Technical Session – Animal Science

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Effect of different aerobic and anoxic time periods on the effluent water quality of a sequence batch reactor in a meat processing plant

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Introduction

A large amount of slaughterhouse wastewater is generated during meat product manufacturing. It contains high concentrations of organic matter, oil and grease and nitrogenous compounds. Hence, releasing waste water to the environment causes many environmental problems such as contamination of groundwater and eutrophication of surface waters (Rodriguez *et al*., 2010). The treatment of waste water is especially important in this view. Treatment of wastewater by means of biological process has been widely implemented from urban to industrial wastewater. Sequencing batch reactor (SBR) is a modification of activated sludge process and operates by a cycle of periods consisting of fill, react (alternatively aerobic and anoxic periods), settle, decant, and idle (Mahvi, 2008).

In the SBR process there is no standard time combination for aerobic and anoxic period. It will depend on the effluent waste water components and vary plant to plant. Currently aerobic and anoxic period is operated as 2 hr aerobic and 1 hour anoxic period in the waste water treatment plant of CIC meat processing company. The present investigation was undertaken to study best time combination of aerobic and anoxic time period for simultaneous carbon oxidation, nitrification and denitrification performance of sequencing batch reactor to treat slaughterhouse wastewater.

Methodology

The current study was carried out at CIC Poultry Farms Pvt Ltd (Processing Plant), Badalgama. Laboratory analysis was done at CIC Processing Plant Laboratory and Uva Wellassa University laboratories. Model structure of aeration tank which has the capacity of 600 L was used to conduct the research experiments. 180 mL of sludge from SBR unit in CIC meat processing plant and 420 mL volume of wastewater was fed to tank each day of the treatment. Air was supplied to the reactor during aerobic phase of react period with the help of diffused aeration system and Anoxic conditions were maintained by switching off the aerators. Eight different combinations of aerobic and anoxic periods were used. Every sequence was operated totally for 20 hrs of react period by alternating the aerobic and anoxic period according to selected different time combinations (Table 01).

Table 01: Selected time Combinations for Aerobic and Anoxic time periods

	Control T1	T2	T3	T4	T5	T6	T7	T8
Aerobic (Hours)	2	2	3	3	4	4	4	4
Anoxic (Hours)	1	2	1	2	1	2	3	4

The best combination of aerobic and anoxic time period was determined by analyzing water quality parameters as, COD, BOD, ammonium nitrogen, total nitrogen, TSS, TDS and pH. Complete Randomized Design (CRD) was conducted and data obtained from chemical and physical tests were analyzed using analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (SAS Institute Inc., 2000). Significant means of treatments were separated using the Least Significant Difference ($P< 0.05$) test.

Results and Discussion

There was a significant difference ($P<0.05$) between aerobic and anoxic time combinations regarding COD removal, BOD removal, TN removal and ammonium nitrogen removal. 4 hour aerobic and 2 hour anoxic period showed higher COD removal (95%), BOD removal (90%), TN removal (89%), and ammonium nitrogen removal (92%). There was no significant difference ($P>0.05$) regarding phosphorus removal, TSS removal and TDS removal among different aerobic and anoxic time combinations.

Highest COD and BOD removal occurred in 4 hour aerobic and 2 hour anoxic cycle. Second highest COD removal (92%) was achieved during 4-1 react period. This might be due to during 4-2 hr and 4-1 sequence total aerobic react time is higher than other react cycles. Therefore, longer aeration was achieved. Longer aeration period has been found to be effective in achieving higher degree of nitrification and COD, BOD removal according to the findings of Debsarkar *et al.* (2006).

Due to less total aeration time in 4-3 and 4-4 hr cycles, less COD and BOD removal was achieved. That means one cycle was alternatively operated for 20 hrs totally and in the 4-3 and 4-4 cycles has high anoxic time periods. Therefore, less COD and BOD removal occurred (Kundu *et al*., 2013).

Treatment 6 (4-2) is significantly different from other treatments and also treatment 5 has high BOD removal. This may be due to long aeration time and effective denitrification. According to Kishida *et al*. (2003), BOD concentration of the effluent was relatively high because the oxygen demand by nitrifying bacteria increased the total BOD, when the NH,-N concentration of the effluent was too high (average = 187.1 mg/L). NH,-N concentration of the effluent was high due to partial denitrification. According to this experiment ammonium nitrogen concentration also affect to the BOD removal. And treatment 6 had low level of ammonium nitrogen concentration in effluent water (1.048 mg/L ± 1.07 mg/L).

Longer aeration period (5 hour) has been found to be effective in achieving higher degree of nitrification from Debsarkar *et al*. (2006). But according to preliminary study at the middle of

5th hour pH is reached to 6.9, but optimum pH for nitrification is 8.2. Therefore, in this experiment longest aeration time per one cycle was selected as 4 hr.

According to the statistical analysis, there is no significant difference (P> 0.05) between different aerobic, anoxic time combinations and total dissolved solid and total suspended solids removal. This might be due to activated sludge treatment is not intended to remove dissolved or suspended solids (Sustarsic, 2009).

Conclusions

The combination of 4 hours aerobic react period and 2 hours anoxic react period has been found to be optimum from the view point of both nitrification and denitrification, and COD, BOD removal. When total aeration time period is low, removal of COD, BOD is not efficient in 4 hr aerobic – 4 hr anoxic and 4 hr aerobic – 3 hr anoxic time combinations.

Acknowledgment

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Development of Avocado (*Persea americana*) Incorporated Set Yoghurt

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Introduction

Yoghurt is one of the best known of all cultured-milk products in the world. According to SLS standards (1989) *Streptococcus thermophillus* and *Lactobacillus bulgaricus* are used to convert lactose in milk in to lactic acid during yoghurt production. Fruit yoghurt is produce by adding fruits and their nectars, jams, marmalade, fruit jellies, fruit drinks, fruit syrups and concentrated fruit drinks to yoghurt or cultured pasteurized milk and fruit yoghurts enhances versatility of taste, color and texture for the consumer (Chandan and Shahani, 1993).

Avocado (*Persea americana*) is a fruit which is having a very good nutrient profile and thus incorporation endorses the healthy image of yoghurts. However, incorporation of avocado in to set yoghurt is limited by enzymatic browning or formation of brown color melaniodins from polyphenol oxidase enzyme in avocado (Bindesh, 2010). Pauker *et al.* (1992) have found incorporation of avocado in to yogurt in the form of fresh avocado pulp is impossible due to enzymatic browning. Therefore, control of enzymatic browning is essential in producing avocado incorporated set yoghurt. Current study was carried out to develop avocado incorporated set yoghurt that is having an adjusted solid content based on sensory properties and controlling enzymatic browning of avocado pulp.

Methodology

Market available fresh ripened avocados (Fuerte variety) were manually peeled and crushed in to a smooth pulp. It was divided in to seven samples with same weight and preserved using several preserving and enzymatic browning control methods such as 1% citric acid, 1% (w/w) ascorbic acid (Patricia *et al*., 1993), 1% (w/w) citric acid and 1% (w/w) ascorbic acid together (Lopez, 2001), 0.1% (w/w) sodium benzoate (Patricia *et al*., 1993), 0.1% (w/w) potassium sorbate (Singha, 2011), heat treatment at 40 ºC temperature for 30 minutes (Cantwell, 1992) and preparation of avocado pulp as a jam (Connelly, 2013). The best avocado pulp preserving method (least color changing treatment) was selected by conducting a sensory evaluation using 30 untrained panelists.

The selected method of preserving avocado pulp (avocado jam) was used in preparation of avocado incorporated set yoghurt. Yoghurt mix preparation was done according to Pande (2010). Preliminary trials were used to select the appropriate level of ingredients (avocado

jam, sugar and gelatin). Sugar and gelatin levels were finalized after having several sensory trials using 30 untrained panelists. Potassium sorbate 0.03% (w/w) was added to the final mixture as preservative (SLS Standards, 1989) and homogenized using a beater (National™, MK-H100N). Inoculation of lactic acid bacteria culture of YC 350 freeze dried (DVS) was done at 45 °C temperature. Then mixture was poured in to 80 mL plastic yoghurt cups and incubated at 42 ±2 ˚C for 4 hours. Each treatment consisted with three replicates.

Total plate count, coliform bacteria count, yeast and mold count, pH, titratable acidity and peroxide value of selected avocado incorporated set yoghurt and avocado jam was tested at 1st, 3rd, 5th, 7th, 9th and 11th day under refrigerated storage. A proximate analysis was done to determine the composition of the avocado incorporated set yoghurt.

Results and Discussion

Addition of 50% (w/w) sugar in to avocado pulp showed lowest brown color development ($P<0.05$). Added sugar may have reduced the water activity of the avocado pulp. Enzymes require certain level of water in their structures to maintain their natural conformation, allowing them to deliver their full functionality. Therefore, presence of 50% sugar inhibits the activity of polyphenol oxidase enzyme. Adding more than 50% of sugar, crystalize sugar in the avocado pulp which gives undesirable consistency. Twenty percent of avocado jam incorporation level shows the best results according to the sensory evaluation ($P<0.05$).

Total plate count, yeast and mold and coliform counts of the avocado incorporated set yoghurt were not exceeding SLS standards for set yoghurt during 11 days of refrigerated storage. Titratable acid percentage of avocado jam has increased from 1.22±0.07 to 1.4±0.07 during day 1 to day 11 ($P<0.05$). It may be due to conversion of fermentable sugars in to acids by microorganisms available in avocado jam. Further, titratable acid percentage of avocado incorporated set yoghurt increased from 0.86±0.03 to 0.94±0.03 during 11 days storage period ($P<0.05$). This is due to the presence of live lactic acid bacteria in culture which ferment lactose in milk to lactic acid with the time (Chandan and Kilara, 2013). pH of avocado jam and pH of avocado incorporated set yoghurt was reduced from 3.52±0.06 to 3.35±0.06 and from 4±0.03 to 3.91±0.03, respectively during day 1 to day11. Increasing acidity results in decreasing pH level in the product.

No fatty acid oxidation was detected in the avocado jam during storage period of 11 days. Avocado incorporated set yoghurt started free radicle formation and rancidity development 7th day of storage onwards. Moreover, it shows increasing browning effect. Since, avocado is a fruit with high fat and it contains considerable level of fatty acids, there is a potential to observe oxidation in this product. Statistical analysis showed that enzymatic browning has an influence on the increment of changing rapidity of titratable acidity, pH and peroxide value. Further, it showed fatty acid oxidation and pH are not related. In the view of avocado incorporated set yoghurt and avocado jam, avocado jam is having very low water activity due to saturated sugar solution. Avocado incorporated set yoghurt is having an environment with increasing acidity and decreasing pH with lactic acid fermentation. Water activity of avocado incorporated set yoghurt also very high compared to avocado jam. These factors may have influenced on the observed color change in avocado incorporated set yoghurt.

Proximate analysis of avocado incorporated set yoghurt showed that there is a significant difference with plain yoghurt ($P<0.05$). Fat (3.6±0.42%), fiber (0.3±0.21%), ash (0.9±0.14%), protein (3.5±0.07%) and total solids (16.10±1.31%) in avocado incorporated set yoghurt is comparatively higher than available fat (3.0±0.42%), fiber (00±0.21%), ash (0.7±0.14%), protein (3.4±0.07%) and solids (14.24±1.31%) in plain yoghurt.

Conclusion

Avocado incorporated set yoghurt is more nutritious compared to set yoghurt as it has included with more protein, minerals and fiber. There is a relationship between enzymatic browning and fatty acid oxidation. Further studies are required to identify how enzymatic browning and fatty acid oxidation relates with each other and to extend the shelf life of avocado incorporated set yoghurt.

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Production characteristics and technical efficiency of buffalo farmers in Thanamalwila veterinary division

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Introduction

At present milk production from large ruminants only meet 17% of the countries requirements (Ministry of livestock and rural community development, 2012). According to Department of animal production and health (2012) *Thanamalwila* Veterinary division (VD) in *Moneragala* district has the highest buffalo population in *Uva* province which is well established over cattle rearing and plays an important role in income generation of rural farm households. Therefore, this study was conducted to identify the important socio-economic determinants of milk production and to estimate the technical efficiency of dairy production in *Thanamalwila* VD.

Materials and methods

Study was conducted in *Thanamalwila* VD. Fifty buffalo farmers were selected using multi stage sampling technique. Random numbers of buffalo farms were selected from each *Grama Niladhari* division to field survey based on buffalo farm population. Rearing buffalo as primary and secondary income source was the selected criteria for buffalo farmers. Primary data were collected using pre tested structured questionnaire and following models were used in the analysis of stochastic production function and inefficiency model. Then, data were analyzed using Minitab 14 and STATA 11 software packages.

Model 1: Cobb-Douglas model

$$\boldsymbol{ln\,Y_i = \beta_0 + \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \beta_4 lnX_{4i} + \beta_5 lnX_{5i} + \beta_6 lnX_{6i} + \beta_7 lnX_{7i} + \beta_8 lnX_{8i} + (V_i - U_i)}$$

Where "ln" denotes logarithms to base e, while, Y_i= Milk yield (L animal^{-1} day^{-1}), X_1= Breed, X_2= Average birth weight (kg), X_3= Condition of the shed , X_4= Grazing duration (hours day^{-1}), X_5= Labor allocation (hour animal^{-1} day^{-1}), X_6= Frequency of water given (number of times per day), X_7= Cost of buffalo farming (LKR per month), X_8= Value of feed, V_i= Random variable, U_i= Non negative random variables.

Model 2: The inefficiency model specification (Battese and Coelli, 1995),

$$\boldsymbol{Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + W_i}$$

Where, Z_1 = Age of the farmer (Year), Z_2 = Education level (Year), Z_3 = Monthly income level (LKR), Z_4 = Experience of the farmer (Year), W_i = Unobservable random variables

Result and discussion

All the buffalo farmers in the sample were male and majority was belonged to 21-30 age category (30%) and a high proportion (62%) of buffalo farmers had education up to grade 10. Only 6% of respondents had the education level beyond GCE ordinary level.

Most of the villages (98%) reared both local as well as exotic river type buffalo breeds and the preferable breed combination was local buffalo and Murrah or Niliravi cross breds. Only 2% of farmers reared solely local buffaloes. Herd size ranged between 2-185 animals and majority of respondents (38%) had a herd size of 21-40. Moreover, the predominant management system (94%) was the extensive management system. Interestingly, one farmer (2%) has practiced the intensive management system. Moreover, 6% of farmers practiced artificial inseminations (AI) in their breeding program. Feed availability, water availability, changes in rainfall pattern, and land availability were the most serious constraints faced by respondents. Elephant attack and illegal smuggling were also critical problems in buffalo farming in the area.

The *maximum likelihood estimates* (MLE) of the parameters of stochastic frontier production function are present in Table 01. The OLS function provided the estimates of the average production function while MLE model provided the estimates of stochastic production frontier. The MLE coefficient for breed, allocation of labour hours day^{-1} animal^{-1} and average birth weight shows a positive and significant contribution to determine the output of stochastic production function. Therefore, by improving these aspects the farmer can enhance the milk output by the given MLE.

Table 01: Estimates of stochastic production function

Variable	Coefficient		Standard error		p value	
	OLS	MLE	OLS	MLE	OLS	MLE
Breed	0.4768**	0.5830***	0.1834	0.1428	0.013	0.000
Birth weight	0.5367	0.6169**	0.3802	0.2856	0.166	0.031
Shed condition	-0.1626	-0.2230	0.1798	0.1375	0.371	0.105
Grazing duration	-0.0047	-0.0833	0.2994	0.2237	0.988	0.709
Labour hours	0.0941*	0.2054***	0.0528	0.0564	0.082	0.000
Frequency of water supply	0.0086	0.1461	0.1152	0.1183	0.941	0.217
Cost of buffalo farming	0.0341	0.0187	0.0275	0.0217	0.223	0.391
Feeding method	0.0954	0.0570	0.2038	0.1674	0.642	0.733
Constant	-1.1127	-0.7375	1.5874	1.1581	0.487	0.524

OLS= Ordinary Least Square estimation, MLE= maximum Likelihood estimation, *Significant at 10%, **Significant at 5%, ***Significant at 1%

Estimated variables of the inefficiency model are represented in Table 02. Monthly income was the only significant variable of inefficiency model in this study. Therefore, farmers with higher monthly income have the capacity to increase the efficiency of milk production. Moreover, farmers had tendency to invest their money on livestock than cash crop cultivation

because they considered cash crop cultivation as relatively risky business due to dry climatic condition in the area.

Table 02: Technical inefficiency estimates- buffalo farming

Variable	Coefficient	Standard error	p-value
Age	0.0459	0.039481	0.243
Education level	0.1189	0.615439	0.846
Monthly income	-0.0005*	0.000026	0.052
Experience	-0.1057	0.085551	0.217
Contact times of VS/LDI	-0.3871	1.024504	0.709

*Significant at 10% **Significant at 5% ***Significant at 1%

Moreover, mean technical efficiency for buffalo farmers in *Thanamalwila* VD is 86.83, which indicates that the output could be increased by 13.7%, if all farmers achieved the TE level of the best farmer.

Conclusion

Coefficients for breed, feed, average birth weight, and level of labor power allocation on dairy industry have significant impact on milk production of buffalo farms in *Thanamalwila* VD. Moreover, by reducing the technical inefficiency by 13.7% the farmers can increase the milk yield without increasing the level of inputs.

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Development of drinking yoghurt by incorporating corn (*Zea mays*) milk and corn seeds

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Introduction

Cereal grains are considered as important sources of dietary proteins, carbohydrates, vitamins, minerals and fiber for people all over the world (Chavan and Kadam, 1989). Corn (*Zea mays*) is locally grown cereal that can be purchased at low price from several areas in Sri Lanka. Corn milk is considered as a new innovation, especially in making yoghurt based products. Vegetable based corn milk yoghurt is an alternative to substitute the cow milk based yoghurt. Drinking yogurt is the fastest growing food and beverage category in worldwide (Yasni and Maulidya, 2013). However, still value added drinking yoghurts are rare in Sri Lankan market. Adding cereal grains is a perfect way to upgrade a drink to a nutritious breakfast. Therefore, this study was conducted to develop yoghurt by incorporating corn *(Zea mays)* milk and corn seed to cow milk.

Methodology

The study was carried out at Lucky Lanka Milk Processing Com. Ltd (LLMP), Matara and Uva Wellassa University. Six experimental trials with different treatments were conducted. In trial I, mature fresh corn seeds, mature boiled corn seeds and germinated corn seeds were separately used to extract corn milk and the best extract of corn milk was evaluated by sensory properties (odor, taste, color and mouth feel) using untrained panelist. In trial II the most compatible sugar (8%, 9% and 10% w/v) and gelatin (0%, 0.2% and 0.4% w/v) levels for different corn milk percentages (5%, 10%, 15% and 20% w/v) were identified. After selection of appropriate combinations of sugar and gelatin levels, trial III was done to select the best corn milk incorporation level by narrow downing the corn milk percentages (6%, 8%, 10%, 12% and 14%). Preserved in sugar syrup and boiled corn seeds were crushed into two sizes (> 3.15 mm and 2 mm –3. 15 mm) to prepare different types of corn seeds. Trial IV was carried out to select best corn seeds particles on the textural basis and trial V was done to assess the consumer acceptability for the presence of corn seeds in the corn milk incorporated drinking yoghurt. Finally three treatments (trial VI) were prepared and evaluated on sensory, chemical and microbiological properties. The sensory evaluation was done using 35 untrained panelists. In chemical analysis, proximate analysis (moisture content, crude fat, total solid, crude protein, ash and crude fiber content) was conducted. pH value and titratable acidity were evaluated and microbiological analysis was done for Yeast and Moulds, and *Escherichia coli* for three weeks in one day interval. The sensory data were analyzed using Friedman

nonparametric test. Complete Randomized Design was conducted and data obtained from chemical and microbiological tests were analyzed by Analysis of Variance using the General Linear Model procedure of SAS. Significant means of treatments were separated using the Least Significant Difference test ($P< 0.05$).

Result and Discussion

In trial I, boiled corn seeds (mature) based method was selected to extract corn milk. Other two methods were rejected due to the unpleasant odour and taste which may be due to the activation of various food enzymes and breaking down the higher molecular components to simple molecules during germination.

Eight per cent sugar (w/v) for 5% corn milk (w/v) and 10% sugar (w/v) for other 10%, 15% and 20% corn milk (w/v) incorporation levels were selected due to desirable sweetness. The gelatin level (w/v) was selected as 0% due to the presence of appropriate drinking yoghurt properties including texture, mouth feel, appearance and viscosity. The whey separation has been prevented by stabilizing effect of corn starch in corn milk.

In sensory evaluation, 8% corn milk incorporation level was significantly highly preferred by panelist with respect to mouth feel, taste and overall acceptability ($P<0.05$). However, there is no significant difference in color and aroma of the three treatments ($P>0.05$) (Figure 01). Addition of corn milk had no influence to change colour and aroma of the product.

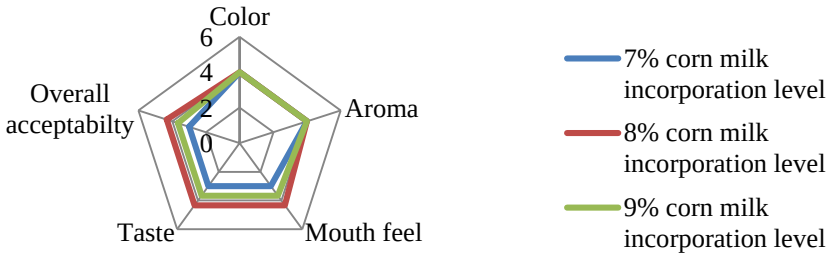

Figure 01. Web diagram for level of corn milk incorporation in sensory evaluation

In trial IV, sugar syrup based method was rejected due to hardness of the seeds and crushed boiled corn seeds were selected. Further, the sensory results revealed that the preference (taste, aroma, mouth feel, color and overall acceptability) for corn seeds >3.15 mm or 2 mm to 3.15 mm particles incorporated drinking yoghurt is less whereas preference for corn milk incorporated drinking yoghurt without corn seeds was high. The observed difference is due to the disturbance for the drinkable property of product by presence of corn seed particles. The composition of the selected corn milk incorporated drinking yogurt is given in Table 01.

There was a significant difference between treatments for change in pH with the storage period ($P<0.05$). pH values of the T8 (with preservative) and control were not changed dramatically. Control of pH by potassium sorbate could be due to inhibition of the activity of starter culture by inhibiting various enzymes in microbial cell (Rajapaksha *et al*., 2013).

There was a significant difference between treatments with respect to acidity ($P<0.05$) and titratable acidity increased significantly with storage period and in treatments without preservatives. According to Rajapaksha *et al.* (2013), titratable acidity of yogurts increased over the time and acidity of yoghurt without potassium sorbate increases drastically than other treatments reflecting the inhibitory activity of potassium sorbate on post fermentation.

Table 01. Composition of select corn milk incorporated drinking yoghurt

Raw material	Percentage	Quantity (g)
Milk	79.54%	867.03
Dairy cream	1.03%	11.33
SMP	1.42%	15.49
Corn milk	8.00%	87.20
Sugar	10.00%	109.00
Total	100.00%	1090.00

There were no contaminations with Coliform and *Escherichia coli* and thus safe for human consumption. There were no yeast colonies in T8 and control sample. At day 11, yeast colonies were exceed the SLS standards of <1000 only in T7 (without preservative).

Proximate analysis revealed all the physiochemical characteristics of corn incorporated drinking yogurt (protein, fat, ash, fiber and total solid), except moisture significantly higher compared to plain drinking yoghurt ($P<0.05$). Usually drinking yoghurt does not contain fiber. However, due to addition of corn, milk fiber was increased up to 0.5%.

Conclusion

Eight per cent corn milk incorporation level with selected sugar (10%) and gelatin (0%) level has best consumer preference with respect to the taste, mouth feel and overall acceptability ($P<0.05$). Moreover, drinking yoghurt without corn seed particles is preferred by the panelists. Shelf life of product without potassium sorbate is around 11 days at 4 ºC with respect to microbiological analysis and physiochemical analysis.

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Effect of tropical forages on growth performance and carcass quality of rabbits

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Introduction

Rabbit (*Oryctolagus cuniculus*) is a small mono-gastric animal which has a very small body size and an efficient reproductive ability. Backyard rabbit keeping supplies additional protein with low investment and labor inputs. Rabbit meat has many nutritional benefits which include high protein, low cholesterol and high palatability (Samkol and Lukefahr, 2008).The major problem with rabbit production is high feeding cost (Lebas *et al*., 1997). Feeding cost for rabbits account more than 75% of total cost of production. At present there is a competition for protein sources between man and animals (Jiya *et al*., 2011). Rabbits are herbivores and can be successfully raised on diets with low in grains and high in roughage. Therefore tropical legumes can be used as an alternative for fed rabbits. The objective of this study was to determine the growth performance, carcass quality of weaner rabbits with diet containing forage supplements and commercial layer pellet.

Methodology

The experiment was carried out at Uva Wellassa University, Badulla. Sixteen (16) weaned cross bred rabbits, mixed sexes were used for the feeding trial which conducted for 45-days. All rabbits selected which were born on same day,a few from same litter. Rabbits were grouped according to Complete Randomized Block Design (CRBD) with four replicates, 2 males and 2 females for each diet group. Ration for all the diets were formulated according to the nutritional requirement of grower rabbit. Maximum inclusion levels for the selected leaves also considered. All animals were kept for an adaptation period during the adaptation period rabbits were fed with only the control diet (Prima layer pellet) with fresh guinea grass (*Panicum maximum*). The experimental diet was introduced gradually for 8 days. Water was supplied ad-libitum for each rabbit. Guinea grass (*Panicum maximum*), Erythrina leaves (*Erythrina indica*), Cassava leaves (*Manihot esculenta Crantz*) and Leucaena leaves (*Leucaena leucocephala*) were harvested from the surrounding environment of the university premises. Guinea grass was harvested one week before feeding to the animals and hay was made by keeping under sun. Erythrina leaves, Cassava leaves and Leucaena leaves were harvested three to four days before feeding rabbits. Those harvested leaves were chopped and wilted until constant weight was gained. Wilted leaves and dried grass were stored under dry condition. Diet 1 = Only layer pellet 100% (control), Diet 2 = Layer pellet 70%, *Erythrina indica* 20%, *Panicum maximum* 10%, Diet 3 = Layer pellet 65%, *Manihot esculenta Crantz* 20%, *Panicum maximum* 15% and Diet 4 = Layer pellet 92%, *Leucaena leucocephala* 7%, *Panicum maximum* 1%. Data were collected on body weight and weight gains, feed intake and Feed Conversion Ratio (FCR).

Two rabbits (one male and one female) from each group were slaughtered for carcass quality evaluation. After 45 days of feeding trial two rabbits (one male and one female) from each treatment group was slaughtered. Hot carcass weight, pH, Length of carcass, dressing percentage was evaluated under carcass quality parameters. Chemical composition of carcasses was analyzed for proximate constituents according to AOAC, 2002 method. Sensory evaluation of boiled meat samples were evaluated using 15 semi trained panelists.

Collected data was analyzed using Analysis of variance (one way ANOVA and two way ANOVA) - Minitab 16 statistical software package. Analysis of variance fallowed by a mean separation procedure using Tukey's test. Sensory analysis was done by using non parametric analysis of Friedman test.

Result and discussion

Table 01. Performance of rabbits fed experimental diets

Performance characteristics	Diet groups			
	Control (T1)	Erythrina (T2)	Cassava (T3)	Leucaena (T4)
Initial body weight (g)	1981.5[a]	2062.0[a]	1818.5[a]	1836.5[a]
Final body weight (g)	3108.8[a]	2900.5[a]	2903.0[a]	3144.3[a]
Daily weight gain (g/head)	25.62 [a]	19.06[b]	18.97[b]	29.72[a]
Feed conversion ratio	0.2135[a]	0.1588[b]	0.1580[b]	0.2477[a]

a,b: Values in the same row with different letters are significantly different at $p<0.05$.

Growth performance of rabbits fed diets with various forages is presented on Table 01. However, significant ($P<0.05$) differences was observed in the values of daily weight gain with rabbits in treatment 3 having the highest weight gain, could be as a result of high crude protein content in the diet. It is recommended that for good performance of rabbits, doe or buck, 10% leucaena leaves blended with their feed is good (Lamidi and Akilapa, 2013). Therefore diet containing Leucaena may have provided the required proteins and amino acids for the growth of the rabbits. With respect to FCR, it was observed that significantly ($p<0.05$) higher in the rabbits on fed with diet 4 (0.247) than the other diet groups while diet 3 produced the poorest FCR (0.158) compared to the average. The results were similar to the findings of Okonkwo *et al*. (2010). In addition, the feed conversion ratio recorded in this experiment is poorly compared to the normal feed conversion ratio of rabbits (3:1).

All carcass quality parameters were not significantly different with each other ($p<0.05$) (Data not shown). Treatment 4 showed highest dressing percentage among other treatments. Except treatment 3 other results for dressing percentages were similar to the findings of Chisova *et al*., (2013) which dressing percentage ranged from 55.56 % to 59.72 % for growing rabbits. Lowest dressing percentage in treatment 3 may be due to toxic compounds containing in cassava leaves.

Sensory results showed that *Erythrina indica* incorporated diet fed rabbits meat was much preferred than others. Results of sensory evaluation were same for both male and female rabbits.

When consider proximate composition of rabbit meat, Crude protein content was varying between 81.2 to 88.3 % (dry matter basis). Results were differ when consider male and female animals. There is a less variation in fat content of both male and female animals regarding four diets (6.2% - 7.1%). Results of fat and moisture content were similar to the findings of Zotte (2002).

Conclusion

Smaller herbivores can persist on small quantities of food on the condition that the plants are of high nutritional quality. Supplementation of concentrate with forage in the diet of rabbits is cost effective. *Leucaena leucocephala*, *Manihot esculenta Crantz* and *Erythrina indica* forages can be included in rabbit's diet with recommended levels without any adverse effect. Sensory results showed that *Erythrina indica* incorporated diet fed rabbits meat was much preferred than others.

Carcass quality evaluation proved that *Leucaena leucocephala* incorporated diet fed rabbits had highest dressing percentage which showed high weight gain. But proximate composition of rabbit meat was not showed a high variation regarding four diets.

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Diversity and antibiotic resistance patterns of *Lactobacillus* species in traditional curd in Sri Lanka

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Introduction

Lactobacillus is a genus which comprises of more than 50 species as described in the Bergey's Manual of Systematic Bacteriology (2009) *Lactobacilli* are Gram-positive, non-spore-forming rods or coccobacilli. They are generally considered as apathogenic, fastidious bacteria and one of their main habitats is fermented dairy products.

In their fermentative pathways, main metabolic end product is Lactic acid. The fermentation process of *Lactobacillus* increases the shelf-life of the fermented dairy product, as well as adds the taste and improves the digestibility of milk. There are adequate evidences to prove that traditionally fermented milk products have been produced for a long time in different countries. Curd (Sri Lanka and India), Kefer (Russia), Yakult, Yogurt, Kumisss (Russia), Tarhana (Turkey) are some examples.

There are *Lactobacillus* species that have achieved GRAS (Generally Recognized as Safe) or QPS (Qualified Presumption of Safety) status. However, during the past few decades there has been an emerging concern on spreading the antibiotic resistance in the environment. Due to the increasing use of antibiotics and disposing them in to the environment in a considerably inappropriate manner, concerns have arisen on the possibility and probability of spreading the antibiotic resistance genes to *Lactobacillus* in fermented food (Farthing, 2004). The main threat associated with these bacteria is that they can transfer resistance genes to pathogenic bacteria as well as to the commensal flora in the intestinal tract. A number of initiatives have been recently launched across the globe to address the biosafety concerns of starter cultures and probiotic microorganisms. The European Food safety Authority (2007) considers transferable antibiotic resistances as a safety concern. Many studies have detected the acquired antibiotic resistance in fermented food products. Nevertheless, the tetracycline resistance was shown to be able to transferred *in vitro* to *Enterococcous faecalis* from *Lactobacillus* species isolated from fermented sausages (Gevers *et al*., 2003).

The objective of this study was to find out the diversity of *Lactobacillus* species in curd prepared by small and medium scale producers in Sri Lanka and to detect their antibiotic resistances.

Methodology

Total number of 32 curd samples representing different areas of the country were collected from small and medium scale produces (SMS) who do not use starter cultures directly for the process. Samples were enriched in modified Man Rogosa Sharpe broth at 37^0C at room temperature for 24 h, under anaerobic conditions and plated on modified MRS agar medium

using agar overlay technique and incubated at 37^0C, for 24-36 h under anaerobic conditions. *Lactobacillus delbrueckii subsp. bulgaricus* was used as the positive control. Morphologically different colonies were isolated. Identification of the different strains were carried out using morphological and biochemical tests according to the Bergey's Manual of Systematic Bacteriology. For the detection of antibiotic resistances, agar overlay disc diffusion method (Charteris *et al*., 1998) was followed. The bacterial cultures used for this test were grown overnight in modified MRS broth and the densities were adjusted to OD_{590nm} = 0.1 using spectrophotometer in order to obtain consistent growth. Penicillin G(P10),Tetracycline (TE30), Erythromycin (E15), Bacitracin (B10), Rifampicin (RD30) Nalidixic Acid (NA30), Vancomycin (VA30) and Polymixine B (PB300) were selected as the test antibiotics.

Results

For morphological characteristics, shape and colour of the colonies, Gram's reaction, shape and arrangement of cells, motility and endospore formation were observed. For the biochemical characteristics, reaction in the Gibson's medium, oxidase test, catalase test, Arginine utilization, sugar fermentation tests (Arabinose, Cellobioose , Esculin, Galactose, Maltose, Mannose, Melibiose, Raffinose, Ribose, Sucrose, Trehalose, Xylose, Salicin, Sorbitol, Mannitol, Rhamnose, Lactose) were detected.

A total Number of 51 *Lactobacillus* isolates were obtained in this study and all the 51 isolates were comprised with 16 different bacterial species. *Lactobacillus fermentum* (35%) *Lactobacillus acidophilus* (11.11%), *Lactobacillus plantarum* (5.55%) and *Lactobacillus amylolyticus* (8.33%) represented majority. When compare the antibiotic resistance patterns (Table 01), Polymixine B was reported to have 94.44% overall resistance. All the 51 isolates were reported to score 100% of overall resistance for both Vancomycin and Nalidixic Acid. Minimum percentages of antibiotic resistances were observed for Tetracycline (22.22%) and Erythromycin (27.78%).

Discussion

Considering the prevalence of different *Lactobacillus* species, the results obtained in this study correlate to a significant extent to some research carried out on traditional fermented dairy products (Yu, 2011). Conversely, several research studies have been *disclosed that L. delbrueckii subsp. bulgaricus is the most abundant Lactobacilli in* traditionally fermented milk products (Tendakyi *et al*., 2001) and this species was not identified in this study.

Though the present study reveals less abundance of Tetracycline and Erythromycin resistance compared to that of most other countries it can be considered as an important finding. Correlate with the Tet- resistant species identified in this study, R-plasmids encoding Tet-resistance have been reported in *L. fermentum L. planatarum* and *L. amylolyticus.* Because the Tet-resistance has been transferred from *Lactobacillus* to *E. faecalis* in vitro it shows the possibility of in vivo process. Further studies can be aimed at determining the transferability of the Tet-resistance from *Lactobacillus* to commensal flora *in vitro*.

Table 01: Antibiotic resistance patterns of some selected *Lactobacillus* isolates.

Isolate No	Species	Tet	Ery	Bac	Rif	Pen	Poly	Nali	Van
L43	*L. planatarum*	R	S	S	R	R	R	R	R
L3	*L. planatarum*	S	S	R	MS	R	R	R	R
K1	*L. amylolyticus*	R	R	R	R	R	R	R	R
K2	*L. amylolyticus*	R	R	R	R	R	R	R	R
L25	*L. fermentum*	R	R	R	R	R	R	R	R
M2	*L. fermentum*	R	R	R	R	R	R	R	R
L11	*L. fermentum*	R	R	S	R	R	R	R	R
L8	*L.frintoshensis*	R	R	R	R	R	R	R	R
L29	*L. gastricus*	S	R	R	R	R	R	R	R
Tcb	*L. acidophilus*	S	S	R	R	R	R	R	R

S; Sensitive, R; Resistant, MS; Moderatly sensitive
Tet; Tetracycline, Ery; Erythromycin, Bac; Bacitracin, Rif; Rifampicin,
Pen; Penicillin G, Poly; Polymixine B, Nal; Nalidixic acid, Van; Vancomycin

Conclusions

16 different Lactobacillus species were isolated. *Lactobacillus fermentum* was the most abundant organism. Minimum percentages of antibiotic resistances were observed for Tetracycline and Erythromycin while maximum percentages of resistances were observed for Nalidixic Acid and Vancomycin. The relatively high percentage of vancomycin resistance (85%) is due to the fact that the majority of the lactobacilli are intrinsically resistant to this glycopeptide.

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A preliminary study on Milk Urea Nitrogen values of the Ambewela farm

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Introduction

Feeding management is a key factor in profit maximizing of a dairy farm. Milk Urea Nitrogen (MUN) is a tool that measures the efficiency of protein and carbohydrate feeding to milking cows (Jonker *et al*., 1999). Implementing routine use of MUN on dairy farms could reduce nutrient loading to natural environments and improve farm profitability (Jonker *et al*., 2002). According to Kohn (2007) dairy herds should have MUN concentrations between 8 to 12 mg dL^{-1}. However, the MUN values could be affected by many factors such as environment, breed, feed, season, etc. (Godden *et al*., 2001). Hence the use of 8 to 12 mg dL^{-1} MUN values to evaluate the dairy herds in the Sri Lanka would be inappropriate, since there were no studies carried out in to determine the baselines of MUN values in Sri Lanka. Therefore, this study has been carried out as a preliminary study, to study about the prevailing MUN values of one of the commercial dairy farm in Sri Lanka.

Methodology

The study was conducted at Ambewela farm and Veterinary Research Institute, Sri Lanka. Four groups of the milking herd in the Ambewela farm (treatments) which have been made based on the production levels of the cows were used to collect milk samples. Samples from each group were taken once in fortnight during three months' experimental period. During each sample collection, 15 cows were selected randomly from each group and 50 mL of milk from each cow was obtained after complete milking. Milk from five cows belonging to each group was pooled. Hence, each treatment consisted with three replicates. Milk fat was analyzed using the Gerber method. Solids-non-fat (SNF), protein, salts and lactose contents were measured using a portable ultrasonic milk analyzer (Lactoscan MCC, Milkotronic Ltd., Bulgaria). Lacto meter was used to measure the milk specific gravity. The urea content in milk was estimated according to the method described by Malik and Sirohi (1998) and the optical density of the sample was measured at 450 nm using the spectrophotometer (Cary 50 Conc - 10069600, Agilent Technologies, Australia). In the statistical analysis, according to the normality of the sample data test by Anderson-Darling test, the relationships were evaluated using multiple regression analysis or Spearman Rank Correlation Coefficient. STATA® S/E 11.2 and Minitab® 17 software were used in statistical analysis of the data. The MUN levels were interpreted based on the current recommended levels of Kohn (2007).

Results and Discussion

The results revealed that the milk fat%, SNF%, protein%, lactose%, and specific gravity does not have a significant relationship with MUN ($P>0.05$). Similarly Godden *et al.* (2001) have stated that there is no association between MUN and either milk fat or true protein percentages. Broderick and Clayton (1997) also confirm that there is no significant relationship between milk SNF% and MUN values. Therefore, it can be stated that MUN values are not related with fat%, SNF%, and protein% in dairy cow milk.

The variation of MUN values of each group in the selected weeks of experimental period are shown in Figure 01.

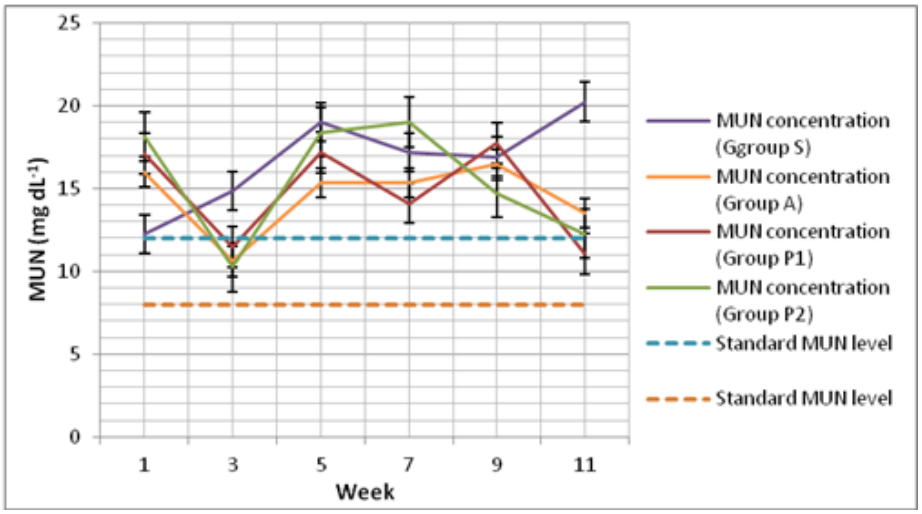

Figure 01: Average MUN concentrations of different groups during the experimental period

All the groups showed higher MUN values during the experimental period except in 3rd and 11th weeks. On the 3rd week, all groups and on the 11th week, group P1 and P2 showed MUN values close to the upper limit of Kohn (2007). However, on 11th week also group S and A showed higher MUN values than the reference range. Moreover, the analysis of mean MUN values of each group during the experimental period also revealed mean MUN values of each group is higher than the recommended levels of Kohn (2007) (Table 01).

The highest mean MUN value is recorded in Group S consisting highest producing cows. High levels of MUN are generally interpreted as an indication of inefficient utilization of protein, which is economically unfavorable. However, high MUN values could be found in high producing cows due to high protein provided with their rations. (Godden *et al*., 2001).

Feed formulation records of the farm did not indicated any higher deviations from the standard NRC recommendations for dairy cattle feeding. Therefore, the higher mean MUN values cannot be strictly interpreted along with inefficient utilization of protein. Hence, establishment of MUN reference range for Sri Lankan dairy herds for evaluation of efficient dietary nutrient utilization is an essential.

Table 01: Mean MUN values of different groups during the experimental period

Group	Mean MUN ± SEM (mg dL^{-1})	Standard deviation	Max (mg dL^{-1})	Min (mg dL^{-1})
S	16.75 ± 1.17	2.87	20.24	12.25
A	14.53 ± 0.89	2.17	16.43	10.59
P1	14.77 ± 1.23	3.01	17.72	11.04
P2	15.46 ± 1.49	3.64	19.02	10.24

SEM- Standard Error of Mean

Conclusion

The mean MUN values of each milking cow group were higher than the recommended range indicating the inefficient utilization of protein in the ration given to these groups. However, the feed formulation records did not indicated higher deviations from the recommended nutritional requirements of these animals. Therefore, further research is needed to make the baseline levels of MUN to farms of Sri Lanka.

Acknowledgement

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Comparison of broiler chick performance in single stage incubation and multi stage incubation

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Introduction

Among livestock industries, poultry sector is widely spread throughout Sri Lanka. Chickens raised for meat purpose are broilers. In current broiler market, the competition is high. To face this competition, companies need to have strong production line with the companies. The main input of the broiler industry is day old chicks. The commercial operations depend on the hatcheries for the supplying of day old chicks. Hence, the hatchery should have considerable capacity to produce required amount of chicks to fulfill the demand using artificial incubation. Currently, the commercial markets have Single Stage (SS) and Multi Stage (MS) incubators. According to the specialists in the industry, the SS machines are more effective and efficient than the MS machine. To meet the competition successfully company need to establish an efficient machine type in incubation procedure. Therefore, the primary objective of this research is to compare the performance of broilers incubate in SS and MS incubators and to investigate the effect of SS and MS incubation on chick quality.

Methodology

The hatching eggs were obtained from Cobb 500 female × Cobb 500 male broiler breeders at 54 and 64 week old age. The collected eggs were graded using egg grading machine. The eggs weighing 63 g – 80 g were selected in present study. The setter trays were taken from top, middle and bottom positions from both SS and MS machines. Setter trolleys were set in the Petersime® SS setter machine and Petersime® MS setter machine. After 18 days, incubated eggs were transferred to the hatcher baskets. At the transferring, the weight was measured and recorded. Weight loss was calculated. The hatcher trolleys were placed in Petersime® hatcher machines.

Chick pullout (hatch-out) was obtained at the 21 day of incubation. Live hatched chicks were counted and recorded separately. Thirty newly hatched chicks were selected randomly from the hatcher baskets. The hatch residuals were collected separately, stocks in egg trays and tagged them for break out analysis. Death chicks were recorded separately. Chick weight was measures separately in the replications by using weighing scale and recorded. Chick length was measured using standard chick ruler and recorded in centimetres. Pasgar© scoring method was done to analysis chick quality. Breakout analysis was done using hatch residuals. Then chicks were sent through the chick grading and counting machine. Chicks were packed in

paper laid plastic chick boxes as 50 sets and 100 sets.

Chicks were vaccinated with IB, ND and IBD vaccines. Chick boxes were stock in chick room separately as SS and MS. Then chicks were transported to the boiler farm. Chicks were brooded at the closed housed using gas brooder. All chicks were given similar environmental condition, same floor space, feed, and water. Brooding, feeding and watering were automated. Weekly body weight gain, Feed conversion ratio (FCR) and weekly mortality data were collected at the broiler farm level. At the farm level, data were collected from SS - close house and MS - close house.

Results and Discussion

There was no significant difference between initial eggs set for the two machine types. The eggs set for the SS were had 69.73 ± 4.26^{a} g of weight and 69.59 ± 3.93^{a} g of eggs were set for the MS machine. Hence, there was no significant effect of machine type to the results obtained throughout the experiment. Yet, there was a significant relationship between machine type and weight loss. The highest weight loss was shown in eggs set in MS machine. Weight loss in SS machine was 9.1 ± 3.7^{b} and MS was 11.5 ± 3.5^{a}. The results obtained for the weight losses can be between 9 – 11% (Metzer, n.d.). The weight loss from SS and MS machines were lined within 9 – 11%. There was a significant different between two means ($P < 0.05$) of the chick weight. The MS incubated Day old chicks were shown a higher chick weight of 48.4 ± 3.5^{b} g than SS incubated chicks (Table 01).

According to a study, the chicks have divided in to three groups and they were 18.0 – 18.3 cm as middle group, higher than 18.3 cm as large group and less than 18 cm as small group (Table 01). A positive correlation between chick Length and chick weight was observed at day zero of age (Petek, *et al.,* 2010). The SS incubated chicks have lower FCR with compared to the MS incubated chicks in days 7 and days 14. There was a similar mortality percentage (1.3%) in SS and MS incubated chicks in the first week and no mortality in the second week at the brooding. Table 1 showed there was no significant difference between hatchability and fertility.

Table 01: Effect of incubation type on Weight loss, Day old chick weight, Chick length, Hatchability, Fertility and Average feed conversion ratio

Parameter	Incubation Type	
	Single-stage	Multi-stage
Weight loss (%)	9.10 ± 3.7^{b}	11.50 ± 3.50^{a}
Day Old Chick weight (g)	47.10 ± 3.5^{b}	48.40 ± 3.50^{a}
Chick length (cm)	19.20 ± 0.58^{a}	19.10 ± 0.59^{a}
Hatchability (%)	81.67 ± 2.21^{a}	82.08 ± 2.63^{a}
Fertility (%)	92.50 ± 1.48^{a}	92.00 ± 3.57^{a}
Average Feed conversion ratio	0.92	0.98

Means not labeled with letter a are significantly different from control level mean ($P<0.05$)

There was a significant different ($P<0.05$) in broiler weight gain. SS incubated chicks have been obtained higher body weight gain than the MS incubated chicks (Figure 01). It was a 19.23 g of body weight increment compared with the MS incubated chicks.

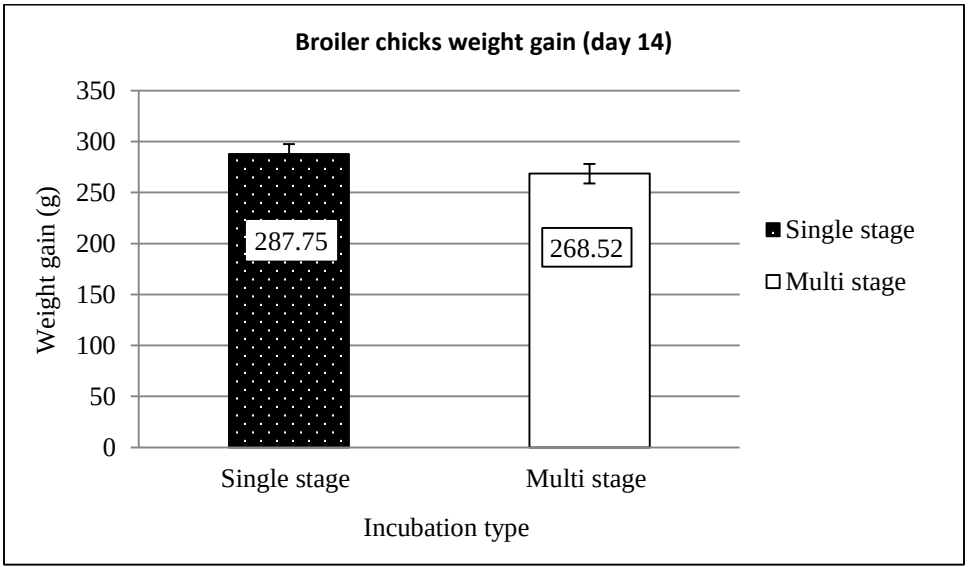

Figure 01: Bar chart of the broiler weight gain versus incubation

Conclusion

Multi stage incubated chicks have higher chick weight and incubation has effect on the broiler performances. Single stage incubated chicks show high quality than multi stage incubated chicks and incubation has effect on quality. Single stage incubated broilers show higher weight gain at the brooding time and incubation has affect to the broiler performances.

Acknowledgement

The hatchery of the Bairaha Farms PLC, Pasyala and Opathalla Boiler Farm, Opathalla are gratefully acknowledged.

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Potential to use extracts from *Lawsonia inermis* (Marathondhi) leaves and *Emblica officinalis* (Nelli) fruits as tannin agents in leather manufacturing

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Introduction

In Sri Lanka mainly mimosa bark powder and chesnut powder are used to produce vegetable tanned leather. However, these tannin agents can produce limited number of colors and are imported to Sri Lanka with high import cost. As a result, final vegetable tanned leather products become high in price. Thus, it is necessary to find out locally available, low cost tannin agents to produce vegetable tanned leathers. *Emblica officinalis* (Nelli) fruits and *Lawsonia inermis* (Marathondi) leaves are two such locally available tannin agents with considerably high tannin content (nelli fruits-18-35 % (Pushpakumara and Heenkenda, 2012) and Marathondi leaves- 11.12% (Musa, 2012). Therefore, the objective of the present study was to assess the quality of leather prepared using locally available tanning agents, Marathondhi leaves and Nelli fruit extracts.

Methodology

3.6 kg of marathondi leaves and 1.2 kg of nelli fruits were first crushed and ground separately. Then it was mixed with 3 L of water and was filtered into separate containers. Same tannin concentration (5 backometer value) was maintained in all containers. Further, a mimosa solution with same concentration was prepared as the control.

Then, the buffalo hides were, soaked, dehaired and delimed and partial pickling was also done prior to the tanning according to the leather manufacturing procedure of Ceylon Leather Products PLC. Then, nine hide pieces with 6 x 7 inch was selected from same area of these buffalo hides. Weight and thicknesses of each piece was measured and recorded. After that, solutions were added into separate containers and three pieces of hide were dipped in each container.

After hides were dipped, concentration of each solution was increased by 5 backo every four days up to four weeks. Tannin penetration was also measured until it obtains 3 mm. After finishing process, physical parameters, mean penetration rate (mm/day), thickness, mean yield of the leather (%) and mean tensile strength was measured in all treatments and was compared with control. Completely Randomized Design (CRD) was used to allocate treatments and data

analysis was done using Minitab 15 software. Analysis of Variance (ANOVA) was used for comparison of data at (significance level of 95%) and. Dunnet's procedure was used for mean separation. Sensory evaluation was conducted to select the best tannin agent based on the appearance, hardness, fullness and overall acceptability of finished leather using 10 trained panelists and results of the sensory evaluation after analysis by Friedman test.

Result and Discussion

During tanning of hides Nelli tannin media was seen as light cream color whereas control (Mimosa) and Marathondi media were darker in color. Though, Nelli and Mimosa media had pleasant smell, Marathondi had an unpleasant smell. Nelli was more acidic (pH 3.2) and pH values of Mimosa and Marathondi were pH- 4.6 and pH 4.3, respectively. After the tannin process, loose grain was observed on the Nelli treated hides. Mean penetration rate, yield, thickness reduction and tensile strength were measured as physical parameters (Table 01).

Table 01: Mean values of physical parameters of leather treated with tannin agents, Mimosa, Nelli and Marathondi

Treatments	Mean values			
	Penetration rates ($mmday^{-2}$)	Yield of the leather (%)	Thickness reduction (mm)	Tensile strength of the leather (Nmm^{-2})
Mimosa (Control)	0.29 ± 0.02^{a}	51.27 ± 3.84^{a}	0.17 ± 0.06^{a}	270.00 ± 6.00^{a}
Nelli (Treatment 1)	0.20 ± 0.00^{b}	44.15 ± 4.35^{a}	3.43 ± 0.25^{b}	517.33 ± 54.86^{b}
Marathondi (Treatment 2)	0.13 ± 0.00^{b}	43.45 ± 3.82^{a}	1.23 ± 0.15^{b}	262.33 ± 7.37^{a}

^{a,b} means with same letter are not significantly different

According to Dunnet's mean separation procedure, highest mean penetration rate was recorded in Mimosa compared to other two treatments ($P< 0.05$). The studies indicated that tannins first approach the surface of collagen fibers by hydrophobic bonding, and then combine with collagen fibers by multi-hydrogen bonding (Zhongbing, 2003). However, the other components of plant extracts, including polyphenolic compounds with small molecular weight, are not able to form multi-hydrogen bonding with collagen fibers due to the fact that they have no enough phenolic hydroxys or are lack of structure of ortho-phenolic hydroxys (Zhongbing, 2003). Therefore, they have relatively weaker adsorption capacity on collagen fibers. Thus, molecular weights of tannin agents are important for tannin penetration into the hides. Nelli and Mimosa have tannins with higher molecular weight compare to Marathondi. Molecular weight of tannin agents in Mimosa and Nelli are 1250 and 782.52, respectively (Pushpakumara and Heenkenda, 2012). However, molecular weight of tannin agents in Marathondi (gallic acid) is 170.17 (Musa and Gasmelseed, 2012). Therefore, these can be reasons for low penetration rates of tannin in to hides.

Yield of the vegetable tanned leathers is important since it determines the price of the leather. However, there is no any significant difference (P>0.05) between mean yields of the leather. Thickness of the hide needs to be lowered after drying. Lowest mean thickness reduction was observed in Mimosa (P< 0.05).

Highest mean tensile strength was observed in Nelli followed by Mimosa and Marathondi. According to these results, mean tensile strength of Nelli is significantly different (P<0.05) from other two treatments. Nelli contains hydrolysable tannins whereas Mimosa and Marathondi mainly contain condensed tannins (Pushpakumara and Henkenda, 2012). Since, hydrolysable tannin agents give more strength to leather compare to condense tannin type of tannin agent present in Nelli can be the main reason for the results obtained.

When measuring qualitative parameters best appearance was recorded in Nelli treated leather whereas fullness, hardness and overall best leather were reported in mimosa treated leather (Figure 01).

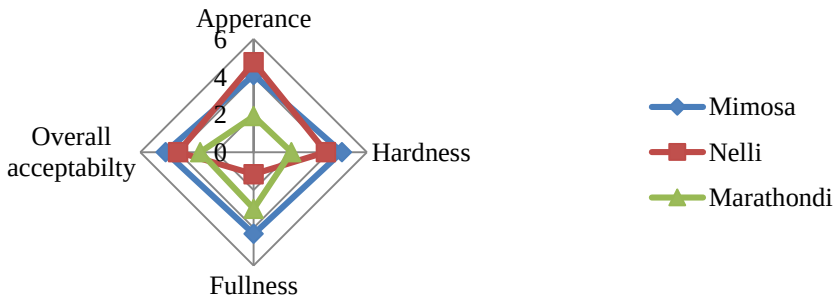

Figure 01: Sensory evaluation for all qualitative parameters

Conclusions

Mimosa is the best tannin agent to produce sole leather compare to other two treatments, Nelli and Marathondi.

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Performance evaluation of different broiler strains under environmental controlled broiler house in Sri Lanka

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Introduction

Broilers are bred and rose specifically for meat production. Hubbard breed is mainly used to produce meat in large scale farms. They are imported from Europe. CIC farm is one of the large scale farms in Sri Lanka and they are rearing two different strains; Hubbard Flex and F 15 under environmental controlled broiler house system. The aim of this study is to compare and find the best strain in assessment of body weight, growth rate, mortality and feed conversion ratio between Hubbard Flex and F 15.

Methodology

The experiment was conducted in closed house at C.I.C. poultry farms (Pvt.) during 2nd May to 14th June 2014. Five hundred day old broiler chicks (Hubbard Flex and F 15) from hatchery were used in the total experiment. Each (250 Flex + 250 F 15) were considered as two treatments. Each treatment was divided into 5 subgroups as replicates as fifty birds per each. Separation was made without including automated feeder line by using plastic boxes.

Before placing, initial weight of the premium category birds were recorded and then adequate amount of feed was given separately. According to the space requirement feeders and waters were used to each separation. Unlimited feeding was done throughout the study period (42 days). All the birds were vaccinated through drinking water against Newcastle disease and Gumboro disease. Same conditions and feed were maintained for each group.

Group feed intake, Average body weight were measured daily until slaughtered at 42nd day. Average weight gain and Feed Conversion Ratio (FCR) of bird was calculated during period of growing birds. Mortality, if any, during the rearing period was recorded. Feed intake was calculated as the difference between the amount of feed supplied and the amount of feed that remained at the end of each feeding period. Feed conversion (feed: gain ratio) was calculated as the ratio between feed intake and body weight gain every day. The experimental data were processed and analyzed using Microsoft Office Excel (2007) and Minitab16 software. Performances of two groups were compared using two sample t tests. Mean comparison was used to find the best strain in performance.

Result and Discussion

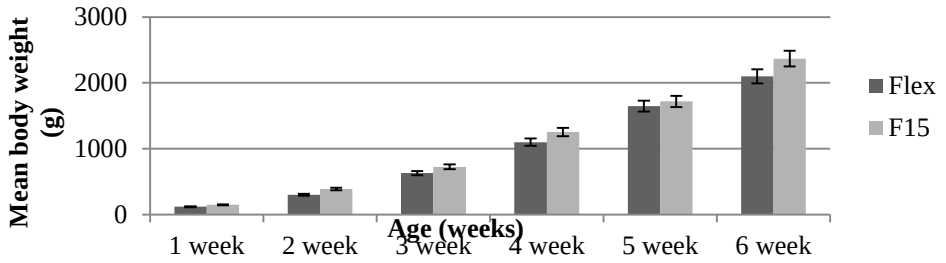

Figure 01: Body weight of Hubbard Flex and F15

When consider the body weight of the broilers there was significant (P<0.05) difference among the treatments in first week, second week, third week, fourth week and sixth week. However, there was no significant (P>0.05) difference among the treatments in fifth week (Figure 01). Average body weight of Flex and F 15 was increased throughout the rearing period. However, F 15 was shown the highest mean body weight than Flex broiler chicken throughout the rearing period.

When consider the feed intake of the broilers in weekly basis, there was no significant (P>0.05) difference among the treatments in third week, fourth week, fifth week and sixth week. However, there was significant (P <0.05) difference among the treatments in first and second week. Mean value of F 15 was shown the highest mean of feed intake with in 1st and 2nd week. Mainly the first two weeks were considered as brooding period which was helped to increase the performance throughout the rearing period.

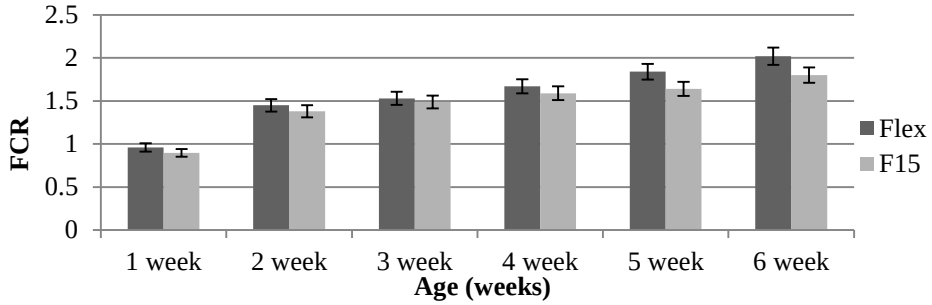

Figure 02: Feed Conversion Ratio of Hubbard Flex and F15

According to the Figure 02, feed conversion ratio was shown significant (P<0.05) difference between two treatments within 2nd, 5th and 6th week with that highest mean of feed conversion ratio was recorded in Flex treatment. F15 broiler chicken was shown higher feed conversion efficiency than flex broiler chicken throughout the rearing period. Feed Conversion Ratio was increased with increasing age of birds in both treatments.

According to the analyzed data weight gain was shown significant (P<0.05) difference between the Hubbard flex and F15 commercial broiler chicken with in first, second and sixth weeks. (Figure 03) Weight gain did not show significant (P>0.05) difference among the

treatments with in third ,fourth and fifth week throughout the production period, The highest mean values in weight gain was shown in F 15 in last week of the production which is the most important traits because that will give high profit to the farm.

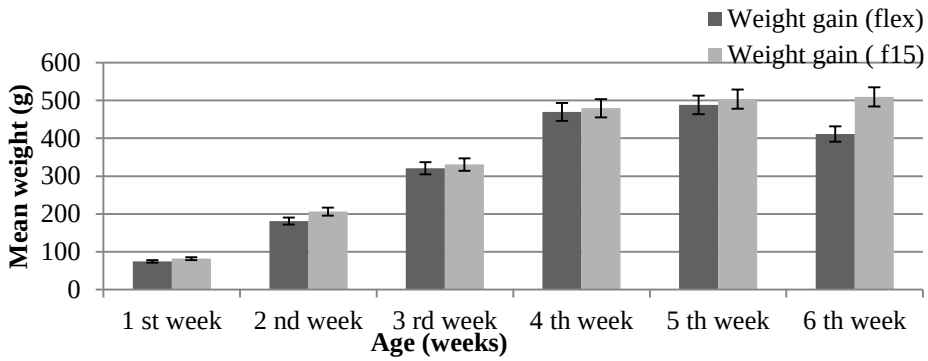

Figure 03: Weight gain of Hubbard Flex and F15

Flex group was shown the highest mortality percentage than F15 group. Mortality during the whole rearing period was higher in Hubbard Flex. The number of deaths in Hubbard F15 chickens was lower, which may indicate that these birds had better immunity. Mikulski *et al.* (2011) observed a similar tendency and have found mortality to be higher in fast-growing Hubbard F15 compared to slow-growing Hubbard JA 957 chickens (6.03 vs. 2.50%).

Conclusions

It can be concluded that F15 commercial broiler strain was superior in body weight and weight gain during the study. The feed efficiency and FCR were related negatively. Strain F15 was adjusted good and profitable because the strain had the highest mean values in body weight and feed efficiency coupled with the lowest FCR at maturity. Strain F15 could be recommended to poultry farmers in study zone for highe productivity and maximum profit.

Acknowledgement

Management staff of CIC poultry farm (PVT) Ltd is gratefully acknowledged.

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Development of Fishmeal using Knifefish *Chitala ornata*

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Introduction

Knifefish (*Chitala ornata*) is a freshwater fish introduced to Sri Lanka as an aquarium ornamental fish in 1980's (Gunawardena, 2007). They were introduced to wild habitats by accidental release and now found in the rivers and lakes in Colombo and Kalutara districts (Sriyananda, 2004). The predatory nature of the knifefish and its ability to spread fast has posed a threat to native aquatic animals in Sri Lanka, especially to endemic species. At present, knifefish is listed as one of the invasive alien species in Sri Lanka (Gunawardena, 2007). Due to their large size and predatory nature, they have lost demand as aquarium fish and they have no demand as food fish. Hence, in order to eliminate these fish from wild habitats a new use should be introduced which would encourage the fishermen to catch them. In this research the possibility of using knifefish to produce fishmeal which could be used as a protein source in fish feed was evaluated.

Methodology

Knifefish for the experiment was collected from Kalutara area. Large bones and skin were removed and flesh was sun dried for 4-5 days. Dried flesh was ground and sieved to produce fishmeal powder. Two experimental diets were prepared as treatment 1 (containing Peliyagoda fishmeal) and treatment 2 (containing knifefish fishmeal) using the trial and error method. Other ingredients used were wheat flour, soyabean meal, rice bran and fish oil. Both diets were formulated to contain 30-35%. Proximate analysis was done for the ingredients and the two diets. Feeding trial was conducted for 20 days using guppies (2.34 ±0.24 cm), male and female separately. Three replicates were used for each treatment. Length and weight of the fish were measured weekly. At the end of the experiment Feed Conversion Ratio (FCR), Specific Growth Rate (SGR), weight gain and protein efficiency ratio (PER) were determined. Production cost of 1 Kg of each diet was calculated and compared. Statistical analysis was done using two-way ANOVA using minitab16 software.

Results and Discussion

Proximate compositions of the two diets are shown in Table 01. As shown by table 2 there was no significant difference between mean values of the two treatments with respect to FCR, SGR, weight gain or the PER. There was also no effect of the interaction between the sexes and the treatments on the above parameters ($P>0.05$) according to the results of the two-way

ANOVA. Therefore, it is possible to use knifefish fishmeal as a substitute for Peliyagoda fishmeal in fish diets.

Table 01: Proximate composition of experimental diets

Component	Treatment 1 (%)	Treatment 2 (%)
Protein	33.30±0.34	35.29±1.74
Lipid	7.98±0.22	4.25±0.43
Moisture	2.34±0.42	2.27±0.16
Ash	22.05±0.10	15.82±0.23

Treatment 1- diet with Peliyagoda fishmeal, Treatment 2- diet with Knifefish fishmeal

Table 02: Mean values of the parameters

Treatment	Sex	FCR	SGR	WG	PER
Treatment 1	Male	3.46 ±0.40	1.82 ±0.41	0.05 ±0.01	2.3 ±0.29
Treatment 1	Female	2.00 ±1.30	1.71 ±0.52	0.05 ±0.01	1.8 ±0.11
Treatment 2	Male	2.61 ±0.33	2.28 ±0.33	0.06 ±0.01	2.2 ±0.98
Treatment 2	Female	2.00 ±1.10	1.95 ±0.06	0.05 ±0.00	2.7 ±1.14

FCR- feed conversion ratio, SGR- specific growth rate, WG- weight gain, PER- protein efficiency ratio

When the production costs of 1 Kg of each diet were compared, it was more expensive to produce the diet with knifefish fishmeal than with Peliyagoda fishmeal. This was due to the high cost incurred on the production of knifefish fishmeal. If the whole fish was used for the production of fishmeal instead of using only the flesh, cost of production could be reduced. However results of the proximate analysis showed higher ash content in Peliyagoda fishmeal (26.6±0.25) which shows that it contained higher amounts of impurities in contrast to the composition of knifefish fishmeal (7.55±0.07) which contained only the flesh of the fish.

Conclusion

Knifefish fishmeal and Peliyagoda fishmeal have similar protein efficiency ratios and similar effect on growth of guppy. Therefore it is suitable to be used as a protein source in guppy feed. Domestic production of feed using knifefish fishmeal by fishermen could be encouraged.

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A study on microbial contaminations, sources and preventive measures in salted butter production in a commercial dairy plant

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Introduction

Dairy fat spreads are milk products relatively rich in fat in the form of a spreadable emulsion principally of the type of water-in-milk fat that remains in solid phase at a temperature of 20 °C (Codex Standard for Dairy Fat Spreads, 2006). There are two kinds of butter as sweet cream and ripened-cream. Sweet cream butter may or may not contain salt (Fernandes, 2008). To overcome the high demand of butter, a reputed dairy company in Sri Lanka engages in manufacturing salted butter. However, finish product frequently contain high microbial load before releasing to the packing which leads to quick rancidity. Consequently, it has become a problem to the company to obtain a profit. Therefore, this research was carried out to assess microbiological quality at different production steps to determine the sources of microbial contamination in salted butter production.

Methodology

A preliminary study was carried out to identify possible sample collection points including swab sampling points during production process. Samples were collected from raw cream, before and after pasteurization, after aging, during churning, final product, and wash water of butter granules and the churner. Swab samples were collected from cream and aging vats, hands of permanent workers (randomly), and inside and outside of the churner. Time and temperature during storage of cream in the cream vat, pasteurization and aging were recorded. Sample collection procedure was repeated for every batch up to identification of the contamination points. Quality of samples was evaluated by performing microbiological tests (total colony count, Coliform and fecal Coliform). According to the test results, contamination points were identified and microbiological (*E. coli*, yeast, and moulds), chemical (free fatty acid level of the final products) and physical (foreign matter observed from naked eye) properties were further analyzed. Entire tests were conducted in triplicate according to the analytical testing procedure of company. Data were finally analyzed by mean value comparison using Microsoft Excel 2013. Further, analyzed data were compared with the standards (SLS 279:1988).

Results and Discussion

According to the preliminary analysis, raw cream was stored for 4-5 hours at 7-8 °C in a cream vat. Mean total colony count in raw cream of seven batches was ranged from 110×10^6 to 127×10^6 cfu/g and Coliform and fecal Coliform bacteria were detected in all samples tested. After pasteurization (95 °C, 20 minutes), mean total colony count of all samples were lower than 10^4 cfu/g and after aging (5-7 °C, 12 hours) (Table 01). *Coliform* and fecal *Coliform*

bacteria were detected in all samples tested however, after pasteurization and aging, *Coliform* and fecal *Coliform* bacteria were not detected in any of the samples.

Table 01: Average total colony counts (cfu/g) of raw cream

Batch no.	B. P ($\times 10^6$)	A.P ($\times 10^3$)	A.A ($\times 10^3$)
A	111±9.07	66±7.37	65±3.21
B	124±7.00	49±14.98	52±5.69
C	129±2.52	49±16.29	52±9.50
D	131±3.05	57±8.39	59±2.00
E	118±12.34	41±8.19	44±3.05
F	119±2.08	34±3.00	40±2.08
G	126±3.00	46±3.51	53±6.03

B.P-Before Pasteurization, A.P-After Pasteurization, A.A-After Aging

Before churning, the mean total colony counts in aged cream were ranged from 44×10^3 to 67×10^3 cfu/g in all samples. However, after washing, the mean total colony count was decreased to a range of 19×10^3 to 53×10^3 cfu/g. Before churning, *Coliform* bacteria were not detected in samples tested (except B). However, "before washing" *Coliform* bacteria were detected in the four samples (A, C, D and G). Furthermore, products after washing and final products from these four batches contained *Coliform*. *Coliform* bacteria were not detected in chilled pasteurized water samples (0-2 °C). However, *Coliform* was detected in swabs taken from inside of churner in A, B, C, D and G batches. Swabs obtained from outside of churner and random swab samples of the permanent workers' hands were negative for *Coliform.* Thus, churning process was identified as the contamination point of *Coliform* during salted butter production and samples collected from contamination points from new four batches were further analyzed.

The mean total colony counts in four batches were ranged between 30 × 103 – 64 × 103 cfu/g. During churning, the mean yeast counts ranged from 137 to 670 cfu/g and mould counts ranged between <10 and 50 cfu/g in samples of tested batches. However, before washing, Coliform bacteria were detected in the samples of A1, B1, D1 batches. Further, Coliform was detected after washing and in final product of same batches. Coliform bacteria were not detected in chilled pasteurized water samples (0-2 °C) used to wash the butter granules in all four batches during churning. In swabs analysis; Coliform was detected in swabs taken from inside of churner in A1, B1, D1 batches. However, swabs obtained from outside of the churner were negative for Coliform. This confirms the results of the preliminary analysis which was due to improper sanitary conditions of the churner inside. Hence, water used to wash the churner (before production) was also analyzed. Results showed that this water (27-30 °C) contained Coliform in batch A1, B1, and D1.

To prevent the contamination, hot water and steam cleaning implementation was done during washing. According to the Robinson and Tamime (2002), hot water and steam were the best sanitizers against gram-positive and gram-negative bacteria and yeast. Cords and Dychdala (1993) reported that combination of hot water and steam are more efficient than dry heat. Therefore, samples from four batches; A2, B2, C2, and D2 of salted butter were analyzed after the implementation of hot water (70-75 °C, 15 minutes) and steam (80-85 °C, 5 minutes)

cleaning. Further, samples from six batches; A3, B3, C3, D3, E3, and F3 of salted butter were analyzed after implementation of hot water and steam treatment as above. In wash water analysis; Coliform bacteria was not detected in both samples. In swabs analysis; Coliform bacteria was not detected in swabs taken from the inside and outside of churner. With the increasing water temperature, the mean total colony count was reduced in both tested batches. Yeast and moulds counts were within the standard level except B2. After implementation of hot water and steam treatments, samples of tested batches were within the standard level. Coliform were not detected in all samples tested. White (1996) stated that, Coliforms were destroyed by pasteurization therefore according to the analysis; product had not been contaminated after pasteurization, due to implementation of hot water and steam.

In chemical analysis; before implementation of the hot water and steam, the mean free fatty acid level of the final products were ranged between 0.22 and 0.52 and only one batch was within the standard level among the tested batches. After implementation of hot water (70-75 °C) and steam, it was ranged between 0.29 and 0.40 and after implementation of 75-80 °C hot water and steam; it was ranged between 0.24 and 0.30. Accordingly eight batches (among ten batches) were within the standard level. Moreover, with the temperature increment of the wash water, free fatty acid level of the final product was lower than the previous. Furthermore, no physical contaminants were observed in all tested batches.

Conclusion

Water used to wash churner was the main contamination source of Coliform in salted butter production. Microbiological and chemical quality of salted butter can be improved by using hot water (75-80 °C, 15 minutes) and steam (80-85 °C, 5 minutes) for cleaning the churner.

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A Study on Crocodile Behavior (*Crocodylus palustris*) and Public Value Orientation in Ethimale of Monaragala District

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Introduction

Mugger crocodile (*Crocodylus palustris*) is principally restricted to Indian subcontinent and the highest number is recorded in Sri Lanka (Da Silva and Lenin, 2010). *Crocodylus palustris* is categorized as a vulnerable species in IUCN red list (2011). Furthermore, due to destruction of their natural habitats, illegal hunting, fishing activities and crocodile attacks during sand mining, bathing and washing, there is an emergence of this interaction as a human-crocodile conflict. Though the existence of considerable number of *C. palustris* is recorded in Uva less literature is available on their status in Uva Province of Sri Lanka. Therefore, this study was conducted to understand people's attitudes, risks, believes and practices towards human crocodile conflict and to study the behavior of crocodile in Ethimale area.

Methodology

The study was conducted in villages surrounding eight perennial and seasonal tanks (Doser tank, Wattarama tank, Kotiyagala tank, Heekaduwa tank 1 and 2, Karadandara tank, Karakolagaswewa tank and Vila oya) at Ethimale of Monaragala district from May to August 2014. Ninety four individuals were interviewed using a pre-tested structured questionnaire including farmers, fishermen and villagers to determine their awareness, knowledge, practices, believes and attitudes regarding *C. palustris*. The information on purpose, frequency and duration of water body usage by the villages, crocodile population, their approximate size, migration and their availability throughout the year in the area was gathered through the questionnaire. Moreover, the practices of the people and attitudes regarding crocodiles were identified by gathering information on crocodile attacks, financial damages, people's reaction when seen crocodiles, offending actions, benefits/uses of crocodiles and threats face by crocodiles. Presence of fecal pellets, footprints, smashed vegetation and cleared basking areas were observed to study the migration and basking behavior. Data analysis was carried out by Microsoft Excel and map was created using ArcGIS software including crocodile migration paths.

Results and Discussion

Awareness of the people

The main water sources of Ethimale were tanks and Vila oya. Therefore, around 97% of the respondents used tanks for their needs daily. Moreover, most of households are by or close to the tanks which explains their close relation with the crocodiles.

Knowledge of the people regarding crocodiles

Sixty eight percent of the respondents considered that crocodiles were useful and 32% of respondents believed that crocodiles were not useful or did not know the ecological roles played by the crocodiles. According to them, consumption of crocodile meat and egg are the major uses. Around 53% of the respondents have eaten crocodile meat while 5.3% have consumed crocodile eggs. Though few had heard the uses of crocodile hide they have not done any hide processing.

Though the respondents have seen crocodiles throughout the day, crocodiles were common on tank sides especially in the morning (6.00 to 8.00 a.m.) and evening (5.30 to 7.00 p.m.). Based on the observations of the respondents, highest crocodile number was reported from Kotiyagala tank (20 to 25), followed by Heekaduwa tank-1 (15 to 20) and Heekaduwa tank-2 (10 to 15). Regarding the approximate length of the largest crocodile seen by the respondents, majority (62%) of has seen largest crocodile in between 2-3 m in length.

Nesting season, i.e., from June to August of *Crocodylus palustris* coincides with the dry season in Monaragala (June to September) (Department of meteorology statistics, 2014). Therefore, the hatching of eggs takes place with the beginning of the rainy season. Around 45% of the respondents have seen crocodile nesting sites at tank bunds, Vila oya sides, canal sides, Vila oya anicut and jungle area which close to tanks.However, 11% of respondents have seen Water Monitors (*Varanus salvator*) and Land Monitor (*Varanus bengalensis*) as main predators of crocodile eggs.

Among the crocodile deaths observed by the respondents, most of the recorded crocodile deaths were due to human actions such as shooting and hitting when the crocodiles attack to the fishing nets (Specially for hatchlings). Two crocodile attacks to the fishermen while fishing were reported. However, 37% of the respondents have faced some financial damages from the crocodiles as damage to livestock (especially to calves) (37%), loss of fish yield (29%), fish net damage and damage to pet animals. Among them damage to livestock and damage to net and loss of fish yield were common. Moreover, threat from crocodiles was reported as one reason to refrain youngsters from fishery.

Attitudes regarding crocodiles

Though 77% of the respondents have agreed that the crocodiles have become threat to fishery or daily uses of the water body, 73% of the respondents still believe that conservation programs for crocodiles are essential, since they believe that the number of crocodiles are depleting annually. Moreover, they have suggested translocation of crocodiles (to large tanks, national parks and zoo) and ecotourism to minimize the human crocodile conflict may be due to the ethical reasons since all the respondents are Buddhists.

Crocodile migration and basking behavior

Crocodiles were migrated during the dry season and they were returned to their original habitats at the beginning of the rainy season. Therefore, crocodile migration was highest during August where all most all the seasonal tanks were dried and low water level was observed in perennial tanks. With the beginning of rainy season in September, crocodiles were returned to their original habitats.

Crocodiles were basked commonly during 6.00 am to 9.30 am under direct sun light (average 33°C daily temperature) in open areas such as dead trees in water, on the Vila oya river bank, tank sides/bund and surrounding rocks. With the high day time temperature, they were moved to the tank bottom and come to the top only for breathing meanwhile some crocodiles were moved to burrows.

Recommendations to solve human crocodile conflict and conservation

To minimize human-crocodile conflict conducting awareness program to villagers including conservation and laws related, installation and maintenance of crocodile excluding areas at bathing places, installing warning sign boards and translocation of crocodiles which trap to fish nets can be done. The crocodile conservation can be done to some extent by sharing conservation and management responsibility among local community. The crocodiles can be an attraction of visitors and create employment opportunities for the local community. Eco-tourism may be a good solution for involving people with their traditional knowledge about crocodile conservation and will be helpful to uplift the local socio-economic conditions. Other than eco-tourism, protection of nesting habitats, initiation of crocodile parks or sanctuary, conservation education and public awareness also can be practiced.

Conclusion

Majority of the villagers have sound knowledge regarding crocodile population, behavior, migration patterns and availability. Since almost all the people were engaged with the tanks for their daily needs and majority was farmers and fishermen. Though there are several livestock attacks and economic losses from crocodiles no fatal attacks recorded to people. Therefore, majority of the people in Ethimale was having a positive attitudes regarding conservation of crocodiles.

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Development of Tomato (*Solanum lycopersicum*) Incorporated Fish Nuggets

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Introduction

Modern consumers prefer processed foods and the changes in consumer life styles have resulted in increasing demands for ready-to-eat and ready-to-cook seafood products (Venugopal, 2005). But due to high post-harvest losses and busy life style fish consumption has reduced gradually in Sri Lanka. Therefore value added fish products have become familiar among most consumers (Sri Lanka Fisheries Year Book, 2009). Fish nuggets are formed meat product in ready-to-cook form and it is a good substitute for above situations.

Most of the people nowadays concern more about their health and prefer to have healthier diets. Tomato is considered as one of the healthiest vegetable and fruit in the world (American Cancer Society, 2014). Tomato contains carbohydrates and several vitamins such as Vitamin A, Thiamine, Niacin, Vitamin B6, Vitamin C and Vitamin E. In addition, tomatoes possess one of the most powerful antioxidants, lycopene (Choski and Joshi 2007; Kavanaugh et al., 2007). It has shown a wide variety of positive health benefits, including a reduced risk of cancer (American Cancer Society, 2014). Therefore tomato incorporated fish nuggets contain more health benefits and deliciousness due to incorporation of tomato. On the other hand, the production of value added fish products using locally available resources is important for the wide range of consumers and manufactures and it is also important to fulfill the market gap by production of healthier fish based formed meat product in ready-to-cook or ready-to-eat forms. The objective of this research is to develop a tomato (*Solanum lycopersicum*) incorporated fish nugget with higher levels of antioxidants.

Methodology

Initially, the basic composition of fish nuggets was determined. The ingredients for fish nuggets were identified and new recipes were formulated based on different fish percentages (30%, 35%, 40% and 45%). After production fish nuggets, a sensory evaluation was carried out using 10 trained panelists to find the best combination. For selection of the best heat treatment for tomatoes, keeping qualities (pH, titratable acidity, moisture content and salt content) and sensory qualities of different heat treated tomato pastes were evaluated. Boiling (10 min, 100 ^{o}C), microwave-cooking (50 s, 800 W) and steaming (10 min) were selected as the best heat treatments (Kamiloglu *et al*., 2013). After selecting the best heat treatment for tomatoes, the best level of tomato paste to be incorporated in to the selected fish nugget recipe

was determined by a sensory evaluation. Tomato paste was incorporated at 5%, 8%, 12% and 15% (w/w) (Deda *et al*., 2007).

Tomato incorporated fish nugget and fish nugget without tomato incorporation (control) were further analyzed for its physicochemical properties and microbiological quality. Proximate composition, pH value and water holding capacity of the final product were determined. Microbiological analysis was done for *Escherichia coli, Staphylococcus aureus*, Total Plate Count (TPC) and Yeast and Moulds. Sensory data were analyzed according to the Friedman test using MINITAB 15 software package. Data obtained from melting tests were analyzed by analysis of variance using MINITAB 15 software package.

Results and Discussion

45% fish incorporated fish nugget sample was selected as the best sample. According to the sensory evaluation, there was significant difference ($p<0.05$) among treatments. Then 45% fish incorporated fish nugget sample was used as the control. According to another sensory evaluation and keeping quality evaluation, boiling (10 min, 100 ^{o}C) was selected as the best heat treatment for tomato paste. The results of the above mentioned sensory evaluation showed that there was significant difference between different heat treatments of tomato paste related to the quality parameters such as appearance/ color, aroma flavor/ taste and mouth feel ($p<0.05$). According to the results (Figure 01), there was significant difference between fish nugget samples with different tomato incorporation levels related to the organoleptic properties such as appearance, color, taste, texture and overall acceptability ($p<0.05$). Finally 12% tomato incorporated fish nugget sample was selected as the best.

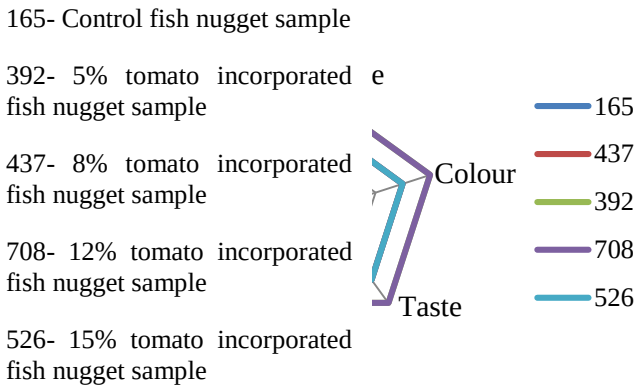

Figure 01: Web diagram of sensory evaluation on different levels of tomato incorporation in fish nugget

The composition of tomato incorporated fish nuggets is given in Table 01. The total solid, organic non-fat, moisture, crude protein and ash contents of the samples were significantly different ($P<0.05$). But crude fat content of the samples were not significantly different ($P>0.05$). Tomato incorporated fish nugget sample was contain high amount of crude protein and moisture. This may be due to the incorporation of tomato paste in the fish nuggets.

Table 01: Proximate composition of the samples

Test Parameters %	Fish nugget sample	Tomato incorporated fish nugget sample	Standard Limits
Total Solids	49.01±0.05	45.96±0.1	45% (min)
Crude Fat	10.05±0.14	9.70±0.16	15% (max)
Organic Non Fat	36.30±0.21	33.79±0.12	32.5% (min)
Ash	2.66±0.06	2.47±0.04	2.7% (max)
Moisture	30.99±0.05	34.04±1.0	40% (max)
Crude Protein	27.37±0.14	27.71±0.04	25% (min)

Microbiological analysis revealed, though the microbial count was increased with the time, microbe count of tomato incorporated fish nuggets were within the SLSI requirements. There was a positive effect on reduction of microbial count by frying of fish nuggets. Cost analysis indicated that cost of 1 kg of tomato incorporated fish nuggets is Rs.325.00.

Conclusion

12% (w/w) is the best level for the incorporation of tomato in to fish nuggets. The analysis of the chemical composition in tomato incorporated fish nuggets showed high values for total solids, crude fat, organic non-fat and ash. Boiling is the best heat treatment for tomato paste to retain the sensory qualities, keeping qualities and nutritional value.

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Analysis of Consumer Food Safety Knowledge and Practices in Rathnapura

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Introduction

Food safety is a scientific discipline describing handling, preparation, and storage of food in ways that prevent food borne illness. Unsafe food is the likely vector of multiple biological, chemical or physical hazards and certainly of several nutritional problems. Consumers are the end-users of food chain. With their attitudes, knowledge, age, sex, income level and social status food safety knowledge and practices are different. According to the World Health Organization (WHO), up to 30% of the population of developed countries are affected by food borne illness each year; more than 75 million people get sick from food related illnesses in the USA resulting in 325,000 hospitalizations and 5,000 deaths annually (WHO, 2007). The problem is expected to be even more severe in developing countries.

Now Sri Lanka is more concern about food safety and handling practices. There are many rules and regulations. Food Act No. 26 of 1980: This Act controls, manufacture, importation, transport, sale, distribution, advertisement labeling of food. Sri Lankan food & beverage products comply with international standards such as ISO 9000, ISO 22000, HACCP, Halal, Kosher, Organic etc. In Sri Lanka also have many of food borne diseases, but they are not reported often. But mainly diarrhoeal diseases are the prominent. This study assesses the consumer food safety knowledge and the practices among the Rathnapura households.

Methodology

A survey strategy was used in the research. Target population was the entire household in Rathnapura district 301,876 .Thought it was large to do an investigation within limited time period and inadequate financial budget, multi stage random sampling technique was employed to select appropriate sample to evaluate the objectives of this study. Eventually 120 household were selected as the sample size where can meet 95% confidential level.

Five key principles of Food safety by WHO, are used to find out consumer knowledge level in food safety. The association between socio economic characteristics and knowledge on food safety was revealed by applying chi-square test. Prevailing food safety measures were identified by using significant measures like smell, appearance, special package, and price and quality certificates. Consumer food safety knowledge was evaluated with household experiences of physical symptoms associate with food borne illness. And also food preparation, purchasing and storage practices were used to identify food safety knowledge and practices of consumers. Analysis was done by using Minitab 14.0 software package and Microsoft Excel.

Results and Discussion

Descriptive statistics for the sample were produced using descriptive statistical analysis. The purpose of generating descriptive statistics was to describe the demographic characteristics of the sample.56% females and 44% males are in the sample. To prevent contamination of food with pathogens spreading from people, pets and pests, separate raw and cooked foods to prevent contaminating the cooked foods, cook foods for the appropriate length of time and at the appropriate temperature to kill pathogens, store food at the proper temperature, do use safe water and cooked materials. Majority of consumer's (58%) food safety knowledge level was low. 30% of consumers were had high food safety knowledge level.12% had medium level knowledge on food safety.

Food safety measures were identified by the study as smell, appearance, special package, and price and quality certificates. Among them 12% considered price, appearance and smell as important factors.7% were merely concern about one factor of them. Smell, package and special offer were identified by 10% of consumers. And also 10% of them were concerned about all measures. Among respondents 63% selected food items without considering about quality certification. The association between socio economic characteristics and knowledge on food safety was analyzed by using chi-square analysis. Income level had significant association with food safety knowledge of consumers. Education level did not show any association on food safety knowledge.

95% of respondents had experienced with any of the food borne illnesses. This shows that consumers have low confident on food safety and how to protect their family from food borne illnesses. Daniels (1998) verified that consumers who considered themselves knowledgeable make food handling errors.

By considering food safety practices on storage and preparation, 53% of consumers agreed that peeled and chopped fruits and vegetables kept in open air for long time cause contamination. But 23% strongly agreed that before using vegetables and fruits, they should be soaked in salt water. Only 10% kept cooled vegetables and fruits in open air more than one hour. In purchasing fish, 8% of consumers observed red color gills, discoloration and brightness of eyes. Majority were concerned on one factor. And also 48% were concerned about cleanliness of preparation and operator. Storage period of fish and usage were not concerned by consumers of 36%.some consumers never keep cooked meat and raw meat at the same place in refrigerator (34%). Cleaning of food preparation area with soap and water was practiced by only 6%. Washing the cutting board with water, used to chop vegetables or cut raw meat was practiced by 8% of consumers (Table 01).

Lack of knowledge is likely to lead to inappropriate food handling behaviors. Generally, consumer's knowledge has been found to be inadequate to ensure that food preparation in the home minimizes the risk of food borne illness. Personal hygiene and cleanliness of surfaces where food is prepared were identified as practices that have to be developed. Nearly 48% consumers were concern on personal hygiene highly,

Table 01: Descriptive on Food preparation practices

Practices	Always	Sometimes	Rarely	Never
Wash hands before prepare foods.	42%	27%	16%	15%
Before prepare food clean hands and equipment with soap and water.	6%	25%	19%	39%
Using cutting board to cut without cleaning after cutting meat.	8%	28%	35%	18%
Keep leftover food at room temperature for more than 2 hours.	47%	11%	18%	18%
Check cleanliness of surfaces where you prepared food.	33%	20%	29%	7%

47% of respondents were unaware on keeping leftover food at room temperature for more than 2 hours can cause contamination. 42% of consumers wash hands before preparing meals. However some respondents were say always if leftovers were safe. 53% of consumers thought that vegetables open up to air cause contamination. Although that 40% of consumers were not aware on cleaning procedure of vegetables and fruits.

Conclusion

Consumers in Rathnapura district express low level of self-related confidence and awareness on food safety. Information and low understanding of food bone illness issues. However, findings also reveal gaps in consumer's knowledge of safe food handling practices. For instance many of them believe they can tell food borne illnesses by its appearance, smell, and price.

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A study on shelf life of export oriented fresh chilled Yellowfin tuna loins in relation to histamine content

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Introduction

Sri Lanka has become a leading country which produces Yellowfin tuna (*Thunnus albacores*) and other large pelagic species in the Indian Ocean. (Indian Ocean Tuna Commission, 2011). To meet export market, maximum histamine content of the product should not exceed 50 ppm (Food and Drug Administration, 1998). Seafood processing factories guarantee a shelf life of 14 days for the product fresh chilled Yellowfin tuna loin, even though shelf life of different Yellowfin tuna loin batches is varied. Shelf life can be exceeded or not exceeded 14 days in different batches. These batches represent Yellowfin tuna received from different fishing harbors in different proportions. According to the fishing harbor environmental factors and practices followed by fishermen can be varied. There is evident that depending on the nature of the environment, different proportions of decarboxylase positive bacteria would be present in water and external fish tissue, and therefore the level of histamine and other toxigenic amines formed in fish tissue would not be uniform (Yoshinga and Frank, 1982). This research is to identify whether these fishing harbors have an effect on the shelf life of fresh chilled Yellowfin tuna loin in relation to histamine content.

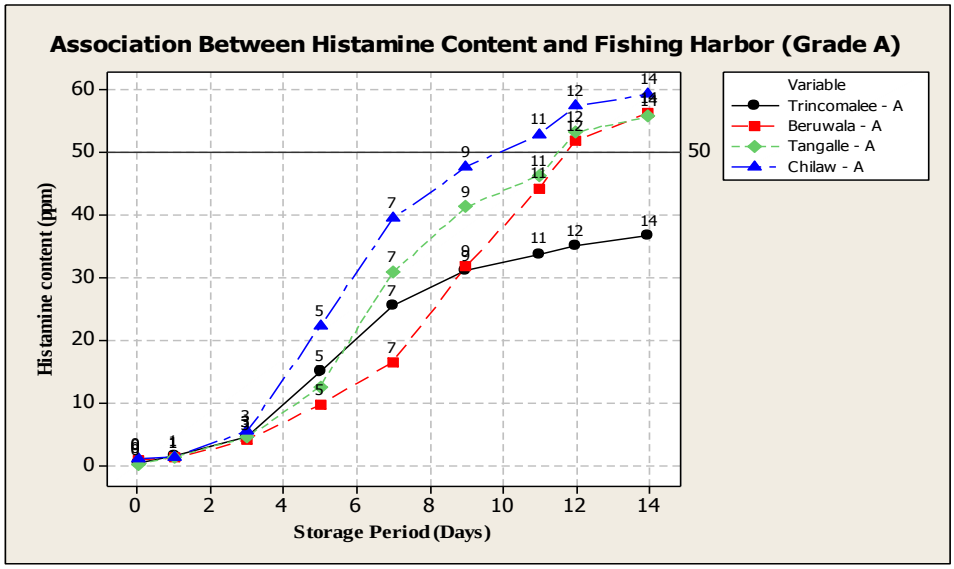
Methodology

The study was carried out at SGS Lanka (Pvt) Limited, Colombo 02. The sample collection and background study of fresh chilled Yellowfin tuna loin exportation was done at Global Seafoods (Pvt) Limited. Three repeated experimental trials on histamine analysis of Yellowfin tuna loin samples were conducted during a time period of 42 days. Storage time period of each set of samples for an experimental trial was 14 days. Selected fishing harbors were Beruwala, Tangalle, Chilaw, and Trincomalee. Yellowfin tuna loins of Grade A and B were selected from each fishing harbor. All collected samples had an on-broad freezing time period, which was varied between 18 - 22 days. Labeled and vacuum packed samples were stored at 0 ^{0}C, in the fresh chilled condition. Histamine analysis was carried out from the time period of zero day of storage to 14 days of storage. Histamine was analysed using flurometric method according to the AOAC official methods of analysis. Data collected from the three experimental trials were analysed using Minitab 14 statistical software. Descriptive statistics of means, Standard deviation, two-way ANOVA and one way ANOVA with tukey's pairwise comparison was applied in analysing the results. A significance level of 5 % was used.

Result and Discussion

Histamine content was increased with storage time period in each and every sample. The increment pattern of Yellowfin tuna loins received from four selected fishing harbors of Grade B did not show any significant difference (P>0.005). It was concluded that there was an effect from fishing harbor on average histamine content of Yellowfin tuna loins within fish grade A (P<0.005). Further analysis of one way ANOVA with tukey's pairwise comparison revealed that Trincomalee fishing harbor had the least contribution for histamine formation.

Figure 01: Association between the average histamine content of Yellowfin tuna loins and



fishing harbor (Grade A – Histamine analysis experiment 1)

According to Figure 01 the shelf life of Yellowfin tuna was varied between 10 to 14 days. Figure 2 revealed a Shelf life of 9 to 10 days in Yellowfin tuna loin samples of Grade B. Higher bacterial loads seemed to be associated with the formation of higher amines in storage (Koutosomanis *et al.*, 1999). Thus this study reveals due to high microbial contamination in Grade B, a significant difference cannot be identified in the pattern of histamine formation of the loin samples received from four different fishing harbors. Furthermore due to high microbial contamination histamine formation was happened at an alarming rate. Fish grading A with the least microbial contamination had shown a difference in histamine formation according to the fishing harbor. It was proven Yellowfin tuna loins received from Trincomalee fishing harbor had the best shelf life in relation to the histamine content with in the "A" grade fish. The reason behind this is histamine formation is highly affected with the amount of microflora and the microbial load that could contaminate a fish would not uniform from place to place, due to factors like environmental conditions, post harvest practices followed by fishermen and fish catching methods.

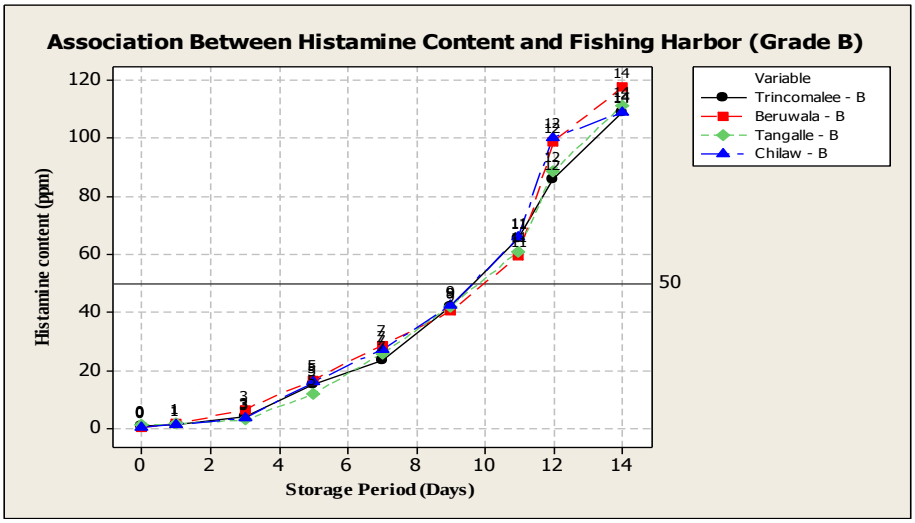


Figure 02: Association between average histamine content of Yellowfin tuna loins and fishing harbor (Grade B - Histamine analysis experiment 1)

Conclusions

Shelf life of fresh chilled Yellowfin tuna loins, in relation to histamine content was highly dependent on the fish grading rather than the conditions of the fishery harbor.

Acknowledgement

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Development of Finger millet *(Eleusinecoracana)* incorporated symbiotic drinking yoghurt

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Introduction

Sri Lankan yogurt market is characterized by intense competition prompting leading players to differentiate themselves by focusing on health benefits, branding, and incorporation of different ingredients. Yoghurt is a popular fermented dairy product due to its health benefits as a functional food in addition to its nutritional benefits (Robinson and Tamime, 1999). High calorie yogurt drink that contains any kind of a cereal powder is completely a new product concept to the Sri Lankan market. Therefore, the objective of the current study was to develop a health beneficial probiotic drinking yoghurt by incorporating finger millet as a cereal which can be used as a breakfast food, sport supplement and also as a weaned food for toddlers. Nutritionally, finger millet is used as a whole grain, it is higher in protein and minerals in comparison to all other cereals and millets. Accroding to previous studies, finger millet is also known for several health benefits such as anti-diabetic, antitumerogenic, atherosclerogenic effects, antioxidant and antimicrobial properties which are mainly attributed due to its polyphenol and dietary fiber contents (Dykes and Rooney, 2007; Chethan, 2008). Therefore this study was conducted to develop a cereal based probiotic yoghurt drink which can be promoted as a natural source of high calorie that can be consumed as an alternative for the imported, artificial and expensive sport nutrition's and weaned foods.

Methodology

The study was conducted at the research and development and quality assurance laboratories in Ceylon cold stores PLC, Ranala, Kaduwela. In the preliminary trial 1 most compatible sugar percentages for different incorporation levels of finger millet flour from the three experimental forms (roasted flour, germinated flour and raw slurry) were selected. Then preliminary trial 2 was carried out using ranking method to select the best finger millet incorporation levels (4 %, 5 %, 6%, 7% and 8 % (w/w)) for each incorporation form. The best sugar percentages and incorporation levels of finger millet from preliminary trials were used in next steps of

experiments. Sensory evaluation 1 was carried out to select the best form/type of finger millet flour to incorporate out of three forms. In second sensory evaluation, the most suitable stage for finger millet incorporation was determined by using two treatments. Each sensory evaluation was conducted with 30 untrained panellists and color, taste, aroma, mouth feel and overall acceptability were considered as sensory properties. Finally proximate analysis, physico- chemical and microbial analysis were conducted for the selected final probiotic drinking yoghurt by comparing with a control sample. Probiotc lactic acid bacteria enumeration was carried out using the selected final product by pour plating on MRS media to find out the effect of finger millet incorporation on the viability of probiotic lactobacilli. Selected final product was compared with a control sample and enumeration was done at 1, 7 and 14 days interval.

The sensory data were analyzed using Friedman non-parametric test with 95% significance by using Minitab 16 software. Complete Randomized Design (CRD) was conducted and data obtained from chemical and microbiological tests were analyzed using analysis of variance (ANOVA) using the SAS 9.0 software. Significant means of treatments were separated using the Least Significant Difference test (LSD) ($P< 0.05$).

Results and Discussion

According to the results of the series of preliminary trials 5% (w/w) was selected as the best incorporation level from each three finger millet forms and 8 % (w/w) sugar as the compatible sugar percentage. In the first sensory evaluation for selecting best form/type of incorporation out of three experimental forms, germinated /malted flour incorporated yoghurt was selected as the best due to higher preference than other two. There was a significant difference ($P<0.05$) between treatments regarding and overall acceptability. Second sensory evaluation revealed, 5 % (w/w) germinated (malted) finger millet flour incorporated (Addition before fermentation) drinking yoghurt have the higher preference compared to the other treatment with respect toall the sensory parameters considered ($p<0.05$). The selected composition of synbiotic drinking yoghurt is given in Table 01.

Table 01. Composition of the selected final product

Ingredient	Percentage (w/w)
Raw milk	84.54 %
Sugar	8 %
Stabilizer	0.25 %
Finger millet (Germinated flour)	5 %
Skim milk powder	0.83 %
Dairy cream	1.37 %

In the shelf life evaluation of the final product, there was a significant difference ($p< 0.05$) in lactic acid development (Titratable acidity) during cold storage between control drinking yoghurt sample and germinated finger millet flour incorporated yoghurt.

During the 21 days of storage period, titratable acidity of the selected final product was between 0.68% ± 0.08 to 0.89% ± 0.08. During the storage period of 21 days, pH of the control yoghurt sample reduced from 4.58± 0.09 to 4.25±0.09 and pH of germinated finger millet flour incorporated yoghurt reduced from 4.62±0.09 to 4.38±0.09. The pH drop of both treatments is due to the acid development as a result of the activity of lactic acid bacteria (Tammie and Robinson, 1999).Yeast andmold and *E.coli*, Coliform counts of the both germinated finger millet flour incorporated drinking yoghurt and control were not exceeding SLS standards for yoghurt during 21 days of refrigerated storage.

The probiotic *lactobacilli* count in both experimental and control yoghurt samples have decreased over the storage period (Figure 1). Reason for that may be the low pH (high acid development with the time) levels.Low pH level of the fermented milk products was directly affected the survival of probiotic bacteria. However, as shown in the figure probiotic *lactobacilli*population in germinated finger millet flour incorporated drinking yoghurt is higher compared to the control sample. Finger millet contains prebiotic substances such as resistant starch, oligosaccharides, crude fibers and also it acts as fermentable substrates for growth of probiotic microorganisms (Dykes and Rooney, 2007; Chethan, 2008). There is a significant difference in probiotic bacteria population over the storage period between control and germinated finger millet flour incorporated yoghurt sample ($p < 0.05$).

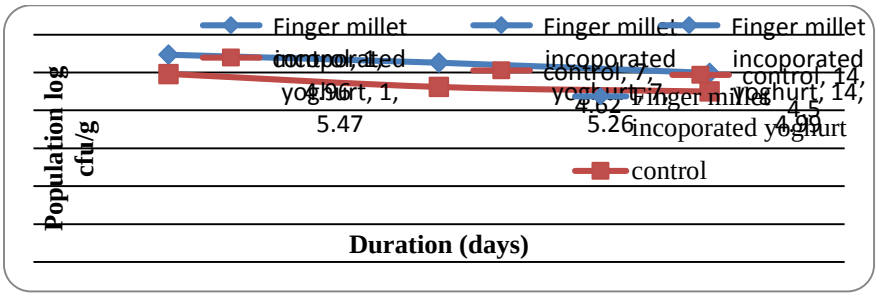

Figure 01: Changes of probiotic lactobacilli population during refrigerated storage

Conclusions

5 % (w/w) finger millet flour incorporation level was selected as the best and germinated/malted flour was selected as the best form of incorporation while addition of finger millet before fermentation was determined as the most suitable stage of incorporation. Further, the incorporation of finger millet into the yoghurt has enhanced the survival of probiotic *lactobacilli* during refrigerated storage.

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Development of soursop pulp (*Annonamuricata)* incorporated fermented sweet cream buttermilk beverage

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Introduction

In Sri Lankan context buttermilk removed from the dairy processing plants considered as a dairy waste and utilization of dairy by product is considerably low compared to other countries. Sri Lankan market is still having a market gap for locally produce fermented flavored milk base beverages. Buttermilk could be used to produce fermented milk beverages replacing milk which would result in differentiated products. Buttermilk is also considered a nutritious dairy ingredient that is saturated in milk fat globule membrane (MFGM) components (Sodini *et al*., 2006). Addition of fruit juices or pulps is an attractive avenue for the utilization of buttermilk. Soursop is one of the fruit spp. which can be incorporated to manufacture beverages with good consumer demand. The fruit is rich in vitamin B, potassium, fructose and vitamin C (**Pamplona-Roger, 2005** cited in Ekaluo *et al*., 2013). Soursop fruit is a proven cancer remedy for cancers of all types and broad spectrum antimicrobial agent for both bacterial and fungal infections, antiparasitic activity, lower high blood pressure and is used for depression and stress (Camiel *et al*., 2008).

Methodology

The current study was carried out at Pelwatte Dairy Industries Limited, Pelwette and laboratory analysis was done at Pelwatte Dairy Indusries Limited and Uva Wellassa University laboratories. Soursop pulp was prepared by flowing method. Fresh fully ripped Soursop fruit was washed by chlorinated water and disinfected by using 70% of ethanol. Then fruit was cut it to halves by using a sharp knife and seeds and blemishes were removed. After that, flesh was scooped out using a clean stainless steel spoon and blended it using an electric blender. Initially incubation time was standardized for the buttermilk base by incorporating different levels of Skim Milk Powder. Several preliminary studies were done to select the best

Soursop pulp and Sugar incorporation level for the final product. Sensory evaluation was done using 30 untrained panelists for the final three treatments (12%, 13% and 14% of Soursop). The pH value and acidity were evaluated in one day intervals for thirteen days in both Potassium Sorbate added sample and without preservative sample and microbiological analysis was done for *Escherichia coli*, Coliform and Yeast and Molds. The sensory data was analyzed using non- parametric procedure, according to the Friedman test with 0.05 levels of significance in Minitab 16 software package. Complete Randomized Design (CRD) was conducted and data obtained from chemical and microbiological testes were analyzed using analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS software.

Results and Discussion

Skim Milk Powder was added to buttermilk to increase the total solid content. The increase of total solid content has reduced the incubation time by influencing the growth and activity of starter culture (Figure 01). Incubation time was reduced to 4 hours by adjusting Skim Milk Powder level to 6 grams/100 mL. Eight grams of Skim Milk Powder addition level was not selected as it can increase the cost of production.

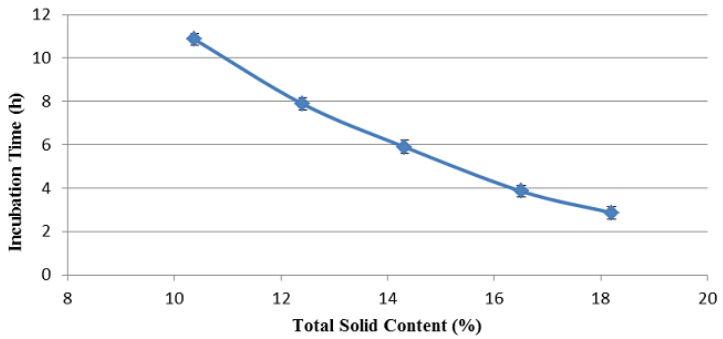

Figure 01: Incubation Time variations with the Total Solid Content

According to the sensory evaluation, formulation with 13% Soursop incorporation level has shown higher preference than the other formulated treatments (Figure 2). According to above results mouth feel and taste were overlapped in all three treatments. 13% Soursop level was not significantly masking the milky flavor of the beverage this might be a reason for higher preference.

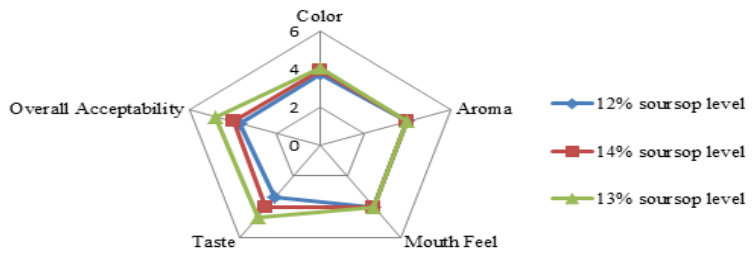

Figure 02: Sensory attributes of the different Soursop incorporation levels

Titratable acidity of the Soursop incorporated sweet cream buttermilk beverage has increased while the pH of the beverage was decrease with the days of storage. The decrease of pH during the storage is common in fermented dairy foods and can be attributed to the growth of bacteria and lactic acid production (Lucey, 2004). The pH reduction in the beverage with preservatives was in a higher pH range than beverage without preservatives. Buttermilk beverage without preservatives was having a significantly higher mean acidity than the buttermilk beverage with preservatives ($P<0.05$). Fermentable sugars in the product produces lactic acid this lactic acid may increase with storage time period. It may lead to increase the acidity of the product.

Negative results for *E. coli/* Coliform could be a result of good hygienic practices conducted during processing of beverage. Beverage without preservatives was positive for yeast and mold count after the 5^{th} day of storage and beverage with preservatives was negative for yeast and mold count during 13 days of storage. Thus Potassium sorbate is an effective preservative for the beverage.

Conclusions

Starter culture multiplication was not harmed by use of sweet cream buttermilk for the production of fermented beverage. Further, incubation time was reduced to favorable level with increase of total solid content in sweet cream buttermilk base. 13% Soursop incorporation level and 12% sugar incorporation level were selected as the best incorporation level according to the sensory attributes. Potassium sorbate can be used as a preservative for the Soursop incorporated sweet cream buttermilk beverage. The crude protein level of the most preferred sample was 3.6% while its ash content was 0.8%. Its also had a fat content of

0.6%.Further studies should be done on the shelf stability of the Soursop incorporated sweet cream buttermilk beverage.

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Development of fruit (*Musa* spp.) puree incorporated synbiotic stirred yoghurt

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Introduction

Yoghurt is one of the most nutritious fermented milk products that can be used to enhance the nutrition condition of people. It is obtained by introducing specific strains of Lactic acid bacteria. The Lactic acid micro flora reduce risk of colon cancer (Foissy, 1983 cited in Huma, 2003), reduce the serum cholesterol level (Anderson and Gilliland, 1999 cited in Huma, 2003) and also maintain the intestinal ecosystem (Saarela *et al.*, 2002 cited in Huma, 2003). Prebiotics are non-digestible food ingredients that improve the host health by selectively stimulating the growth of certain beneficial microorganisms. Fructo-oligosaccharide is prebiotic source that can be found in ripe banana around 2 mg/g. By incorporating banana with yoghurt is best way to improve the health benefits and taste of the yoghurt. Stirred type fruit yoghurt is one of the best products that can be used to gain consumer preference. Therefore, this study was conducted to develop a Banana puree incorporated symbiotic stirred yogurt.

Methodology

The current study was carried out at Ceylon Cold Stores PLC (CCS), Ranala, Kaduwela. Laboratory analysis was done at CCS and laboratories in University of Kelaniya. First, yoghurt base and the banana puree were prepared according to the predetermined recipe after various preliminary trials. For final sensory evaluation, three treatments were used with three replicates. The incorporation levels of fruit puree with yogurt base is given in table 01.

Table 01: Incorporation levels of fruit puree with yoghurt base

Treatment	Yoghurt % (w/w)	Fruit puree % (w/w)
1	86	14
2	85	15
3	84	16

Table 02: Composition of the Final stirred yogurt base

Ingredient	%	Weight (g)	Fat (g)	MSNF (g)
Raw Milk	92.67	1010.00	35.40	85.90
Fresh Cream	0.70	7.80	2.80	0.30
SMP	3.20	35.10	_	33.90
Sugar	0.40	4.40	_	_
Gelatin	3.00	32.70	_	_
Total	100.00	1090.00	38.20	120.10

Table 03: Composition of Final Fruit puree

Ingredient	Amount (w/w)
Banana ('Anamalu')	45%
Pineapple	15%
Cane sugar (white)	40%
Ascorbic acid	500 ppm

Then the best incorporation of fruit puree was determined by using five point hedonic scale with 30 sensory panel. Physicochemical and microbiological properties were observed in the selected best sample. Chemical composition (Moisture &crude fat) was tested. Titratable acidity and pH were evaluated for 14 days period and microbiological analysis was done for *E.coli* and Yeast and mould content. Also probiotic bacterial count was determined using Man Rogosa Sharp Media. In addition effectiveness of the Potassium sorbate against yeast and mould count was evaluated. The sensory data were analyzed using non-parametric procedure, according to the Friedman test using Minitab 15 software programme. The data obtained from physicochemical and microbiological tests were analyzed using analysis of variance (ANOVA) using SAS 9.0 software programme. Significant means of treatments were separated using Least Significant Difference ($P<0.05$).

Results and Discussion

The sensory evaluation with Friedman test revealed all sensory parameters were significantly difference except color ($P<0.05$). The 15% incorporation level of fruit puree was obtained higher estimated median value for taste and overall acceptability. After analysis, 15% incorporation level of banana puree was selected as the best percentage for stirred yoghurt. The composition of the final selected final stirred yogurt and composition of final fruit puree is given in table 2 and table 3; respectively.

The microbilogical analysis revealed that the *E. coli*/ Coliform and yeast and mould count were in acceptable range according to the SLSI standards. Preservative treatment was significantly difference with without preservative treatment ($P<0.05$). Sorbic acid and/ or

sorbic acid salt prevent the growth of yeast by blocking their dehydrogenase system. Potassium sorbate is very effective against *Saccharomyces* spp., *Debaryomyces* spp., *Candida* spp. (Mihyar, Yamani and Al-Sa'ed, 1994 cited in Yildiz, 2010).

The probiotic activity of banana stirred yoghurt was significantly different from plain stirred yoghurt ($p<0.05$) (Figure 1). It may be due to the prebiotic (FOS) compounds that present in ripe bananas. The highest FOS content was found in ripe bananas, which contained 2.0mg/g of FOS (Environ International Corporation, 2000).

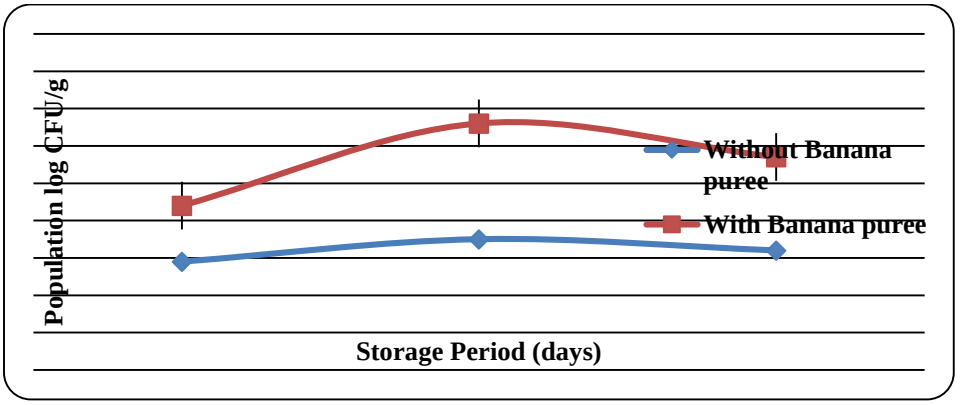

Figure 01: Viability of probiotic lactobacilli with storage life

Conclusion

The best incorporation level of fruit puree for the stirred yoghurt was 15%. Ripe banana contains prebiotic source that enhance the probiotic lactic acid bacteria. Potassium sorbate is an effective preservative against yeast and mould count.

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Quail egg consumption: patterns, preferences and perceptions among consumers in Galle district, Sri Lanka

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Introduction

Owing to the changing life style and food availability, Quail egg is being used as analternate potential and acceptable egg source in many parts of the world. Regular consumption of quail eggs helps fight against some diseases such as digestive tract disorders, tuberculosis, asthma, diabetes and stomach ulcers, strengthen the immune system, promote memory health, increase brain activity and stabilize the nervous system. Nutritional value of quail eggs is higher than those offered by other eggs and contain high amount of antioxidants, minerals, and vitamins and less amount of cholesterol (Tanasorn*et al.*,2013).Compared to chicken eggs, there is a limited body of scholarly literature in related to consumer behavior of quail eggs. Most literature to do with quails and their eggs has focused on production and processing issues, not consumer market studies. Therefore, present study was aimed to determine the quail egg consumption patterns, preferences and perception among consumers in Galle district, Sri Lanka.

Methodology

Ten Divisional secretariats (Akmeemana, Ambalangoda, Baddegama, Balapitiya, Bope-poddala, Elpitiya, Galle four gravates, Habaraduwa, Thawalama and Yakkalamulla) in Galle districts were purposively selected as the research area. 200 consumers, who toured to local markets and supermarkets in those areas were purposively selected and interviewed.Information related to consumers' age, sex, education, occupation, income, consumption pattern and attitude towards quail eggs were collected using a pre-tested questionnaire with havingboth open and closed form questions. Primary data were processed and analyzed using the Microsoft Office Excel (2003) and SPSS 20 package. The association between demographic data and egg consumption pattern was tested using chi square, with a p-value of less than 0.05 considered statistically significant.

Result and Discussion

As to present study produced data it is revealed that majority of the respondents (57%) did not consumed quail eggs, while 43% consumed. Table 01, shows the relationship between

demographic data with the quail egg consumption. These demographic indices did not significantly ($p>0.05$) influence the quail egg consumption, except gender, with female respondents consuming less eggs. Findings of the study is revealed that purchasing frequency is not satisfied, because most of the respondents who consume quail eggs (81%) rarely purchasedeggs every month. Most of them had purchased quail eggs once or twice during the past year. Findings revealed, quail eggs were not a regular food item in their diet.

Boiled eggs were most preferred (61%) as egg serving method than any other preparations (Figure 01). This can be expected because of the small size of quail eggs,it is inconvenient to prepared comparing withother poultry eggs especially chicken eggs. Consumers had purchased quail eggs from Food Cities (34%), from Farm shops (30%), from grocery stores (20%) and directly from farms (11%). 5% of consumers had supplied quail eggs by home production.

When the quail egg consumers were asked about the major factors that limit their consumption of quail eggs, it was found out that the most common limiting factor was the low of availability of quail eggs (54%) in the accessible markets, the high price of the quail eggs became the second factor (23.3%) and less preference of other family members was the third factor (16.3%).

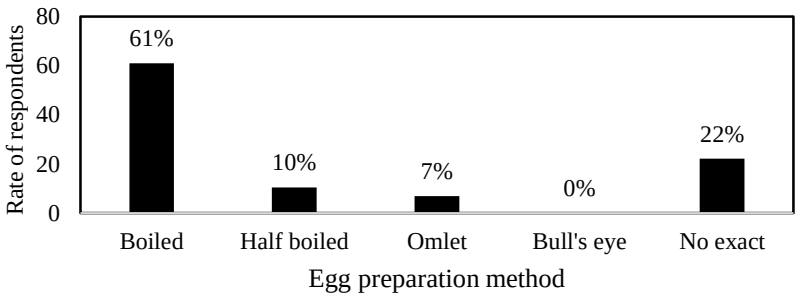
Variable	Frequency	Percentage (%)	χ^2	p-value
Gender (n=200)				
Male	119	59.5	9.929	0.002*
Female	81	40.5		
Age (Years)(n=200)				
Less than 30	47	23.5	0.166	0.920
30-50	121	60.5		
>50	32	16		
Religion (n=200)				
Buddhist	179	89.5	0.998	0.607
Catholic	5	2.5		
Islam	16	8		
Educational level (n=200)				
Below secondary	68	34	5.475	0.065
Secondary	81	40.5		
Tertiary	51	25.5		
Income (per month) (Rs.)				
<20,000	62	31	4.231	0.124
20,000-50,000	102	51		
>50,000	36	18		

Egg consumption (n=200)				
Yes	86	43		
No	114	57		

Table 01:Demography and egg consumption among respondents
*Relationship with the egg consumption is significant at 0.05 level.

Table 02 revealed that, awareness on the nutritional and health benefits of quail eggs among the people had significant influenced on egg consumption. Majority of egg consumers had knowledge that quail eggs are better for asthma and have a low level of cholesterol.

Respondents who did not consume quail eggs mentioned their reasons as follows: a) they are



not used to eat quail eggs as a food (50%), b) do not like the appearance of the egg (17.5%), c) not available where they usually shop (14.9%) and d) do not like taste and odour of eggs.

Figure 01: Way of preparation of quail eggs for consumption

Table 02: Awareness of nutritional and health benefits of quail eggs among respondents

Consumption of quail eggs	Awareness about the qualities of quail eggs		χ^2	p-value
	Yes	No		
Yes	74	12	45.626	<0.0001
No	44	70		

It is recommended to keep cholesterol level below 200 mg per day for whom with cardiovascular diseases, diabetic patients, those with hypercholesterolemia and serious risk factors and those with a history of familial early atherosclerosis (Cengizhan, 2012). Hence, there is a potential to increase the quail egg consumption within the society due to its low level of low density lipoprotein cholesterol ((Polate*et al.*, 2013; Tanasorn*et al.*, 2013).

Conclusions

Quail egg consumption is low in the society. But there is a potential to enhance it as an alternative egg source among the people. Effective promotion and advertising campaign about the nutritional and health benefits for a healthy society should be organized to create well-informed consumers. As well as quail egg production should be promote to increase the availability of them.

Acknowledgement

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