to optimize the alcohol fermentation process, three sugar concentrations (16, 18 and 22°Brix), three methods of sugar additions (adding sugar at once, adding equal portions sugar in 4 days, gradual addition of sugars i.e. 36% in 1st and 2nd day and 28% in 3rd day) were tested. Gradual addition of sugar efficiently produced alcohol (13.5% by 5 days), because it lowers the stress for yeast by reducing the osmotic pressure. Produced alcohol was used to optimize the acetic acid production. 5% (w/v) of mother pineapple vinegar (containing 1.4×10^5 CFU/mL *Acetobactoraceti*) was added to all treatments. Acetic acid production was tested with five levels of unpasteurized coconut vinegar (0%, 10%, 15%, 20%, and 25% v/v), and aeration (0, 15, 30, 60, and 120 L/hour/L of liquid). 15L/hour/L of liquid of aeration without unpasteurized coconut vinegar gave the highest acetic acid production (5.2 g/100L) by 5 days because the lower aeration reduced both evaporation of alcohol and the over oxidation of acetic acid which produced CO₂ and water as oxidative products. The effect of addition of wood shavings i.e. *Albizzialebbeck* (L.) *Benth*(Albizzia) and *Pongamiapinnata* (L.) *Pierre* (Beech wood) in production of acetic acid and enhancing of functional properties of produced vinegar was studied. Beech wood shavings added pineapple alcohol produced vinegar by 4 days with 5.03 acetic acid as it functioned as substrate and giving favorable pH (3-4) for the culture. Further, Beech wood shavings added vinegar obtained better sensory qualities in terms of color, texture and overall acceptability compared Albizzia. Moreover, produced vinegar shows 0.476 (SD 0.01) mg Gallic acid equivalent/mL of Total Phenolic Content, 41.67 (SD 4.41) mg Rutin equivalent/L of Total Flavonoids Content and 61.13 (SD3.51) % of Antioxidant Capacity (DPPH free radical scavenging assay) that assured it gained better functional properties. Industrial waste pineapple peel can successfully utilize to produce vinegar with 5.03 (g/100mL acetic acid) acid level within 9 days. The process can be supported to reduce the industrial wastage in fruit processing industries and environmental stress while producing value added commercially viable product. Acknowledgement: Financial assistance granted by the SRHDC/RP/04/15-22 project is highly acknowledged.

Keywords: *Albizzialebbeck* (L.) *Benth*; functional vinegar; pineapple peel; *Pongamiapinnata* (L.) *Pierre*; wood shavings.

Assessment of pesticide residues in vegetables of selected domestic markets in Sri Lanka

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Pesticides are being widely used in crop production in Sri Lanka. The prescribed pre-harvest intervals in pesticide application are neglected by some farmers due to high demand of fresh vegetables. Intensification of pesticide application for vegetables is likely to result accumulation of pesticide residues in food commodity which may cause health risks to the consumers. This study was conducted to analyze the residues of commonly used pesticides namely Chlorpyrifos, Phenthoate and Tebuconazole in locally grown vegetables. The vegetable samples of tomato (*Solanum lycopersicum*), capsicum (*Capsicum annuum*) and cabbage (*Brassica oleracea*) were collected from selected domestic markets representing three districts: Nuwara Eliya, Puttalam and Matale. Pesticide compounds were extracted from the collected 45 vegetable samples by QuEChERS method. Samples were extracted by the application of a single-phase extraction of 10 g of sample with acetonitrile containing 1% of acetic acid, followed by a liquid-liquid partition formed by the addition of MgSO₄ and NaOAc. Cleanup of the extract was carried out with primary secondary amine (PSA) and magnesium sulphate. The extract was analyzed by gas chromatography equipped with mass detector. The average recovery of pesticide residues in tomato, capsicum, and cabbage samples were 75.0 to 120.0 %. Among the analyzed vegetable samples, 40% of vegetables showed the presence of pesticide residues and among them 40% of tomato, 40% of capsicum and 46.66% of cabbage showed the presence of pesticide residues. Presence of pesticide residues in vegetables in Nuwara Eliya, Puttalam and Matale varied as 33.33%, 40% and 53.33% respectively. The prominent pesticide residue in tomato and capsicum was shown to be Phenthoate at levels of 0.345 and 0.20 mg/kg respectively while the residues of Tebuconazole was more prominent in cabbage at a level of 0.33 mg/kg. Chlorpyrifos, a banned pesticideresidue was detected in 27% of vegetable samples collected from Puttalam district. The Results of this study conclude that, the analyzed vegetable samples contained detectable levels of pesticide residues below the Maximum Residue Limit (MRL), showing minimum risk in health aspects. Periodical assessments are required to investigate further on this issue.

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Keywords: Chlorpyrifos, GC-MS, Phenthoate, QuEChERS, Tebuconazole

Formulation of dietary fiber enhanced multi-grain noodles for adults using selected locally available cereals and legumes

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Non communicable diseases (NCDs) are most prominent health issues worldwide. A high intake of carbohydrate eventually results in developing NCDs and generous intake of dietary fiber (DF) has a protective effect against NCDs. Whole grain cereals and legumes are rich sources of DF. Therefore, the aim of this study was to develop multi-grain noodles high in DF and low in glycaemic index (GI) as an alternative to less healthy noodles available in the market. Whole grain cereals; brown rice (AT 362), atta (whole grain wheat) and whole grain legumes; chick pea, green gram, black gram were used as the raw materials. Proximate composition and total DF content were determined for all raw materials. The possibility of preparation of noodles from different composite flour mixtures of raw materials was tested. Three products which had minimum total solids (TS) in gruel were selected among developed products and sensory evaluation was carried out. Chemical properties (proximate composition, DF and resistant starch contents, GI) and physical properties (TS in gruel, cooking time) were determined for selected products and also for the commercial wheat and rice noodles.

Ash, fat, protein and DF contents of raw materials were found to vary in ranges 1.34-3.96%, 0.85-6.85%, 10.43-28.17%, and 2.99-12.86% respectively. Both DF and protein contents were highest in black gram and lowest in brown rice. In the preparation of noodles, it was found that not more than 30% of legume-flour-mixture can be incorporated with the whole grain cereals without affecting to the rheological properties. TS in gruel of developed products were significantly ($p < 0.05$) higher than the commercial noodles. Among the developed products, low levels of TS in gruel values were obtained for F₄, F₅, and F₆ products with F₆ having the lowest. Different proportions (%) of brown rice and atta in F₄, F₅, F₆ were 40:30, 30:40 and 20:50 respectively and proportions of chick pea, black gram, green gram were equal at 10:10:10 in all. In the sensory evaluation, F₆ came out to be the most preferable one with regard to the all sensory attributes. Ash, fat, protein, total DF, resistant starch contents were comparatively higher in F₄, F₅, F₆ than commercial noodles. Highest protein and DF contents were found in F₆ whereas lowest was found in commercial rice noodles. Ash, fat, protein, DF, resistant starch contents of selected three products ranged from (dry basis) 2.11-2.13%, 0.55-0.69%, 19.37-20.69%, 7.87-9.31%, 0.78-1.13% respectively. By considering the GI; F₄, F₅, F₆ and commercial rice noodles can be classified as low GI foods and commercial wheat noodles as an intermediate GI food. Commercial rice noodles showed significantly lower ($p < 0.5$) cooking time (4.5 min) than F₄, F₅, F₆ and commercial wheat noodles. Thus the results indicate that F₆ (legumes:30%, brown rice:20%, atta:50%) as the most preferable and high DF and low GI product.

Key words: Dietary fiber; glycaemic index; legumes, noodles; resistant starch

An *in vitro* study of Arrow root (*Maranta arundinacea*) based synbiotic supplement in enhancing gut probiotic *Lactobacillus acidophilus*: An approach towards treating Inflammatory Bowel Disease

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Inflammatory bowel disease (IBD) is an autoimmune disease of two types as Crohn's disease (CD) and Ulcerative colitis (UC) of which dysbiosis of gut microbiota is a probable cause, which leads to activation of immune system giving rise to inflammation. Prolonged inflammation of this nature imposes a threat of cancers. IBD shows increasing prevalence worldwide and in Sri Lanka. The currently used medication in treatment of IBD shows many side effects. Probiotics are considered a better alternative to treat IBD by sustaining healthy microflora in the gut. Arrowroot is rich in prebiotics and increases the biomass of probiotics⁽¹⁾ showing potential as a supplement for IBD patients. This study was aimed at collecting descriptive data of IBD in selected areas of Sri Lanka and studying the capability of a synbiotic dietary supplement (SDS) from Arrowroot in enhancing probiotics (*in vitro*), as an attempt towards treating the disease. The descriptive data were collected using 32 IBD patients of the gastroenterology clinic of Colombo North teaching hospital, Sri Lanka, using a pre-tested semi-structured questionnaire. The results revealed that the prevalence of UC (87.5%) was 7 times higher than CD (12.5%), with predominance in women. The common symptom was blood and mucus diarrhea. It was noted that there was a lack of probiotic sources in their diet. In preparation of Arrowroot based supplementary, Arrowroot carbohydrates (AC) were extracted by wet milling and recovery was 14.32% (w/w). 12% (w/v) of AC were incorporated into 12% skim milk (SM) and distilled water (DW) separately along with an inoculum of 10⁹ colony forming units (CFU) /g of *Lactobacillus acidophilus* in order to test the growth performances. 12% SM was used as a control. Treatments were incubated at 37°C anaerobically for 12 h followed by storage at 4°C for 14 days. Results showed that AC significantly ($p < 0.05$) increased the *in vitro* CFU (log₁₀)/g of *L. acidophilus* compared to the control (6.71) in both DW (9.34) and SM (9.01) media. Then the SDS was prepared by freeze drying of fermented 12% (w/v) AC in DW and stored at 4°C for 30 days. The viability of *L. acidophilus* in SDS was 9.19 CFU/g that is above lowest recommended therapeutic level of 6 CFU/g. Results reveal that AC shows significant prebiotic effect by maintaining a higher viability of probiotics in the SDS, showing the possibility of improving healthy gut flora of IBD patients. Further *in vivo* studies are necessary to confirm these revealing.

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Keywords: Freeze dried; gut microflora; inflammatory bowel disease; prebiotic; probiotic

Optimization of osmotic dehydration of “ambul” banana followed by hot air drying

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Ambul banana (*Musa mysore*) is a popular variety, it has short postharvest shelf life and postharvest losses of banana are estimated to be more than 25%. An optimum drying system for the preparation of quality dehydrated products is cost effective as it shortens the drying time and cause minimum damage to the product. The process of osmotic dehydration followed by hot air drying was studied and modeled for ambul banana preservation. Preliminary trials were done to identify the correct total soluble solid content, thickness and diameter of banana slices for the dehydration. Three anti browning pretreatment were evaluated for banana slices. They are 0.1M ascorbic (A), 0.1M citric (C) and 0.1 M ascorbic citric (50:50) combination(AC). Samples were immersed in 60° brix sucrose solution in 1:30 solid to solution ratio at room temperature (30°C) until it became equilibrium. The effective diffusion coefficients for water and sucrose transport were determined according to predictive mathematical model based on Fick's 2nd law. The osmotically pretreated banana slices of sucrose solution were convectively dried in a tray dryer at air temperatures of 50, 60 and 70°C at constant velocity. Color attribute of final dried banana slices were evaluate by “image J” software (version IE 6.0 java). Vitamin C change with time was determined by titrimetric method.

The moisture content in ambul banana was 75.47% (SD 0.699) in wet basis. Preliminary study showed the optimum thickness, diameter and soluble solid content of banana slices were, 5 mm (SD 0.243), 21mm (SD 0.375) and 16° (SD 1.384) respectively. According to Predictive mathematical model effective diffusion coefficients of A, C and AC pretreated samples were 5.65×10^{-10} , 5.86×10^{-10} and $6.74 \times 10^{-10} \text{ m}^2/\text{s}$ respectively. Solid gain observed in samples were not correlated linearly with the time, solid gain in nine hours osmotic process maximum in A and AC pretreated samples (17.94%) whereas the lowest solid gain was observed in C pretreated sample (16.41%). In the hot air drying process moisture content decrease in a nonlinear manner with time at all three temperatures. It was faster in the initial period of drying and then the rate decreased. The surface color (browning index) increased with drying temperature while vitamin C content decreased when increased drying time and temperature. The dried banana prepared by nine hours osmosis in 60° brix with AC pretreatment and subsequent drying at 50°C hot air for eight hours showed better color, appearance and moisture content.

Keywords: Ambul banana; effective diffusion coefficient; Fick's law; hot air drying; osmotic dehydration

Radiological impact of dietary intakes of gamma emitting radionuclides on Sri Lankan adult population

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Dietary ingestion of radionuclides causes a radioactivity dosage in human body, which will lead to many hazardous effects such as cancers. No studies have been conducted to estimate the level of radioactivity dosage received from Sri Lankan homemade foods. In order to find out the levels of radionuclides in Sri Lankan cooked foods, the mid-day meal plans that are commonly consumed by local adults were analyzed by means of a gamma spectroscopy which measures the activity concentrations of gamma emitting radionuclides such as naturally occurring radionuclides ²²⁶Ra, ²¹⁰Pb, ²³²Th, ⁴⁰K and artificial radionuclide ¹³⁷Cs. Based on the activity concentrations, the radionuclide with highest consumption was ⁴⁰K. The radioactivity levels of ⁴⁰K varied from 80.6 Bqkg⁻¹ to 137.3 Bqkg⁻¹ in meal plan. The radionuclide levels of ²²⁶Ra, ²¹⁰Pb, ¹³⁷Cs and ²³²Th were below the Minimum Detectable Activity (MDA) in any of the meal plans analyzed. Contribution of radioactivity due to ⁴⁰K to internal radiation doses on adult population was estimated using the published mass fractions in local daily diet. The effective dose received to an adult who consumes the local meal plans ranged from 29 to 50 μ Svyr⁻¹. However, the values of effective dose and levels of radionuclides in analyzed Sri Lankan meal plans are less than the guideline limit specified in ICRP-101 (1000 μ Svyr⁻¹) [1] and other countries. The cancer risk incurred by Sri Lankan adult population was estimated by assuming a linear dose-response relationship with no threshold as per ICRP-101 guidelines. The ICRP-101 radioactive dose limit of 1000 μ Svyr⁻¹ results a cancer risk factor of 3.5×10^{-3} and due to that the loss of life expectancy is 5 days. Radioactive dose values in Sri Lanka resulted a cancer risk factor for adults fold between 1.0×10^{-4} - 1.8×10^{-4} and due to that the loss of life expectancy is 0.15 - 0.26 days. The calculated cancer risk factor from consuming selected meal plans is only a minor fraction of cancer risk factor indicated in ICRP-101.

Since selected meal plans does not contain any artificial radionuclide ¹³⁷Cs, it can be assumed that local foods might not be contaminated by radioactive waste materials. Further the radioactivity dosage and cancer risk for adults from local cooked foods are negligible in values, it can be considered that local foods are radioactively safe for consumption. This is the first study carried out in determination of radionuclides in Sri Lankan selected cooked foods and study reveals the necessity of thorough scientific investigation to find out the radioactivity dosage from other foods consumed in Sri Lanka.

[1]. ICRP (International Commission on Radiological Protection) 2006. *Assessing Dose of the Representative Person for the Purpose of the Radiation Protection of the Public*. ICRP Publication 101. Ann. ICRP 36 (3).

Keywords: Cancer risk; dietary intake; internal dose; radionuclides; Sri Lankan cooked foods

Analysis of antioxidant properties of selected edible flowers in Sri Lanka

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Epidemiological studies suggest that consumption of a diet high in fruits and vegetables is associated with a reduced risk of chronic diseases like cancer, cardiovascular disease due to their high content of natural antioxidants. Antioxidant potential of many plant parts including leaves, fruits and bark have been previously investigated, while the levels of flower is still remains speculative. Since Sri Lanka enriched with lots of underutilized edible flowers, this study was conducted to analyze the antioxidant properties of ten selected edible flower species namely, *Aponogeton crispus* (Kekatiya), *Lasiacis spinosa* (Kohila), *Sesbaniagrandiflora* (Kathurumurunga), *Cassia auriculata* (Ranawara), *Aeglemarmelos* (Beli), *Hibiscus rosa-sinensis* (Pokuruwadamal), *Allium cepa* (Onion), *Brassica oleracea var. botrytis* (Cauliflower), *Gmelina asiatica* (Demata) and *Azadirachta indica* (Kohomba). Methanolic extraction was done for oven dried (40°C) and ground flowers using 80% aqueous methanol. Bioactive constituents; phenolics, flavonoids, anthocyanin, β -carotene, lycopene and vitamin C of the flower extracts were determined. Total antioxidant capacity determination, DPPH assay, hydroxyl radical scavenging assay and reducing power assay were carried out to evaluate the antioxidant activities. The total phenolic content was ranged from 5.28 (SD 0.25) to 35.66 (SD 1.47) g of Gallic Acid Equivalents (GAE)/kg of fresh material (FM) among studied flowers. The flavonoid content was ranged between 1.09 (SD 0.21) to 10.94 (SD 0.35) g of Rutin Equivalent (RE)/kg of FM. The anthocyanin content was in the range of 9 (SD 0.01) to 795 (SD 0.03) $\mu\text{g}/100\text{g}$ of dry matter (DM). β -carotene content fell between 56.9 (SD 0.13) to 1070.4 (SD 0.26) $\mu\text{g}/\text{g}$ of DM and the lycopene content ranged between 18 (SD 0.02) to 359 (SD 0.11) $\mu\text{g}/\text{g}$ of DM. *Aeglemarmelos* species has the highest total phenolic (35.66 SD 1.47 g of GAE/kg of FM) and flavonoid content (10.94 SD 0.35 g of RE/kg of FM) while the *Hibiscus rosa-sinensis* has showed the highest anthocyanin content (795 SD 0.03 $\mu\text{g}/100\text{g}$ of DM). The highest beta carotene content was observed in *Cassia auriculata* (1070.4 SD 0.26 $\mu\text{g}/\text{g}$ of DM) and the highest lycopene was observed in *Gmelina asiatica* (359 SD 0.11 $\mu\text{g}/\text{g}$ of DM). The highest total antioxidant capacity was showed by *Cassia auriculata* (0.82 SD 0.01 mg of ascorbic acid equivalents (AAE) for g of DM). *Azadirachta indica* showed the highest DPPH radical scavenging activity (IC_{50} = 194.5 mg/L of the methanolic extract (ME) and the reducing power (318.69 AAE mg/g of DM) among the studied flowers. *Sesbaniagrandiflora* showed the highest inhibition (82.38%) in hydroxyl radical scavenging activity at 500 $\mu\text{g}/\text{ml}$ concentration of the ME. Vitamin C content was ranged between 0.35 to 174.1 $\mu\text{g}/\text{g}$ of FM. In conclusion, this study revealed that the studied edible flowers are a good source of antioxidants and these flower species can be introduced as a promising source of natural antioxidants.

Keywords: Anthocyanin; antioxidant activity; edible flowers; phenolic; reducing power

Development of ready-to-cook composite vegetable leather using locally available vegetables

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Constant supply of vegetables provides desirable health benefits beyond basic nutrition to furnish the defense mechanism while reducing the risk of non communicable diseases in humans. Although vegetables provide bundle of benefits the mean daily intake of vegetable servings in Sri Lanka is 1.73; which is well below the minimum national recommendation of 3-4 servings per day. The lack of vegetable consumption is due to several reasons such as age, gender, socioeconomic position, individual preferences and parental modeling. Therefore, the research was aimed to develop a ready to cook composite vegetable leather to enhance the vegetable consumption among Sri Lankans.

As preliminary trials, three vegetable formulations were prepared using locally available carrot (*Daucus carota*), beans (*Phaseolus vulgaris*), okra (*Hibiscus esculentus*), pumpkin (*Cucurbita maxima*), and tomato (*Lycopersicon esculentum*). The mixture was spread in the form of thin layer (1.5 cm) in stainless steel trays and dried in an oven at $52 \pm 1^\circ\text{C}$ for 18-20 hrs. The best formulation was selected after performing a sensory evaluation for mouthfeel, texture and overall acceptability using 20 semi trained panelists. The formula which scored the best overall score was selected for further investigations. Proximate composition, selected physiochemical properties, antioxidant capacity, sensory properties and shelf life of the final product was measured. During shelf life studies, suitability of two packaging materials, 300 gauge polypropylene (PP) and laminated aluminum foil (Al) were evaluated by monitoring the colour, water activity, moisture and β -carotene contents. Final product formulation contains (22% carrot: 22% pumpkin: 22% beans: 22% tomato: 11% okra) and produces a 30 g leather from 200g of fresh vegetable. Crude fiber, crude protein, ash, crude fat, beta carotene content of the leather were 10.67% (SD 0.06), 13.48% (SD 0.33), 3.648% (SD 0.02), 1.82% (SD 0.35), 4.69mg/100g (SD 0.28) respectively. From the two packaging materials, laminated aluminum retained significantly higher levels ($p < 0.05$) of color and β -carotene while maintaining significantly lower level of moisture ($p < 0.05$) compared to 300 gauge PP during one month of storage period. Yeast & mold count and total plate count in the safe range (zero colonies at 10^3 dilution) suggests the leather is microbiologically safe for minimum one month packed in 300 gauge PP at ambient temperature. In conclusion organoleptically acceptable composite vegetable leather can be developed from locally available vegetables with minimum one month shelf life.

Keywords: Vegetable leather; dehydration; proximate composition, packaging materials

Physiochemical and microbiological quality of curd produced in three agro climatic zones in Sri Lanka

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Curd is one of the oldest fermented milk products in Sri Lanka obtained by lactic acid fermentation of cow milk ("Deekiri") or buffalo milk ("Meekiri"). Curd is produced both at industrial and house hold level mainly in four different agro climatic zones in Sri Lanka. The physiochemical properties of curd vary depending on milk quality and production parameters. Its physiochemical parameters and their variation according to production scale and production zones are not adequately studied. The research was conducted to analyze the physiochemical and microbial properties of Meekiri and Deekiri in relation to production scale and production areas while comparing the value with fresh curd prepared in the laboratory using standard procedures. Fresh Meekiri and Deekiri samples produced at home scale and commercial scale were collected from three agro climatic zones; dry zone, wet low country and coconut triangle; of Sri Lanka. Selected physical (whey separation, syneresis), chemical (total solid, fat, protein, solid non fat, Ca and Mg) and microbiological (total plate count, total yeast and mold count) properties of collected samples were compared to identify any difference in relation to production scale and production area. Further, these parameters were compared with fresh curd samples prepared in the laboratory using both cows' milk and buffaloes' milk. The results revealed that considering the scale of production house hold level Meekiri was found to be having significantly high ($p < 0.05$) fat (6.37SD 0.82%), protein, solid nonfat (17.09SD 2.45%) and titratable acidity levels compared to industrial products while industrial products showed significantly high whey separation (1.61SD 0.69ml/10g1h). Considering the Meekiri production zones, ash (1.064SD 0.12%) and calcium content was significantly high ($p < 0.05$) in dry zone while solid nonfat (19.01SD 1.68%) was significantly high ($p < 0.05$) in coconut triangle. Further considering "Deekiri", household products were found to be having significantly high fat (5.71SD 0.86%) and protein contents while industrial products were having significantly high values for calcium (4.97SD 0.17mg/g), titratable acidity, whey separation (1.56SD 0.54ml/10g1h) and syneresis (0.64SD 0.34ml/10g). No significant difference ($p > 0.05$) was observed for microbiological properties in relation to production scales or zones for both Meekiri and Deekiri. Additionally, considering laboratory and commercial samples, laboratory Meekiri showed significantly high ($p < 0.05$) total solid (22.67SD 0.51%), fat (7.97SD 0.19%), protein (32.9 SD 0.3%), titratable acidity (2.57 SD 0.2 lactic acid %), and Ca levels while laboratory Deekiri had significantly high ($p < 0.05$) total solid content (19.32 SD 0.6 %). It can be concluded that key physiochemical variations exist among curd in relation to production zones and production scale due to different procedures, techniques and additives used in curd production.

Keywords: curd; physiochemical; microbiological

Characterization and comparison of alkali extracted starches from wheat, rice, foxtail millet, proso millet, cassava and sweet potato

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Starch is used in the food industry to impart functional properties, and to modify food texture and consistency. Both the amount and the physicochemical properties of starch are greatly critical for the texture of a given food product. The physicochemical properties of starch differ with its source. In recent years, substantial efforts have been made to obtain starches from non-conventional sources and to study their functional, rheological and physicochemical properties. In this work, the wheat flour (*Triticum* spp.), white rice (*Oryza sativa*; Bg 357), foxtail millet (*Setaria italica*; ISC 480), proso millet (*Panicum miliaceum*; AC 254), cassava (*Manihot esculenta*; Kirikawadi) and sweet potato (*Ipomoea batatas*; Wariyapola-red) starches were obtained according to the alkali extraction method. Proximate composition, mineral content, physical properties and microscopic characteristics were determined and they were compared with starch extracted from commercial corn flour. The level of starch extracted was ranged within 27.49% and 64.10% on the dry basis, with a high level of purity (>98%). The highest extractable starch was obtained from rice ($64.10 \pm 3.35\%$). Very low fractions of crude protein, crude fat, fiber and ash and minerals (P, Ca, Mg, Fe, Mn, Zn, Al, Cu & Ni) were observed in extracted starches. The amylose content of starches ranged from 17.08% to 27.56% and corn starch contains 27.83% of amylose. The amylose content followed the order: proso millet > wheat > foxtail millet > rice > sweet potato > cassava, whereas amylopectin content followed the order: cassava > sweet potato > rice > foxtail millet > wheat > proso millet. However amylose and amylopectin contents of both corn and proso millet were not significantly different ($P < 0.05$). There was considerable variation in swelling factor, solubility, gelatinization temperature among the all starches. Both swelling power and solubility had positive relationship with temperature and the swelling power (at 90°C) followed the order: corn > cassava > foxtail millet > wheat > proso millet > rice > sweet potato. Gelatinization temperature of starches ranged from 62°C to 76°C and followed the order: sweet potato > rice > proso millet > cassava > wheat > foxtail millet. The gelatinization temperature was similar in corn and cassava (76°C). The starch granules were oval, truncated and rounded. The study would be helpful to better understand about the chemical, physical and microscopic characteristics of these starches and the application of novel starches obtain from non-conventional sources which are foxtail millet, proso millet and sweet potato as a thickening agent and a substitute to other common starches in food.

Keywords: Foxtail millet; microscopic characteristics; physicochemical properties; proso millet; starch isolation

Evaluation of nutrient contents of commercially available dog and cat food and food supplements in Sri Lanka

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Nutrition of cats and dogs is central for health and wellbeing. Quality of life measured in terms of reduced incidence of diseases and the ability to maintain an active life would appear to be able to be enhanced by appropriate nutrition and nutraceutical supplementation. Numerous commercial products are available in the market for cats and dogs, and many are formulated for specific life stages. It is important that the composition and nutrient profiles of pet food correspond to the specific nutritional requirements of cats and dogs in different life stages. A number of different nutritional disorders may arise, depending on which nutrients are under or over abundant in the diet(1). In order to prevent these nutritional disorders estimation of concentration of different nutrients in commercially available pet food and dietary supplements is essential. Therefore, this study was designed to assess the precise content of different nutrients in commercially available cat and dog food and supplements in Sri Lanka to ensure that they are containing nutrients as indicated in the labels. For the study frequently used 28 commercial pet food brands and 19 supplements were selected and triplicates from each sample were taken to determine the exact nutrient contents. Proximate analysis according to AOAC standards was performed to determine crude protein, crude fiber, crude fat, ash, moisture and energy contents in pet food. Mineral analysis was done using Flame Atomic Absorption Spectrometry and UV-visible Spectrophotometry. One sample t-test was employed to compare the mean nutrient values with corresponding label values. Results revealed that at 95% confidence level, all food samples contained the label moisture contents while only 67%, 77% and 73% of pet food included label ash, fiber and protein levels, respectively. There was a large variation in fat content, and most of the analyzed fat levels were lower than the declared values. Even though these products did not contain the label values, most of them fulfilled the nutrient requirements of the animal. Furthermore, all food types and mineral supplements contained excess amounts of calcium when compared with label contents and pet requirements. The results indicated that there should be an improvement and adjustment of nutrients and minerals in all types of commercial pet food and supplements used in Sri Lanka to ensure the health and longevity of cats and dogs.

Bontempo, V, (2005) Nutrition and health of dogs and cats: evolution of petfood. *Veterinary research communications*, 29 Suppl 2, pp.45–50.

Keywords: Cat and dog food; label contents; nutrient requirements; proximate analysis; spectrometry

Spent Brewer's Yeast: a protein rich feed ingredient for dairy cattle

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Dairy sector is considered as one of the most important livestock subsectors. Lack of good quality feed ingredients is one of the major constraints faced by this industry. Spent brewer's yeast is a byproduct produced in brewing industry. This study was an attempt to determine the potentials of brewer's yeast as a cattle feed ingredient and to improve production performances of dairy cattle by utilizing this ingredient. Prior to the experiment on dairy cattle, the proximate analysis of this brewer's yeast revealed to be rich in protein 39.5%(SD 0.4) and energy 4445 kcal/kg(SD 919). Further, it had a moisture content of 1.573%(SD 0.06), fat 0.71%(SD 0.14), fiber 0.20%(SD 0.19) and an ash content of 5.607%(SD 0.19). In addition, CA content was 637.86mg/kg, Mg 1016.91mg/kg, Fe 250.47mg/kg and Zn 79.10mg/kg. Feed formulae were prepared using a feed formulation software with three different inclusion rates such that dairy cattle requirements were met. Wheat bran, rice polish, coconut poonac and Dicalcium phosphate were added with spent brewer's yeast and used as the treatment feed and a control feed excluding brewer's yeast was formulated. According to the formulae, ingredients were mixed, pelleted, dried and fed to selected cows in Gal Pokuna farm at Kuliyapitiya. As a pilot study four cows which were in the same lactation were selected initially to test the best inclusion rate of this ingredient. Samples of three feed with different inclusion rates (5%, 10% and 15%) and a control feed were fed to four cows for a week to select the best performing feed. As a result 5% inclusion rate was selected as the best performing rate and fed for three cows for two weeks. Similarly control feed was given for separate three cows. The milk yield and milk fat content were analyzed. The milk yield showed no significant difference among the two tested groups ($p > 0.05$). But milk fat content showed a considerable increment in the treatment feed. These findings revealed that even though this ingredient will not show a considerable increment in the milk yield still it will show a positive impact on the milk fat content.

Keywords: Dairy cattle feed; milk fat; production performances; Spent Brewer's Yeast

Prevalence and control of mastitis in dry area of Kurunegala district

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A cross-sectional study was carried out from February 2016 to June 2016 to estimate the prevalence and control of mastitis, to assess the associated risk factors and to determine the antimicrobial response pattern in 6 veterinary divisions in Dry area of the Kurunegala District, Sri Lanka (Kotawehera, Polpithigama, Giribawa, Ganewatte, Galgamuwa, Ahetuweewa). From 30 small holder dairy farms, a total of 139 lactating cows were tested for mastitis using the California Mastitis Test. ABST was done for 8 antibiotics and mean responses were given as the following table (P=0.000).

Antibiotic	Mean Response (mm)	±SD
Ampicillin	0.0000	0.0000
Colistin Sulfate	0.3139	1.8833
Cloxacillin	0.3333	2.0000
Penicillin	0.3611	2.1667
Tetracycline	7.1333	7.8527
Oxytetracycline	7.5639	8.4403
Neomycin	10.6611	5.9512
Gentamycin	15.8833	6.1343

Of all tested cows, 36(25.9%) were positively diagnosed having mastitis. Among tested 36 mastitic cows 6(16.67%) were at their initial parity, 7(19.44%) were at the 2nd, 9(25%) at their 3rd, 5(13.89%) at their 4th and 2 at their 5th parity. Consecutively the remaining cows were at their 6th, 7th, 9th, 10th, 11th & 12th parity with equal frequency of 1(2.78%)(P=0.001). When considering the effect of lactation stage 2(55.56%) cows were from 1-4 months from parturition. 12 cows (33.33%) were from 5-9 months from parturition and 4(11.11%) were at their late lactation stage(P=0.005). When

finding out the relationship of occurrence of mastitis and rearing cows within or away from sheds during day time it was found that 21(70%) farmers keep their cows in sheds during daytime and 9(30%) farmers keep cows outside. There was no any significant relationship of keeping cows in sheds or not during day time on the occurrence of mastitis (P=0.314). During the investigation *E-coli* was identified in 44.44% cases, *Staphylococcus* in 30.56% cases and *Streptococcus* in 5.56% cases. Mixed cultures were identified from the remaining 19.99% cases (P=0.008).

For the investigated area, following conclusions can be taken. **Gentamycin** is the most effective antibiotic which can be used at the point of identification of infection and *E-coli* is the most prominent causative agent present. During the initial 4 months of the lactation and the initial parity stages are the critical stages which attention should be paid on cows because there is a higher possibility of infection during these stages than other stages. But there is no effect of keeping cows within sheds during day time on the occurrence of mastitis.

Keywords: Antibiotic treatment; mastitis; causative agent; CMT

Determination of nutritional composition in most common and frequently used commercial dairy cattle feed and mineral supplements in Sri Lanka

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Concentrate feeding is an important aspect of modern day dairy farming. Those must be carefully selected to balance the specific nutrients provided by forages(1). Feeding proper amounts of minerals is equally important to prevent diseases, reproductive problems and production losses(2). In Sri Lanka there are many commercial concentrated feed brands and mineral supplements for dairy cattle available in the market. Therefore, rather than the label content, both large and small scale dairy cattle farmers require guaranteed proximate analysis of those products. Thus the aim of this project is quantitative determination of actual nutritional composition of the most common and frequently used commercially available dairy cattlefeed and mineral supplements in the market. In here eight commercial concentrate feed brands and fifteen mineral supplements were collected. Feed samples were proximately analyzed according to the AOAC standards. After that Calcium, Magnesium, Zinc, Copper, Manganese, Cobalt and Selenium content of both feed samples and mineral supplements were analyzed by iCE 3000 Atomic Absorption Spectrometer. Furthermore phosphorus content was determined with the use of UV-Visible Spectrophotometer (Model no: G10S UV-Vis).One sample t-test was used to compare means ofproximate and mineral analysis data in accordance with their label content. At 95% confidence level, among eight feed brands, 37.5% exceeded their maximum moisture and ash content, while 50% exceeded maximum crude fat level. Only 25% exceeded maximum crude fiber level when 50% of feed brands showed less crude protein level than the minimum label content. Almost all feed brands had higher energy content than the maximum label values. Including seven feed brands and fourteen mineral supplements 64% had higher Calcium values and only 29% had lower Phosphorus level than their label content. Among thirteen mineral supplements 54% brands had higher Magnesium content than label value while Zinchad only (46%). Selenium (33%) and Cobalt (42%) levels among twelve supplements showedless valuesthan indicated in the label. From eleven mineral supplements 45% had higher Copper content compared to the label and 60% of five supplements showed higher Iron value than the label. Only 10% of ten supplements had higher Manganese value than the label. Overall results indicated that label content of tested products could not always provide their actual nutritional composition.

Kellaway, R. & Harrington, T., 2004. *Feeding concentrates - Supplements for dairy cows*, Adams, R.S., 1975. Variability in mineral and trace element content of dairy cattle feeds. *Journal of dairy science*, 58(10), pp.1538–1548. Available at: [http://dx.doi.org/10.3168/jds.S0022-0302\(75\)84750-3](http://dx.doi.org/10.3168/jds.S0022-0302(75)84750-3).

Keywords: Dairy cattle feed; label content; mineral supplements; proximate analysis; spectrometry

Formulation of calcium enriched yoghurt prepared from milk collected from cows fed with a milk booster

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Sri Lankans are at intermediate risk when compared to other countries in Calcium deficiency (International Osteoporosis Foundation, 2013). For this reason there is a high market potential for Calcium enriched products. A study was conducted in National Livestock Development Board (NLDB) farm at Galpokuna to evaluate the effect of a milk booster on Calcium level of cow milk and to determine the extent of Calcium enrichment of yoghurt prepared from cow milk collected from cows supplemented with the milk booster. Six milking cows were selected and fed with the milk booster for 3 weeks at the rate of 50 g/cow/day. Three sets of milk samples were collected during experimental period: before treatment; at the end of 2nd and 3rd week cessations of treatment, respectively. For each milk sample yoghurt was prepared before treatment, at the end of 2nd and 3rd weeks. Then both milk and yoghurt samples were analyzed for the level of Calcium using Atomic Absorption Spectrometry (AAS). At 95% confidence level, there was a significant difference of mean Calcium concentration level in cow milk between, before (196.8 mg/dl) and after two (207.28 mg/dl) and three weeks (216.48 mg/dl) of supplementation. There was a significant difference in mean Calcium concentration level of yoghurts after three weeks (217.92 mg/dl), two weeks (209.56 mg/dl) and before (198.9 mg/dl) supplementation at 95% confidence level. There were significant differences of milk yield after three weeks supplementation and before supplementation in cows. The milk booster has a positive effect on Calcium concentration in dairy milk. Thus Calcium bioavailability in milk and yoghurts could be increased by natural means such as through supplementation.

International Osteoporosis Foundation, 2013. Asia Pacific Audit. Sri Lanka. Available at: <http://www.iofbonehealth.org/sites/default/files/media/Regional>.

Keywords: Atomic absorption spectrometry;calcium;enriched yoghurt;milk booster

Quality parameters of cow milk produced in dry areas of Kurunegala district, Sri Lanka

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Milk has been used for human consumption for thousands of years. Because of its nutritional composition such as fat and SNF % and other micronutrients, cow's milk is the most popular animal milk consumed by humans. Kurunegala district is one of the largest milk producing districts in Sri Lanka due to higher number of dairy cattle and larger number of milk collecting centres. There is statistically proven evidence on the effect of seasonal variation on composition of milk in other countries¹. But in tropical countries like Sri Lanka there is more climatic variation rather than seasonal variation. Thus, the purpose of this study was to check, within same agro-climatic region whether there is a significant difference in quality parameters of cow milk in different dry areas of Kurunegala district and determine the mean values of fat, SNF percentages and specific gravity in dry areas of Kurunegala district. Bulk milk samples were collected from farms of 6 Veterinary Surgeon (VS) divisions to determine the quality parameters of cow milk during the period from March to June. Five bulk milk samples were collected from each VS division and each sample was tested for total fat and SNF percentages by Gerber method and lactometer reading, respectively and total bacterial count by spread plate method. The milk ring test (MRT) was done in order to elicit the incidence of brucellosis. One – way ANOVA was carried out at 95% confidence level to check whether there is a significant difference in quality parameters in different dry areas. As a result, there was a significant difference ($P < 0.05$) in fat, SNF percentages and specific gravity between dry areas. There was no significant difference ($P > 0.05$) in total bacterial count between dry areas and the total bacterial count was more than 1000 colony forming units (CFU) per mL in all dry areas. One sample t-test was carried out at 95% significant level in order to determine the mean values of fat, SNF percentages and specific gravity. The mean values for fat, SNF and specific gravity were 3.71% (SD 1.13), 7.51% (SD 0.61) and 1.0249 (SD 0.0028), respectively. There was an evidence of brucellosis in areas like Kotawehera, Ehetuwewa and Polpithigama. The results of this study showed that within same agro-climatic region, from one area to another there is a significant difference in quality parameters of cow milk, and ranges of the fat, SNF percentages and specific gravity are 2.6% - 4.8%, 7.0% - 8.1% and 1.0221 – 1.0277, respectively.

Abbas, H.M., 2014. Physicochemical Characteristics of Goat's Milk. *Life Science Journal*, 11(1s), p.308.

Keywords: Bulk milk samples; cow milk; dry areas; Fat; SNF

Effect of herbal feed additives on egg Cholesterol level and quality

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Egg is a nutritious and an important component in a balanced human diet. The quality characteristics of an egg affect consumer preference and high concentration of cholesterol in egg yolk has been a major concern of consumers. This study was carried out to test the effect of herbal feed additives on egg quality and cholesterol. Recent researches have revealed that some herbal additives reduce cholesterol in poultry meat and blood. *Murrayakoenigii*, *Psidium guajava* L., and *Desmodium triflorum* leaves are traditionally used to reduce cholesterol level in human.

The experiment was conducted to identify the effect of herbal feed additives on egg cholesterol level and quality. Standard layer diet was made as control (T1) and the experimental diets were consisted of standard layer diet added with 1% freeze dried leafy meal of *Desmodium triflorum* (T2), *Psidium guajava* L. (T3) and *Murrayakoenigii* (T4). Lohmann white hens (N=20) were allocated into 4 experimental groups and from the end of 2 weeks of flushing up time, eggs were collected continuously for three months for analysis. Egg cholesterol level was tested using Stanbio cholesterol liquicolor® analyzing kit and internal and external egg quality parameters; shell thickness, egg weight, albumen height, yolk height, yolk color, albumen width, yolk diameter, haugh unit, albumen index and yolk index were calculated. Significant differences ($p < 0.05$) were observed in egg weight, albumen height, yolk diameter and shell thickness among treatments. Egg weight was significantly ($p < 0.05$) higher in T2 than in T1. Yolk index was affected significantly ($p < 0.05$) by the diets and the highest yolk index was found in T4 compared to T1. Reported cholesterol levels of this study were 13.345 mg/g of yolk (T1), 13.750 mg/g of yolk (T2), 13.817 mg/g of yolk (T3), and 13.675 mg/g of yolk (T4) and those were higher compared to standard cholesterol level and the diets had no significant effect ($p < 0.05$) on cholesterol levels. Albumen index, haugh unit, yolk color, yolk height and albumen width were not significantly affected by the treatments ($p < 0.05$). Based on these findings, it can be concluded that selected herbal feed additives at 1% level had no significant ($p < 0.05$) effect on egg cholesterol level but it affected to some egg quality parameters such as egg weight, albumen height, yolk diameter, shell thickness and yolk index. Further experimentations with high levels of herbal feed additives and different aged groups of hens is suggested.

Keywords: Cholesterol; egg quality; herbal additive; *Murrayakoenigii*; *Psidium guajava*

Formulation of cattle feed using banana (*Musa spp.*) pseudo stems and pineapple (*Ananasspp.*) peels

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Lack of quality forages year around to fulfill the daily requirement of feed is one of the major constraints in Sri Lankadairy sector. Pineapple peel(PP) and banana pseudostem(BS)are good fiber sourcesand could be alternative forage for cattle.The main objective of this study was to develop a balance ration which has high palatability for lactating dairy cows using PP and BS as main fiber sources.The proximatecomposition of both sundried PP and BS were analyzed.Four rations were formulated including different levels of PP and BS at 75% PP and 25% BS (Ration 1), 50% PP and 50% BS (Ration 2), 60% PP and 40% BS (Ration 3)and 25% PP and 75% BS (Ration 4). *Broken rice, soybean meal, copra meal, maize, rice bran and dicalcium phosphate were the other feed ingredients and the rations were pelleted.* Four Jersey × Sahiwal cross breed cows of second parity, 280 – 310 kg of weight and yielding around 10L of milk per day were selected for the palatability experiment. Rate of feed intake of each ration was measured. The average dry matter, crude fiber, crude protein, crude fat, ash, gross energy content of PP and BS were 14.99 ± 0.09 , $2.44 \pm 0.06\%$; 20.47 ± 0.03 , $34.57 \pm 0.08\%$; 5.75 ± 0.04 , $2.31 \pm 0.02\%$; 0.62 ± 0.03 , $0.56 \pm 0.09\%$; 6.85 ± 0.07 , $23.20 \pm 0.28\%$ and 4223.68 ± 10.23 , 3859.88 ± 61.06 cal/g, respectively. Average rate of feed intakes of four rations were significantly different ($p < 0.05$). The highest average rate of feed intake was observed from ration 3 (208.09 gram/minute). Therefore, these results can be concluded that sundried pineapple peels and sundried banana pseudostems can be mixed at 60% and 40% ratio respectively for cattle feed to achieve highest feed intake by animals.

Keywords: Nutritional composition; nutritional requirements of cow; palatability test; proximate analysis; feed intake

Potentials, constraints and present status of goat farming in Puttalam district of Sri Lanka

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Goat farming is a famous livelihood in rural communities because it requires low level of input. Puttalam district accounts for 9.13% of the total goat population in the country. The study was conducted in 60 goat farms using a pre-tested questionnaire to identify potentials, constraints and present status of goat farming in Puttalam district. Goat farming was the main livelihood of 25% of farmers and secondary income source for 70% of farmers. Selling male goats was the main income source for family. Main purpose of rearing was for meat (92%) and breeding (8%). Milking of goat for own use was reported (12%) but not for commercial purpose. Goat manure was a regular secondary income source for 85% farmers. Extensive system (78%) and semi intensive system (22%) were main rearing systems. Breed composition of the study sample was 50% indigenous breeds, 10% exotic and 40% cross breeds and percentage of male and female goats were 71% and 29% respectively. Grazing land for 32% of the farmers were common grass lands while own lands and road sides were used by 18% and 17% of farmers respectively. Free grazing, cut-fodder feeding, and tethering were main feeding systems. Family labour (98%) was the main source of man power and, 2% of farmers used hired labour or tenants system. Permanent housing was available in 65% of farms while rest of the farms had temporary housing systems and 98% of farm structures were constructed in the lands where farmers lived. Stud-mating was the only breeding method. Majority of farmers borrowed (56%) or hired (8%) studs for breeding. Majority (70%) of goat farmers were male showing that goat farming in Puttalam district was male dominated industry while 30% were female. The average number of goats per farm was 17 ± 10.10 goats. Health and hygiene practices were poor in study area. Kids' pneumonia, bloating, diarrhea, Foot and Mouth Diseases (FMD) and parasitic infections were the main field problems and cause of animal death. Kid mortality (69% out of total deaths) has become a serious threat. Majority of farmers (95%) practiced irregular deworming against endo-parasites while other farmers practiced no control measures. Vaccination of goats for any disease was not reported. Identified barriers for expansion of goat farming were lack of extension services, feed, capital and guaranteed market. Availability of underutilized land areas, availability of labourers, high demand for goat meat, and willingness of farmers to be in the goat farming were the major potentials that may be considered in goat development programmes for the area. This study identified that development of appropriate techniques of feeding, breeding and disease control is mandatory for sustainable goat production in the district.

Keywords: Breeding; goat farming; housing; kid mortality; management system

Development of Cow Milk Based Value Added Condensed Curd Product for Sri Lankan DairyMarket

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Curd is the traditional dairy product which has higher consumer demand in Sri Lanka. Demand driven Sri Lankan dairy market requires value added nutritious and quality improved variety of dairy products for the growth of the sector. This present study was conducted to develop and test consumer preference for a new cow milk based value added condensed curd product. A series of flavored curds products were developed from condensed fresh cow milk. By using sensory test 01, (ST₁) was conducted to check the acceptability of the sweetened product (T₁), buffalo curd served with sugar (T₂), and cow milk curd served with sugar (T₃) as controls. At the ($p < 0.05$) by Freedmann method, (T₁) new product preferred same as (T₂) and (T₃). Sensory test 02 (ST₂) was conducted to check the most preferred sugar level by using product-T₁ with point hedonic scale. Used sugar levels were, very low (L₁), low (L₂), medium (L₃), and high (L₄). In ST₂. Most preferred sugar level is L₃. Using T₁L₃, product was further tested at different condensation levels of fresh milk of low (C₁), medium (C₂), high (C₃). Results revealed that C₂ had the most preferred texture. Most preferred flavor type was found to be strawberry (V₁), vanilla (V₂), chocolate (V₃) in high to low preference compared to non-flavored product T₁L₃C₂ according to the sensory test 03 (ST₃). Test results shows that, T₁L₃C₂V₂ & T₁L₃C₂ have no significant difference while T₁L₃C₂V₁ and T₁L₃C₂V₃ having less mean value and consumer preferences accordingly. Proximate analysis proved that the developed T₁L₃C₂V₂, T₁L₃C₂, T₁L₃C₂V₁, and T₁L₃C₂V₃ products contain 5.10% \pm 0.43% protein, 4.43% \pm 0.25% fat 126.3 kcal/100g, Ca 0.13 % (\pm 0.05%) energy, and 71.43% \pm 1.20% moisture.

The shelf life of the T₁L₃C₂ product kept under refrigerated conditions is acceptable based on organoleptic properties up to 14 days and titratable acidity was 0.83%. T₁L₃C₂ with added Potassium Sorbate as a preservative (at SLSI standard), has extended shelf life 28 days in refrigerated conditions with product titratable acidity of 0.85%. Cost of production of this new product was LKR 23.81 while the mark-up price is same as buffalo curd LKR 50.00/ 80ml cup. The results of the test concluded that according to the consumer preference, nutritional profile, shelf life and the cost of production per serving, the new sweetened condensed curd product can be introduced as alternative value added dairy product

Keywords: Condensed curd; value addition; consumer preference; nutritional profile; shelf life

Impact of virgin coconut poonac on performance and carcass quality of broiler chicken

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Virgin coconut poonac (VCP) is the residue left from the extraction of a virgin coconut oil. VCP was found to contain 22.75% protein, 1800 kcal/kg of energy and 2.89% fat. The effect of replacement of expensive protein sources with phytase supplemented VCP as an alternative protein source on the performance and carcass quality of broiler birds was investigated in the study. Cobb-500 (n=50) chicks were randomly assigned to five dietary treatments (T) in a completely randomized design. Maize, coconut poonac and soybean meal based control diet (T1) and four test diets were prepared with VCP at 10% (T2), 15%(T3), 20%(T4), 25%(T5), by replacing normal coconut poonac. Feed intake was recorded daily and live weights of birds were recorded once in every five days. Percentage of carcass recovery, major meat cuts, organ to carcass ratio, feed conversion ratio (FCR), broiler performance index (BPI), and broiler efficiency index (BEI) were calculated. SAS 9.2 and SPSS 16.0 were used to analyze data statistically.

Results revealed that there is no significant difference ($p > 0.05$) between body weights among birds of different treatments at 42 day. But, all the inclusion rates of virgin coconut poonac improved the growth performance and carcass yield of broiler chicken compared to control. BPI of T1, T2, T3, T4 and T5 were recorded as 1.44, 13.92, 21.02, 17.74, and 17.09 respectively and significantly different ($p > 0.05$) compared to control. T3 has higher BPI and higher the BPI, better the performance. Carcass recovery of five different treatments was in the range of 71.55% to 77.42%. T3 showed higher carcass recovery percentage and T5 showed the lowest. FCR values of T1, T2, T3, T4, and T5 were recorded as 1.88, 1.86, 1.81, 1.82 and 1.83 respectively. T3 has the lower FCR value. Low FCR value is an indication of better feed efficiency. Final body weights of T2, T3, T4 and T5 are greater than in T1. Final body weights of all the treatments are in the range from 1.775 kg to 1.836 kg. BEI values of five treatments were recorded as 0.67, 6.43, 9.55, 9.26, and 8.29. Higher BEI value was an indication of higher performance always in relation to better profit, better FCR, lower age at disposal, higher average live weight at disposal and higher survival rate of birds. According to those values, T3 was the most effective in relation to performance of broiler chicken. Replacing normal coconut poonac with phytase supplemented virgin coconut poonac has beneficial effects in terms of performance and carcass quality of broiler chicken.

Keywords: Broilers; carcass quality; inclusion rates; performance; virgin coconut poonac

Production of alternative roughage feed with dry grass meal and evaluation of the feeding value

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Dairy industry is the most prioritized livestock sub sector in economy of Sri Lanka. Lack of good quality forage year around is a major constrain to profitable dairy production. Forage conservation as silage or hay is a limited practice among the Sri Lankan dairy farms mainly due to higher labor requirement. Convenient forage conservation method which require less labor is a timely need. This study was designed to evaluate the feasibility of conserving forages in dry pellet form and to study the palatability and keeping quality. Four forages varieties; *Gliricidiasepium*, Hybrid Napier Grass (CO-3), Hybrid Napier Grass (CO-4), and *Leucaenaleucocephala* (Ipilipil) were harvested at correct maturity and dried under oven (control), sun (T1), and specially developed solar drier (T2) to evaluate the best drying method. Dried forage samples were pelleted and analyzed for crude protein, energy, ash, keeping quality, aroma, acceptability and palatability of dairy cows.

There was a significant difference ($P < 0.05$) in palatability between the pellet and mash form of forages. Pelleted grass meal recorded better palatability than the fresh grass. Among these four types of forages *Gliricidiasepium* was the most palatable forage pellet. But there was no significant different ($P > 0.05$) of palatability based on drying method. There was a significant difference of the dry matter content based on drying method ($P < 0.05$). Average dry matter yield of samples dried in the Oven, developed solar drier and Sun light, were $24.25\% \pm 2.35$, $21.74\% \pm 2.18$ and $14.39\% \pm 1.64$ respectively. Amount of dry matter yield loss of the developed solar dryer is low when compare to sun drying. Average required amount of wet forages to produce the 1 kg of dry grass meal pellet is $4.66\text{kg} \pm 1.23$. the cost of Wet forage was Rs 6.00/kg and, cost of production of dry grass meal pellet was Rs 27.96/kg. Average weight of the one cubic meter of this pellet is $650\text{kg} \pm 5.25$ and that is sufficient to satisfy dry matter requirement of 65 animal units. Under normal condition, pelleted grass meal can be stored over 3 months without mould formation and off colour development. The study indicated pelleted grass meal is acceptable, economical, high in quality and potential alternative method for forage conservation.

(1) Thorpe, W., (2014). Appraisal of the Sri Lanka Dairy Sector Volume 2 : *Synthesis*, 2

Keywords: Conservation; dry grass meal; dry matter; palatability; pellet

Quantification of selected heavy metals and trace elements in cow milk produced in Kurunegaladistrict, Sri Lanka

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Cow milk is recognized as an almost complete food in the human diet as it provides all macronutrients and most of micronutrients. Heavy metals and trace elements are also one of the important categories of micronutrients in cow milk which have various biological functions within the human body. Although they are essential, they can be toxic when taken in excess. That is widely considered all around the world, but only few investigations deal with the Sri Lankan context. Therefore, the main objective of this study was to quantify some selected heavy metal and trace element concentrations (Pb, Cd, Zn, Cu, Cr and Mn) of cow milk produced in Kurunegala district which is the highest cow milk producing district in Sri Lanka and to compare those with the maximum permissible levels.

Fresh cow's milk samples were collected from five randomly selected milk collecting centers in each of 25 veterinary divisions in Kurunegala District and preserved in a deep freezer (-180C). The milk samples were digested by the optimized microwave digestion method using HNO₃. The concentrations of Pb, Cd, Zn, Cu, Cr, and Mn were determined by Flame Atomic Absorption Spectrophotometer. The mean concentrations of Pb, Cd, Zn, Cu, Cr and Mn in 25 veterinary divisions were 221.98(SD 174.60) ppb, 16.49(SD 13.50) ppb, 3353.94(SD 593.28) ppb, 38.88(SD 65.97)ppb, 37.42(SD 133.38)ppb and 0 ppb, respectively. The highest concentrations of Pb, Cd, Zn, Cu, and Cr in the milk samples of 25 veterinary divisions under the study were 607.75(SD 565.14)ppb, 47.5(SD 21.97)ppb, 4367.5(SD 561.78)ppb, 316(SD 604.76)ppb and 675.5(SD 8.76)ppb, respectively. There was no significant difference ($P < 0.05$) in the mean concentrations of Pb, Cd, Zn and Cr in milk of 25 veterinary divisions whereas, mean Cu concentration showed a significant difference ($P > 0.05$) among 25 veterinary divisions. The concentrations of all selected heavy metals and trace elements were lower than the maximum permissible levels. Therefore, it can be concluded that, the fresh cow milk produced in Kurunegala District is safe to consume under current condition.

Keywords: Flame atomic absorption spectrophotometer; fresh cow's milk; maximum permissible levels

Effect of cassava leaf supplement on cow milk composition and shelf life of set yogurt

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Cassava (*Manihot esculenta*) leaf is a commonly available crop by product which has high nutritional value as an animal feed ingredient. Dry matter, crude protein, ash, tannin and cyanide content of cassava leaves are 86.30%, 23.60%, 8.90%, 0.26% and 0.35%, respectively. Cassava leaves contain high amount of lysine, methionine, isoleucine and leucine. This study was conducted to estimate composition of milk and compare shelf life of yogurts made with milk of cows fed with cassava leaves. Jersey × Sahiwal crossbred cows (n = 6) in second lactation with uniform body weight and milk production were selected and allocated into two groups as treatment and control. Cassava leaves were harvested about 10-15 cm above ground level at 3 months after planting and stored under the shade for 1-2 days. Wilted cassava leaves were provided to cows in the treatment group in 3 different ratios (Treatment 1 - 1kg cassava leaves/head/day, Treatment 2- 2kg cassava leaves/head/day and Treatment 3- 3kg cassava leaves/head/day). Each treatment was carried out for two weeks. Milk yield, Fat and protein contents were determined weekly. Yoghurts were prepared using milk collected from cows in treatment and control groups. Titratable acidity of yoghurts was measured weekly up to four weeks and total plate counts of yoghurts were measured at the fourth week of storage. According to the results there was no significant different ($P > 0.05$) in the milk yields of cassava leaves fed cows and cows in the control group. Feeding cassava leaves supplement significantly increased the milk fat ($P < 0.05$) and milk protein ($P < 0.05$) in cows under treatment 3 group than the cows in control group. Mean fat contents of the cows in treatment 3 and control groups were $5.9 \pm 0.4\%$ and $4.9 \pm 0.7\%$ respectively and the mean protein contents of the cows in treatment 3 and control groups were $3.68 \pm 0.03\%$ and $3.1 \pm 0.14\%$, respectively. Titratable acidity of yogurts made with milk of cows in treatment 3 was significantly lower ($P < 0.05$) throughout the four weeks of storage than that of control. Mean total plate count of yogurts made with milk of cows in treatment 3 ($1.31 \times 10^9 \pm 5.5 \times 10^7$ cfu/g) was significantly lower ($P < 0.05$) than that of control ($2.07 \times 10^9 \pm 4.2 \times 10^8$ cfu/g). According to above results it can be concluded that wilted cassava leaves supplementation at the rate of 3kg /head/day increase milk fat and crude protein of fresh milk without any significant increase or decrease in milk yield. Moreover, cassava leaves supplementation has a positive effect for shelf life of set yogurt made with milk of cows fed with cassava leaves.

Key Words: Cassava leaves; Milk composition; Milk yield; Shelf life; Yogurt

Development of commercial goat diet using low cost locally available feed ingredients

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Most significant constraint of goat farming in tropical countries is underfeeding due to limitations of feed both in quantity and quality. This study was conducted to develop a commercial goat diet using locally available, low cost feed ingredients. The pelleted feed were prepared with 14% crude protein, 2400 kcal/kg of digestible energy and 70% TDN according to the recommendations of National Research Council. The experiment was conducted for 15 weeks with 8 weeks old (body weight 20-23 kg) Jamnapari male goats (n=4). In the first step, five commercial goat diets formula were formulated using locally available, low cost feed ingredients and palatability of the goats were checked using each pelleted feed in one week period. Then in the second step, the goats were randomly assigned to two different groups as control group T1 (without pelleted diet) and treatment group T2 (with pelleted diet). The treatment group was fed with the most palatable low cost pelleted diet. The experimental animals were fed based on their body weight according to the NRC recommendations. The data was collected for 60 days based on their daily feed intake and body weight. The average daily feed intake in pelleted form was measured when same amount of fresh forages were also available to all the treatment and control groups. In the T2, commercial feed intake gradually increased considerably until 50 days up to 800g/day and after that slowly increased up to 60 days. Fresh forage intake in same group initially was high as 3000 g/day but decreased gradually up to 2000 g/day. In T1, forage intake remained at 5000 g/day until 30 days. Then it increased up to 6000 g/day until 45 days and became constant around 7000 g/day within last 15 days. Initially the dry matter requirement of T2 group was lower than T1 group, but at the end of the experiment it was higher than the T1 group. There was a significant difference between treatment and control group for body weight gain after 60 days period ($p > 0.05$), But no significant difference was recorded within treatment group ($p < 0.05$). The average daily weight gain of goats under T2 group was 94.44 ± 0.29 g/day and in T1 66.67 ± 0.14 g/day. The calculated Feed Conversion Ratio was 2.23 in T2 and 2.75 in T1.

Cost concentrated feed was LKR 41.55/kg and total feeding cost of T2 group during experimental period was LKR 3,013/= and total feeding cost for T1 group during experimental period was LKR 3,304/= . Thus it can be concluded that, goats fed on pelleted diet had better feed intake and growth performances, suggesting that pelleted concentrated diets formulated with locally available ingredients are economical and potential alternative diet to conventional feed at the farm level for a cost effective feeding.

Keywords: Goat; growth performance; palatability; pellet feed; underfeeding

A study on value chain of dairy sector in Kurunegala district

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Value chain analysis is essential to an understanding of markets, their relationships, the participation of different actors, and the critical constraints that limit the growth of livestock production and consequently the competitiveness of smallholder farmers. These farmers receive only a small fraction of the ultimate value of their output, even if, in theory, risk and rewards should be shared down the chain. Kurunegala district is one of the major milk producing districts in Sri Lanka which contributes around 15% to the national milk production. But less attention has been paid for the development of dairy sector in this district. Therefore, the main objective of this study was to identify the participation of different actors in the value chain and to identify challenges and opportunities for development of dairy industry in Kurunegala district. The data were collected from 15 input suppliers, 420 dairy farmers, 18 milk processors, 50 retail shops and 150 customers from Kurunegala district using validated questionnaires. Apart from that information about the cattle population, data on milk production were collected from the official website of Department of Census and Statistics, Sri Lanka. When considering the participation of different actors in the dairy value chain, it varies according to the type of product which is produced by the processor. To 80g yoghurt cup; farmer adds 18.9% value, collector adds 1.5% value, the processor adds 59.1% value and finally the retailer adds 20.5% of the value to the final output. When producing 1L curd farmer, collector, processor, and retailer adds 42.6%, 2.5%, 42.5% and 12.4%, respectively to the final product. Apart from that when producing 1kg of milk powder farmer, collector, processor, distributor, retailer, government adds 48.9%, 1.7%, 30.2%, 3.4%, 1.7% and 14% value to the product, respectively. According to the results limited veterinary services, poor AI services, inefficient financial support, high cost of feed, lack of labour, poor extension services, lack of dairy related technologies, lack of land for cultivation of different types of grass varieties, lack of grade breeds, lack of awareness in the value added products such as curd, ice cream and yoghurt, lack of contribution from youth, high competitive environment in the milk processing sector, lack of organizations that involve in development of small and medium scale milk processors are the major challenges related to dairy value chain actors in Kurunegala district. The major opportunities for the development of the dairy sector in Kurunegala district include high demand for milk and for other dairy products, presence of people with different cultures and religions, proper milk collecting system, possibilities of genetic improvements and rural nature of most of the area within this district. Thus, in order to develop the dairy sector in Kurunegala district, all the challenges identified in this study need to be carefully considered and addressed. Moreover, the opportunities should be utilized maximally to develop dairy sector in this district.

Keywords: Challenges; dairy sector; major actors; opportunities; value chain

PCR optimization to amplify Single Nucleotide Polymorphisms (SNPs) of LHCGR and GHR genes of cross breed dairy cows in Sri Lanka.

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Single Nucleotide polymorphisms (SNPs) are the most commonly used markers in Marker Assisted Selection (MAS) to select farm animals with traits of interest such as fertility in breeding. Fertility of dairy cows in Sri Lanka is poor due to non-availability of proper breeding strategies to improve fertility and no any researches were focused in this area. Previous studies have proved that four SNPs in exon 11 of Luteinizing hormone receptor (LHCGR) gene and a SNP in exon 8 of Growth hormone receptor (GHR) gene are associated with variations in fertility and production traits. This study was designed to optimize PCR conditions to amplify LHCGR and GHR genes as a preliminary step in MAS. Genomic DNA was extracted from buffy coats of blood samples (6ml) from 15 cross bred dairy cows from a government dairy farm in North Western Province in Sri Lanka. For both genes, PCR was performed using previously designed primers. According to the literature, initial PCR was performed for LHCGR gene with initial denaturation at 95°C for 3 minutes followed by 35 cycles of 95°C for 30 seconds, annealing at 58°C for 30 seconds, extension at 72°C for 2 minutes and final extension at 72°C for 5 minutes. Approximately, 321 ng/μl of extracted DNA was used in a reaction mixture containing 200 μM of dNTPS, 1.25 units of Taq, 1.5 mM of MgCl₂, and 5 μl of 5X PCR buffer in 25 μl reaction volume. PCR conditions were optimized for temperature (48°C, 50°C, 53.8°C, 56°C, 57.8°C, 59.7°C, 63.4°C, 65°C) and primer concentrations (10 pmol, 8 pmol, 6 pmol, 5 pmol). For GHR gene, PCR was performed initially at 57°C annealing temperature and 10 pmol primer concentration according to the literature and optimized for temperature (50°C, 55.2°C, 57.1°C, 58.6°C, 62.3°C) while keeping other cycling conditions and concentrations of other components same as for LHCGR gene. Genomic DNA and PCR bands were visualized by gel electrophoresis using 0.8% agarose under UV transillumination. The PCR which was performed using annealing temperatures mentioned in the literature produced no PCR bands for LHCGR and nonspecific bands for GHR genes. PCR conditions were optimized to 59.7°C and 10 pmol for LHCGR gene, 58.6°C annealing temperature with 10 pmol primer concentration for GHR gene. However, further optimization is required for DNA and MgCl₂ concentrations to improve the accuracy of results. The success rate for DNA extraction (93.33%) was not 100% may be due to DNA degradation during the storage of buffy coat. The success rate for PCR of LHCGR and GHR genes was 93.33% under the optimized conditions. Under the current optimized conditions PCR products can be obtained and sequencing is in progress to find the SNP variations present in the genes to find possible associations of fertility traits in Sri Lankan dairy cows.

Key words: GHR gene; fertility; LHCGR gene; marker assisted selection; PCR

Development of buffalo milk butter and evaluation of consumer preference

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Butter is one of the most popular dairy products which consists a higher amount of fat. Cow milk is the widely used milk type for varieties of dairy products. Buffalo milk is also a popular milk type which is only used for curd production in Sri Lanka. The fat content of buffalo milk (7%) is considerably higher than that of cow milk (4%). Because of the main constituent of butter is fat, considerably higher butter yield would be able to obtain using buffalo milk compared to cow milk. Therefore, this study was aimed to develop buffalo milk butter and compare yield, consumer preference and cost of production with cow milk butter. Both buffalo milk and cow milk butter were made following the standard butter making procedure. Best salt level (among 1%, 2%, and 3%) and the best color level of egg yellow coloring (I.N.S. No110/100g) was determined by sensory evaluation for buffalo milk butter. Final sensory evaluation was conducted to find out the consumer preference for developed buffalo milk butter compared to cow milk butter. Proximate analysis, yield analysis and cost analysis were carried out for both buffalo milk butter and cow milk butter. Sensory evaluation tests for salt levels and color levels revealed that 2% salt and 0.12 mL of egg yellow coloring (I.N.S.No 110)/100g was the most preferred levels by the panelists, respectively. The results of final sensory evaluation test revealed that there was no significant difference ($P > 0.05$) for the consumer preference between two types of butter. Fat, Protein, ash, and moisture contents (%) of buffalo milk and cow milk butter were 82.913(SD 1.498), 83.438(SD 1.351); 1.033(SD 0.008), 1.020(SD 0.060); 0.010(SD 0.009), 0.005(SD 0.003) and 15.452(SD 2.745), 15.948(SD 3.384), respectively. Buffalo milk butter contained higher Ca content (9.76 mg/100g) than cow milk butter (8.05 mg/100g). Results of yield analysis revealed that 9.78g and 10.02 g of butter can be produced from 1% fat of 1 L of buffalo milk and cow milk respectively. Cost analysis results revealed that the milk cost for 100g of buffalo and cow milk butter was Rs 146.22 and Rs 174.65 respectively. Therefore, these results conclude that buffalo milk butter has same consumer preference and higher yield compared with cow milk butter and it would be a profitable buffalo milk product for Sri Lankan dairy industry.

Keywords: Buffalo milk; butter yield; consumer preference; fat content

Productive and reproductive parameters of Jamunapari and Saanen goatbreeds reared in selected farms of Sri Lanka

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Goat is an important species in the livestock sector of Sri Lanka. Although goat farming is popular in Sri Lanka productive and reproductive parameters of goats have not been documented under Sri Lankan conditions. The present study was conducted to estimate the productive and reproductive parameters of Jamunapari and Saanen goat breeds reared in selected farms. Data related to Jamunapari goats were collected from the goat breeding center of Department of Animal Production and Health in Thelaha and data related to Saanen goats were collected from Rosita and Kowulwewa National Livestock Development Board (NLDB) farms and New Zealand farm, using a pre-structured questionnaire. Data related to reproductive parameters and productive parameters of respective farms were collected referring to the records maintained in the period from 2011 to 2016. The average age at 1st kidding, average kidding interval, average birth weight of male and female kids, body weight after 12 months in male and female goats, weaning weight and weaning age of female goats of Jamunapari breed were 585 (SE 10) days, 304 (SE 7) days, 3.1 (SE 0.0) kg and 2.9 (SE 0.0) kg, 22.3 (SE 2.1) kg and 27.8 (SE 0.4) kg, 12.3 (SE 0.3) kg and 116 (SE 2) days, respectively. In Saanen, average age at 1st kidding was 582 (SE 26) days and 733 (SE 23) days in Kowulwewa and New Zealand farms, respectively. Average kidding interval was 389 (SE 14) days, 294 (SE 16) days, and 405 (SE 17) days in New Zealand farm, Rosita and Kowulwewa farms, respectively. Average birth weight of male and female calves in Rosita and Kowulwewa farms were reported as 1.1 (SE 0.2) kg, 1.0 (SE 0.0) kg, 1.8 (SE 0.0) kg, 1.9 (SE 0.0) kg, respectively. Body weight after 12 months for female goat and lactation length were 18.9 (SE 0.7) kg and 221 (SE 19) days in Kowulwewa farm. The average daily milk yield was 1.0 (SE 0.1), 0.5 (SE 0.0) and 0.5 (SE 0.0) liter/day in New Zealand farm, Rosita and Kowulwewa farms, respectively. It can be concluded that, average kidding interval, age at 1st kidding and daily milk yield were between 294 - 405 days, 582 - 732 days and 0.5-1.01 liter/day in tested farms for Saanen breed. The highest average daily milk yield and average age at 1st kidding were reported in New Zealand farm. Poor management practices, poor record keeping, and lack of knowledge were the major constraints for goat farming in these farms.

Key words: Jamunapari goat; parameters; production; reproduction; Saanen goat

Evaluation of an effective genomic DNA extraction protocol from milk somatic cells

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Blood is the most commonly used source for DNA extraction, but it has several negative consequences when obtained from animals since the operation is painful to animal. Thus, milk is a better and convenient alternative source to extract genomic DNA in larger scales. However, DNA extracted from milk is less in quantity compared to a same volume of blood. Therefore, the objective of this research was to evaluate an effective DNA extraction protocol from milk and to define the volume of milk that is required to obtain a similar DNA quantity for a predefined volume of blood. Therefore, to compare and contrast, four different DNA extraction protocols have been used during this research based on the preliminary studies. 100µL cattle blood buffy coat samples were used for column purification in method one for blood DNA extraction. In method two and three RBC lysis buffer, nucleic lysis buffer were used to lyse cells followed by chloroform steps to remove proteins and ethanol steps to precipitate DNA. In method two, the general procedure was followed up to chloroform step and continued with the column procedure. In method three, all the steps were followed and DNA were dissolved in TE buffer and purified with Qiagen® purification kits. In method four, DNA was extracted directly from milk after fat removal by column purification method. 0.8% Agarose gel was used to visualize the extracted DNA. Quantification of DNA was done by UV spectrophotometry to calculate concentration and purity of the extracted genomic DNA. DNA extracted from different volumes of milk (15mL, 30mL and 45mL) were visually compared with 100µL of buffy coat DNA for the method that gave the highest DNA concentration. PCR was performed for the same to compare the PCR amplification results for Luteinizing Hormone Chorionic Gonadotropin Receptor (LHCGR) gene. Based on the spectrophotometric data, method four resulted genomic DNA with higher concentration (258.75µg/mL), whereas method three resulted genomic DNA with the least concentration (135.00µg/mL). Method one and method two resulted 321.25µg/mL and 138.44µg/mL of DNA, respectively. Purity values of the extracted genomic DNA were less than 1.8 which suggests the extracted genomic DNA was not pure with possible protein contamination. 30mL of milk volume has yielded sufficient quantity of DNA which is compatible with DNA extracted from 100µL of buffy coat. Thus the alternative method of extracting DNA from milk using columns is pure enough to obtain similar amplification results as from DNA obtained by 100µL of buffy coat. Therefore, in conclusion method four can be considered as the most effective method to extract genomic DNA from milk.

Keywords: Buffy coat; DNA extraction; milk somatic cells; RBC lysis buffer method

Development of a Polymerase Chain Reaction (PCR) protocol for detection of *Streptococcus agalactiae* in bovine sub-clinical mastitis

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Mastitis is an inflammatory disease of mammary gland caused by bacterial infection. Subclinical cases are hard to detect and caused by contagious pathogens. *Streptococcus agalactiae* is a common cause of subclinical mastitis in dairy cows. Current diagnostic methods, based on microbial culture of milk are time consuming and labour intensive. Therefore, aim of this study was to develop a PCR based method for rapid identification of *S.agalactiae* in bovine subclinical mastitis. *S.agalactiae* was cultured in blood agar and cells were harvested by centrifugation. DNA was extracted, column purified and used as the positive control. Species specific primers were synthesized as previously described in the literature to amplify 405bp PCR fragments for *S.agalactiae*. PCR conditions were optimized to amplify the desired bands. Sensitivity test was performed in which five series from 1uL-5uL of *S.agalactiae* positive cultures (3.348×10^5 CFU/mL) were mixed with bovine milk (3mL) and DNA extraction and PCR amplification was carried out to optimize conditions. A multiplex PCR was also performed for *S.agalactiae*, *E.coli* and *S. aureus* using 405bp, 884 bp and 229bp specific primers, respectively. DNA and PCR products were analyzed by 0.8% agarose gel electrophoresis under the UV transillumination. PCR conditions were optimized to initial denaturation at 94°C for 2 minutes followed by 35 cycles of 94°C for 45 seconds, annealing at 38°C for 1 minute, extension at 72°C for 2 minutes and final extension at 72°C for 10 minutes to observe a band in the expected range. Sensitivity test results showed desired bands for samples if, 3.348×10^5 CFU/mL- 1.0044×10^6 CFU/mL of *S.agalactiae* contains in the infected milk samples. However, the sensitivity test should be further optimized with number of cells less than 3.348×10^5 CFU/mL to exactly detect the number of cell present in sub clinical samples. Multiplex PCR yielded bands only for *E.coli* and *S.aureus* therefore, conditions should be further optimized to develop the multiplex to detect all three species in one reaction. A further sensitivity test should be performed with bovine cells with known amount of cells of all three species. Once the optimization is completed clinically infected samples with variable degree of infection should be collected to extract DNA and test under optimized conditions to check the reliability. In conclusion, simplex PCR can be used as a diagnostic tool to detect the presence of *S.agalactiae* in subclinical samples and optimization of sensitivity test can be improved further.

Keywords: Bovine subclinical mastitis; *E.coli*; Multiplex PCR; *S.aureus*; *S.agalactiae*.

Diluted bee honey and ginger extract as natural preservatives for milk: an alternative to immediate cooling in rural dairy farms

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The preservation of milk is a major bottleneck especially where, refrigeration facilities are limited and in places where the ambient temperatures exceed 30°C. When alternative methods for milk preservation are considered, the addition of antibacterial supplements such as bee honey, cinnamon, citronella, ginger, turmeric and green tea is the most applicable method in such rural areas. This study was conducted to verify whether the incorporation of antibacterial supplements: diluted bee honey and ginger extract in milk extends the shelf life of fresh milk for few hours which is useful to rural dairy farmers to preserve milk until transport their load to milk collecting centers. In this study, diluted bee honey at a concentration of 500mg/ml at which antimicrobial compound is viable and ginger extract at its original pH (5.6-5.9) were prepared as preservatives for milk. Both preservatives were added to milk samples as 1, 1.5, and 2% separately and kept at ambient temperature ($31 \pm 1^\circ\text{C}$) with two controls that did not have preservatives and control-I kept at refrigeration temperature ($5 \pm 1^\circ\text{C}$) and control-II kept at ambient temperature ($31 \pm 1^\circ\text{C}$) for 4 hours of storage period. Lactometer reading, pH, total solids, solid nonfat (SNF) and total bacterial counts were evaluated. In each case, the keeping quality of treated samples was compared with that of control-I. The sight, smell and taste of the milk samples were also evaluated at the end of the storage period. The results showed that there were no significant variations ($p > 0.05$) in the lactometer reading, pH, total solids, solid nonfat (SNF) and total bacterial counts between the diluted bee honey treated and control-I milk samples at the end of storage period. Hence there were significant variations ($p \leq 0.05$) in all mentioned parameters between the ginger extract treated & control-I milk samples at the end of storage period. Among that lactometer reading, total solids, solid nonfat (SNF) and total bacterial counts were significantly increased ($p \leq 0.05$) while pH was significantly decreased ($p \leq 0.05$). As well as in the analysis of sight, smell and taste at the end of storage period, diluted bee honey treated milk samples was characterized as normal milk while control-II was characterized as spoiled. However, ginger extract treated samples became lumpy and smelled with characteristic ginger odor. Considering quality parameters and sensory qualities of milk, 2.0% diluted bee honey is suitable as a preservative for milk as an alternative to immediate cooling in rural dairy farms.

Keywords: antibacterial; diluted bee honey; ginger extract; preservative; refrigeration

Determination of optimum harvesting point of Hybrid Napier (CO-4) grasses under organic and inorganic fertilizer in low country intermediate zone of Sri Lanka

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In Sri Lanka, low productivity of dairy animals could be accredited to the less availability of forage together with poor quality. High yielding forages of Napier hybrids have been introduced recently. Hybrid Napier CO-4 grasses is better intillering capacity, green forage yield and high protein content. CO-4 grasses produce high yield than local grasses. Information is deficient on correct cutting frequency of CO-4 grass which gives maximum nutrition value under intermediate zone of Sri Lanka. Therefore, the objective of this study was to determine the optimum cutting frequency of CO-4 grasses with organic and inorganic fertilizer in intermediate zone of Sri Lanka. CO-4 stem cuttings with two nodes were used for plant establishment under three fertilizer treatments as inorganic fertilizer (T1) [Basel dressing (g/m²) -Urea: TSP: MOP-10:6:5; Topdressing (g/m²) -Urea: TSP: MOP-20:12:10], cattle manure (T2) (Basel dressing; 2kg/pit, Topdressing; 2kg/pit), and control one (T3). The experimental design was randomized complete block design and there were three blocks according to the shade level. Harvesting was done three weeks intervals after the three weeks of plant establishment. Randomly selected two plants from each plot were used to measure proximate composition. Soil was analyzed before plant establishment to compare the Nitrogen and Phosphorus content, soil pH and organic carbon content of each plot. Nitrogen and phosphorus content, soil pH and organic carbon content of each plot were not significantly different ($P > 0.05$). Moisture, ash, protein, fiber and energy of T1, T2 and T3 were significantly different with the age of the plant ($P < 0.05$). Ether extract of T1 and T2 was not significantly different with the time ($P > 0.05$) but ether extract of T3 was significantly different with the time ($P < 0.05$). Protein, fiber and energy content of grass samples of 9th, 12th and 15th weeks were not significantly different with the treatments ($P > 0.05$). In 9th and 12th weeks protein, fiber energy content of grass samples under T1, T2 and T3 were 12.57 ± 1.98 , 32.17 ± 2.08 , 4.75 ± 0.07 (9th week, T1), 10.42 ± 1.71 , 36.41 ± 1.28 , 3.37 ± 0.44 (12th week, T1), 11.94 ± 1.37 , 32.95 ± 3.44 , 5.27 ± 0.16 (9th week, T2), 11.08 ± 0.56 , 34.35 ± 0.78 , 4.10 ± 0.12 (12th week, T2) and 11.23 ± 1.09 , 33.04 ± 2.56 , 4.55 ± 0.66 (9th week, T3), 9.59 ± 0.49 , 34.98 ± 2.02 , 2.99 ± 0.28 (12th week, T3) respectively. Therefore, it can be concluded that 9th and 12th weeks were the most optimum point to obtain first harvest of CO-4 under T1 and T3 and 9th week was the most optimum point to obtain first harvest of CO-4 under T2.

Keywords: Fertilizer; growth parameters; Harvesting point; hybrid Napier CO-4; proximate composition

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