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Comparative Study on Organoleptic, Microbiological and Biochemical Qualities of Commercially and Experimentally Prepared Salted and Sun Dried Talang Queen Fish, *Scomberoides commersonianus*

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ABSTRACT

Talang queen fish, *Scomberoides commersonianus* is the most important widely used species to produce salted and sun dried fish and has high market price in Jaffna district, Sri Lanka. The present research work was carried out from January to June 2011 to compare the qualities of commercially prepared dried fish sample of *S. commersonianus* from four different sites with that of the experimentally prepared one. Organoleptic assessment of samples showed experimentally prepared dry fish are of very good quality than commercially prepared ones. Microbial qualities of dried fish were determined using total bacteria count, total coliform count and methylene blue reduction test. Amount of sodium chloride, moisture content and amount of acid insoluble ash were also tested. The results indicated that the total bacteria count within the preparation sites ranged from 2.849×10^9 to 4.674×10^9 cells g^{-1}, the average number of coliforms from 19-25 cells g^{-1} and time taken to reduce methylene blue from 470-830 min. Percentage of sodium chloride content ranged from 28.68-35.05% and the moisture content ranged from 29.59-37.05%. The amount of acid insoluble ash varied from 1.05-1.15 mg g^{-1}. From the present study, it can be concluded that the experimentally prepared dry fish consists less microorganisms and high shelf life due to the clean preparation methods than the other traditional methods. Chemical and microbial analysis showed that the quality of experimentally prepared dry fish was better than the commercially sundried fish. Therefore, in our region it is essential to improve the dry fish preparation techniques by utilizing clean utensils and water, drying the fish in wooden racks or in the solar drying systems and paying more attention to the hygienic condition of people who are involved in preparation of dried fish.

Key words: Biochemical, hygienic condition, microbiological, organoleptic, Talang queen fish

INTRODUCTION

Ancient methods of preserving fish include drying, salting, pickling and smoking (Al-Subhi, 2011). Salting and sun drying is a simple, ancient and traditional method to preserve fish in Sri Lanka. In Jaffna dry fish preparation mainly occurs in coastal areas, most of the local fishermen produce dry fish by the method of salting and drying. Talang queen fish, double spotted queen fish, sardines, mullet, anchovy, catfish and rays are examples for most common fish organisms used for dry fish production in Jaffna district. Total dry fish production in Jaffna district in year 2010 was 0.777588 metric tons.

Scomberoides commersonianus is the most important widely used species to produce salted and sun dried fish and has high market price in Jaffna district, Sri Lanka. Dry fish preparation is mainly done by the household of the artisanal fishermen. At present, salted and dried fish of *S. commersonianus* costs about one thousand rupees (LKR) per kg, in local market at Jaffna. These dried fish are marketed to other parts of Sri Lanka and are exported to other countries as well. Unfortunately, consumers used to complaint about the quality of the dry fish in Jaffna district.

Broadly speaking, fish is an important perishable food item, the quality of salted and sun dried fish can be affected by microorganisms (Ahmed *et al.*, 2010). Consumption of inferior quality dry fish may cause harmful effect for human beings. Therefore, studies on determination of the quality of dry fish from the market are a prime theme for safeguard consumer's health (Lilabati *et al.*, 1999).

Several similar studies were performed not only on fish but also on cereal products, water, fruit juices and meat in the previous years and few examples for such studies are specified here. Microbial and biochemical qualities of Dambu produced from different cereal grains were studied by Agu *et al.* (2008). Microbial quality of drinking water distributed at Khartoum state was studied by Yagoub and Ahmed (2009). Al-Jedah and Robinson (2002) studied the nutritional value and microbiological safety of fresh fruit juices in Qatar. Survey of microbial quality of drinking water in rural areas of Kashan-Iran was studied by Miranzadeh *et al.* (2011). Selvan *et al.* (2007) evaluated the microbial quality of retail meat products in Chennai city. Biswas *et al.* (2011) wrote a review article about the microbial contaminants in meat.

When considering fish related studies, proximate composition of three commercially available marine dry fishes Bombay duck *Harpodon nehereus*, Sin croaker *Johnius dussumieri* and Savalai hairtail *Lepturacanthus savala* was studied by Siddique *et al.* (2012). A community based study on alternative livelihood options of fishermen of Nijhum Dwip under Hatiya Upazila of Noakhali district in Bangladesh was performed by Rahman *et al.* (2012). Reza *et al.* (2005) performed a study on the traditional drying activities of commercially important marine fishes of Bangladesh. They made a survey on the source of raw materials, handling, transportation, processing and marketing aspects of fish using questionnaires.

Based on the above literature survey it is obvious that no work has been done on the quality assessment of dried fish, *S. commersonianus* and therefore the present study is the first attempt to record its quality in Jaffna district, Sri Lanka. Giving importance to consumer's health the objective of the present study is to assess the hygienic condition of dried fish by three different activities, organoleptic, microbiological and biochemical analysis in order to find out the suitability of the product for human consumption.

MATERIALS AND METHODS

Sampling: *S. commersonianus* salted and dried fish samples were collected from the most popular dried fish preparation sites namely, Point Pedro, Chavakachcheri, Kurunagar and Velanai in Jaffna district and transported to the laboratory (early morning) in sterilized, sealed polythene bags as early as possible under aseptic condition. Four major administrative divisions namely Vahkamam, Vadamarachchi, Thenmarachchi and Islands can be categorized in the Jaffna district and one major popular dry fish preparation site was chosen for sample collection from each administrative division. Locations of four sampling sites are plotted in Fig. 1. Freshly prepared, dried fish samples that had nearly same total length (70±0.71 cm) were chosen for the present

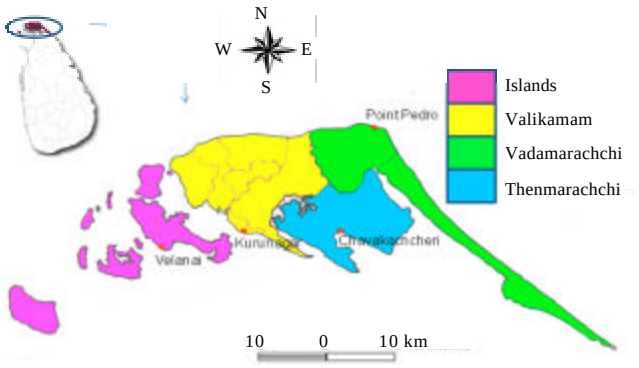

Fig. 1: Administrative divisions and sample collection sites in Jaffna, Sri Lanka

study to avoid variation that may occur due to keeping time and size of the individuals. Collected dry fish samples were kept under normal atmospheric condition at the Zoology Department laboratory. The present study was carried out during the period January to June 2011.

Processing: Fresh fish samples of *S. commersonianus* (70±0.71 cm total length) were also collected from Kurunagar landing centre and dry fish was made at the laboratory. The fish was washed with the clean water. Then the fish was cut in our traditional method by a clean knife. The guts and other parts were removed. Several cuts were made in fish's body with knife from the head towards the tail. The bloody part along the backbone was brushed away with a clean tooth brush. Salt was weighed as a fraction of 25% of the body weight of fresh fish and added to the fish's body for 5 h. Additional salt was removed from the fish. Finally it was placed in an oven at 60-70°C for 24 h for drying. Prepared dried fish was kept under normal atmospheric condition at the Zoology Department laboratory.

From the raw materials of the collected samples, fresh samples were prepared immediately for organoleptic, microbiological and biochemical analysis according to the Sri Lanka Standard, Specification for dried fish SLS 643:2007 (Anonymous, 2007). Standard organoleptic, microbiological and biochemical tests were carried out every week. Six replicates were carried out for each microbiological and biochemical tests.

Organoleptic assessment: Organoleptic assessment was done by a panel consisting of 10 people using score method (Afolabi *et al*., 1984). Dried fish samples were submitted to 10 people test panel from Zoology and Fisheries Department, University of Jaffna and the organoleptic characteristics such as colour, flavor, texture and odour were judged. The panel was requested to rate each organoleptic feature of the products according to a 10 point scale (9-10 = excellent; 8-8.9 = very good; 6.5-7.9 = good; 5-6.4 = fair; <5 bad).

Analysis of proximate composition: Proximate composition of just prepared dried fish was determined. Moisture content, protein, fat and ash content were estimated according to AOAC (1999) and tabulated.

Microbiological and biochemical examination: Microbiological examination was done by total bacteria count (Stokes and Redmond, 1966), total coliform count (Evans *et al*., 1981) and methylene

blue reduction test (Atherton and Newlander, 1977). These tests were done six times for each sample. Sodium chloride content of dried fish was estimated by Mohr's method (APHA, 1999). Moisture content and acid insoluble ash was determined according to Sri Lanka Standard, Specification for dried fish SLS 643:2007 (Anonymous, 2007).

Total bacterial count: To assess the total bacterial count ten grams of ground dried fish sample was weighed and transferred in to a conical flask with 90 mL of sterile distilled water and shaken well. Breed's method (AOAC, 1998) was used to determine the total bacterial count per gram of the sample.

Total coliform count: To determine the total coliform, 3.5 g of Mac Conkey's medium was dissolved in 100 mL of distilled water, ten grams of ground dry fish sample was weighed and transferred into a 90 mL of sterile distilled water and shaken well. Appropriate dilutions were done. Tubes were incubated at 37°C for 24-48 h. Most Probable Number Method (MPN) was used to determine the total coliform per gram of sample with Mac Conkey's medium.

Methylene reduction test: For the Methylene reduction test ten grams of ground dry fish was weighed and transferred into a 90 mL of sterile distilled water and shaken well. This was treated as 10^{-1} dilutions. The above solution was transferred into 7 mL of Mac Cartney bottle. One drop of Methylene blue was added. The bottle was closed air tightly, shaken well and allowed to stand. Time taken for the color change was noted. Control was also maintained.

Determination of moisture content: For the moisture content percentage, initial weight of a crucible with lid was taken. Small amount of dry fish sample was put into the crucible and weighed again. Then the crucible was kept into an oven at 100-105°C for 3 h. It was cooled down to room temperature and the final weight was taken. This was repeated until there was no further loss in mass.

Determination of sodium chloride content: To determine the sodium chloride content 1 g of ground dried fish was dissolved in 20 mL of water and filtered. Then 5 mL solution was pipette out into a titration flask and few drops of K_2CrO_4 were added as an indicator. Then it was titrated against 0.1 M $AgNO_3$ solution until the brick red precipitation was formed.

Determination of acid insoluble ash: For the determination of acid insoluble ash, two grams of dry fish was weighed to the nearest milligram into a porcelain dish and it was ignited with a Bunsen burner for 1 h. The ignition was completed by keeping it in a muffle furnace at 600±20°C until gray ash results. It was allowed to cool and 25 mL of dilute hydrochloric acid was added and covered with a watch glass and was heated on a water bath for 10 min. Then it was allowed to cool and it was filtered through Whatman filter paper. Then the residue was washed with hot water until the washings are free from chlorides and it was confirmed by Silver nitrate solution. Then it was kept in a hot oven and maintained at 135±2°C for 3 h. The residue was ignited in a muffle furnace at 600±20°C for 1 h. Finally it was allowed to cool in desiccators and it was weighed. This process was repeated till the differences between two successive weighing is less than one milligram.

Statistical analysis: Mean±Standard Deviation (Mean±SD) of organoleptic, microbiological and biochemical assessment of dried fish was computed using MINITAB 14 software. Results obtained

for organoleptic, microbiological and biochemical tests for samples collected from different sites were analyzed by ANOVA for significant differences. If there is significant different between samples collected from different sites ANOVA was followed by Post hoc comparison of means, Duncan's Multiple Range Test (DMRT) by using STATISTICA software. The level of statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSION

Organoleptic assessment: The mean scores obtained for organoleptic assessment which emphasizes colour, flavor, texture and odour are tabulated in Table 1. Scores obtained for colour are 7.0, 6.6, 6.4, 5.8 and 8.75; for flavour are 7.9, 5.5, 6.1, 6.7 and 9.2 for Kurunagar, Point Pedro, Velanai, Chavakachheri and experimentally prepared samples, respectively. For texture the scores obtained were 7.0, 6.0, 5.8, 6.5 and 8.55 whereas for odour the scores were 7.5, 5.9, 6.0, 6.8 and 9.16. Results showed that for Velanai and Point Pedro samples, most characteristics of the products fall under the category 'fair' whereas Chavakachheri and Kurunagar samples expressed 'good' category. Experimentally prepared sample showed 'very good' for colour and texture whereas 'excellent' for flavour and odour. Duncan's multiple range test for all characters examined between four different sites expressed, colour, texture and odour are not significantly different ($p>0.05$) among samples collected from Point Pedro and Velanai whereas all other features are significantly different ($p<0.05$) between different sites (Table 1).

Proximate composition: Proximate composition of just prepared dried fish is given in Table 2. Determined protein, lipid, carbohydrate and ash content were 77.62, 4.23, 0.84 and 6.45% of dry weight, respectively.

Microbiological and biochemical examination

Total bacterial count: Mean total bacteria count estimated for dry fish samples collected from four stations are represented in Table 3. Total bacterial count for Kurunagar, Point Pedro, Velanai,

Table 1: The mean scores obtained for organoleptic assessment which emphasizes colour, flavor, texture and odour for *S. commersonianus* dried fish collected from different stations

Collection area	Colour	Flavour	Texture	Odour
Kurunagar	7.00±0.20^{a}	7.90±0.28^{a}	7.00±0.26^{a}	7.50±0.30^{a}
Point Pedro	6.60±0.23^{c}	5.50±0.24^{b}	6.00±0.14^{b}	5.90±0.26^{b}
Velanai	6.40±0.20^{c}	6.10±0.17^{c}	5.80±0.26^{b}	6.00±0.21^{b}
Chavakachcheri	5.80±0.14^{b}	6.70±0.12^{d}	6.50±0.22^{c}	6.80±0.27^{c}
Experimentally prepared	8.75±0.18^{d}	9.20±0.17^{e}	8.55±0.24^{d}	9.16±0.16^{d}

Values are Mean±SD of six replicate determinations, Values with different superscript letters in columns are significantly different at $p<0.05$

Table 2: Proximate composition of just prepared dry fish *S. commersonianus*

Component	Dry weight (%)
Moisture	-
Protein	77.62
Lipid	4.23
Carbohydrate	0.84
Ash	6.45

Table 3: Total bacterial count, coliform count and methylene blue reduction time of different dried fish samples

Collection area	Mean No. of bacteria (g^{-1})	Mean No. of coliforms (g^{-1})	Mean time taken to reduce methylene blue (min)
Kurunagar	$2.849\pm1.58\times10^{9a}$	22 ± 2.00^{a}	830 ± 18^{a}
Point Pedro	$4.674\pm1.91\times10^{9b}$	25 ± 3.00^{a}	683 ± 15^{b}
Velanai	$3.919\pm0.99\times10^{9c}$	19 ± 3.40^{a}	470 ± 13^{c}
Chavakachcheri	$4.543\pm1.13\times10^{9b}$	23 ± 3.16^{a}	553 ± 17^{d}
Experimentally prepared	$6.42\pm0.46\times10^{4d}$	05 ± 2.50^{b}	1118 ± 53^{e}
SLS	1×10^{5}	<100.00	

Values with different superscripts in column are significantly different at $p<0.05$

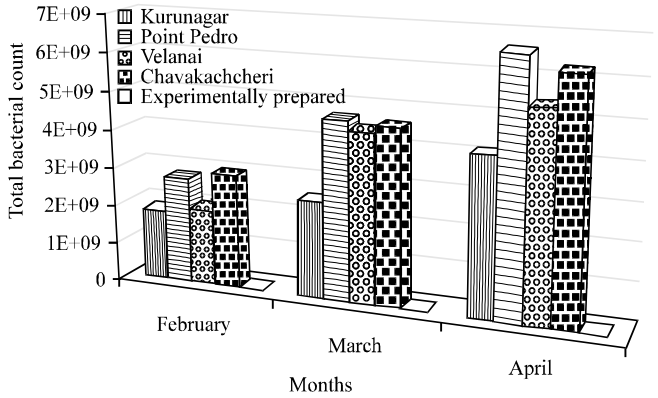

Fig. 2: Monthly total bacteria count estimated for three consecutive months for dry fish samples collected from all sites

Chavakachcheri and experimentally prepared samples were 2.849×10^{9}, 4.674×10^{9}, 3.919×10^{9}, 4.543×10^{9} and 6.42×10^{4}, respectively. Monthly total bacteria count estimated for three consecutive months are plotted in Fig. 2. Among the commercially prepared samples, dried fish sample collected from Point Pedro had the highest number of bacteria and dried fish sample collected from Kurunagar had the lowest number of total bacteria. Mean total bacteria count for Point Pedro and Chavakachcheri samples are not significantly different ($p>0.05$) whereas there were significantly different ($p<0.05$) between samples collected from other sampling sites (Table 3).

Total number of bacteria is one of the main factors which affects the quality of the perishable food. The total bacterial count estimated in the present study was higher than the Sri Lanka Standard (Anonymous, 2007) in all samples except the experimentally prepared sample. In the commercially prepared dry fish samples there were possibilities of bacterial contamination during preparation, transportation and storage of dried fish. With reference to the Sri Lanka Standard 643:2007, it can be specified that the limit for total bacteria count per gram of dried fish is 1×10^{5} (Anonymous, 2007). Only experimentally prepared sample had a count lesser than the standard value and seems to be of good quality for human consumption. While observing the total bacterial count with the time, it was noticed in all samples bacterial count increased with the time. This was due to the multiplication of bacteria which is already available in the samples and also by contamination from indoor air during the storage.

Total coliform count: Mean total coliform counts estimated in dried fish sample collected from four stations are also represented in Table 3. Mean number of coliforms per gram for Kurunagar, Point Pedro, Velanai, Chavakachcheri and experimentally prepared samples were 22, 25, 19, 23

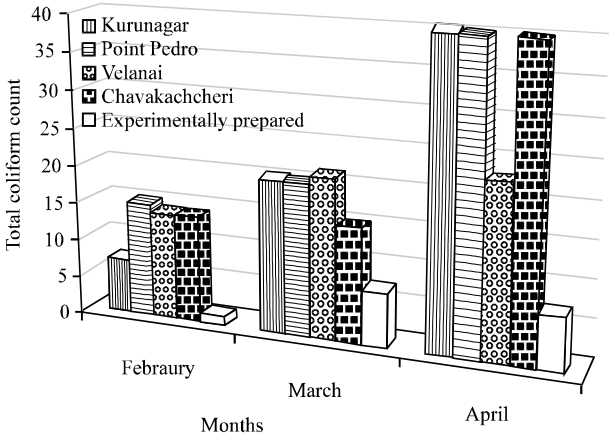

Fig. 3: Monthly total coliform count estimated for three consecutive months for dry fish samples collected from all sites

and 05, respectively. Monthly total coliform count estimated for three consecutive months are plotted in Fig. 3. Among the commercially prepared samples, highest coliform count was observed in Point Pedro sample and the lowest in Velanai dry fish sample. Mean total coliforms for samples collected from all four stations are not significantly different ($p>0.05$) from each other, only experimentally prepared sample showed significant different ($p<0.05$) (Table 3).

Coliform bacteria are commonly used as indicators of sanitary quality of food and water. They are defined as rod shaped, Gram-negative non spore forming bacteria and can ferment lactose with the production of acid and gas when incubated at 35-37°C within 48 h. Coliforms, do not normally cause of serious illness. In fact, presence of coliforms can act as an indicator for other fecal origin pathogenic organisms.

Mainly the coliforms in the dried fish would have been contaminated from the water source. Almost in all samples coliform count increased with the time period due to the propagation of coliforms. In a good quality of dried fish total coliform count per gram shall not exceed 100 (Anonymous, 2007). In the present study, total coliform count was less than 100 in all samples. High number of coliform count was obtained in Point Pedro sample. Contamination of coliforms may have been occurred due to improper handling and usage of unsanitary equipments for the preparation of the dry fish. Reason for the constant coliform count in the experimentally prepared sample with the time is due to clean water used during the preparation.

Methylene reduction test: Average time taken to reduce the colour in the methylene blue reduction test for all samples is also tabulated in Table 3. Time taken to reduce methylene blue for Kurunagar, Point Pedro, Velanai, Chavakachcheri and experimentally prepared samples were 830, 683, 470, 553 and 1118 min, respectively. Of the commercially prepared samples analyzed, for Kurunagar dry fish sample, time taken to reduce the colour was high and for Velanai sample it was low. Average time taken to reduce the colour for all samples are significantly different ($p<0.05$) from each other (Table 3).

Microbial activity was indicated by the methylene blue reduction test. Methylene blue is an auto oxidizing agent. It will give blue colour in oxidized stage, when it is reduced it becomes colourless. McCarteny bottles were filled with the dried fish suspension of the samples without any air in order to prevent the auto oxidation of methylene blue. Dried fish samples usually contain various

microorganisms. During the respiration of microorganism electrons are transported through the electron transport system. H^+ is released, methylene blue accepts H^+ and undergoes reduction. The high microbial activity is indicated by the lesser duration for methylene blue reduction. When the reduction time increases, the shelf life of the dried fish will also increases. In the present study, reduction time of the experimentally prepared sample was high. It can be inferred that the experimentally prepared sample had high keeping quality than the other samples on the basis of microbial spoilage.

The total bacteria count includes viable cells and dead cells. But the microbial activity is only determined by the viable microorganisms. It means if total microbial count increases, microbial activity may or may not increases. This was exhibited in the results that the Point Pedro dried fish sample had high number of the total bacteria than the Velanai sample but the microbial activity was lower in the Point Pedro sample than the Velanai sample. Therefore, the keeping quality of the Point Pedro sample was higher than the Velanai sample.

Determination of moisture content: Percentage of moisture content for Kurunagar, Point Pedro, Velanai, Chavakachcheri and experimentally prepared samples were 37.05, 30.97, 34.04, 29.59 and 19.16, respectively. In the present study all five samples have shown moisture content less than 40%. Moisture content influences the growth and the flora of the microorganisms in dried fish and causes microbial spoilage indirectly. The moisture content also varies with temperature, humidity, drying period and type of fish.

Among the commercially prepared samples, amount of moisture content was high in Kurunagar sample and low in Chavakachcheri sample. Average moisture content for samples collected from all four stations are significantly different ($p<0.05$) from each other (Table 4). The moisture content of a good quality dry fish should be less than 40% by mass (Anonymous, 2007).

Determination of sodium chloride content: Percentage of sodium chloride for Kurunagar, Point Pedro, Velanai, Chavakachcheri and experimentally prepared samples were 35.05, 29.9, 29.56, 28.68 and 17.52, respectively. Among the commercially prepared samples, high sodium chloride percentage was observed in Kurunagar dry fish sample and low in Chavakachcheri dry fish sample (Table 4). A consumable dry fish may contain sodium chloride content of 12 percentage by mass (Anonymous, 2007). Percentage of sodium chloride for samples collected from Point Pedro and Velanai are not significantly different ($p>0.05$) whereas others are significantly different (Table 4).

In the present study sodium chloride content of all five samples were greater than Sri Lanka Standard. Usually, when the salt content is increased the microbial activity will decrease. The variation in the sodium chloride content among samples was due to the amount added during the

Table 4: Sodium chloride, moisture and amount of acid insoluble ash contents in different dried fish samples

Collection area	Sodium chloride (%)	Moisture content (%)	Amount of acid insoluble ash (mg g^{-1})
Kurunagar	35.05±0.10^a	37.05±1.34^a	1.1±0.008^a
Point Pedro	29.90±0.22^b	30.97±0.31^b	1.05±0.02^b
Velanai	29.56±0.67^b	34.04±0.27^c	1.15±0.014^c
Chavakachcheri	28.68±0.23^c	29.59±0.34^d	1.05±0.007^b
Experimentally prepared	17.52±0.30^d	19.16±0.43^e	1.0±0.007^d
SLS (%)	40	12	1.5

Values (Mean±SD) with different superscripts in columns are significantly different at $p<0.05$, SLS: Sri Lanka standard specification for dried fish

preparation of dried fish. Addition of salt to any food causes plasmolysis of microbial cells and reduces the amount of active water (available water) to microorganisms. Adding large amount of salt for making dry fish may cause some adverse effects for human beings such as increased blood pressure, mineral loss, damage to internal organs etc.

Determination of acid insoluble ash: Acid insoluble ash for Kurunagar, Point Pedro, Velanai, Chavakachcheri and experimentally prepared samples were 1.1, 1.05, 1.15, 1.05 and 1.0 in mg g^{-1} respectively. Among the commercially prepared samples, high amount of acid insoluble ash was observed in Velanai sample and low in Point Pedro and Chavakachcheri samples. Amount of acid insoluble ash for samples collected from Point Pedro and Chavakachcheri are not significantly different ($p>0.05$) whereas others are significantly different (Table 4). As per the Sri Lanka Standard 643:2007, limit for acid insoluble ash is 1.5. In the present study acid insoluble ash content of all five samples were in the acceptable range and less than the Sri Lanka Standard.

Acid insoluble ash usually contains silicates and indicates silica contamination, primarily from soil. Here the amount of acid insoluble ash in all samples varied within a narrow range. Acid insoluble ash can also be considered as an indicator for consumer digestibility. Ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents which provides a measure of the total amount of minerals within a food.

Overall findings: While analyzing the chemical parameters, samples collected from all sites exhibited satisfactory results for moisture and acid insoluble ash. In the microbiological analysis, all commercially prepared dry fish samples showed unsatisfactory results for total bacterial count. However, experimentally prepared sample showed highly satisfactory results in terms of microbiological and biochemical quality based on the Sri Lanka Standard.

Therefore, it is essential to improve the dry fish preparation techniques in our region. Utilizing clean utensils, use of clean water, drying the fishes in wooden racks or in the solar drying systems and paying more attention to the hygienic condition of people who are involved in preparation of dried fish are the most suitable options that could be considered for raising the quality of dried fish.

Solar drying systems for example tunnel fish drying systems are most suitable for tropical regions like Sri Lanka as it will save the cost of electric energy while providing job opportunities and profit for young generation. These solar drying systems could be prepared with toughened glasses to ensure absorption of solar radiation and to reduce emissivity. Continuous flow of hot air should also be maintained in the system. The results of the present study shall be disseminated among the local fishing community who prepare dried fish and the subsequent steps to improve the qualities can be achieved.

CONCLUSION

From the present study it can be concluded that the experimentally prepared dry fish consists less microorganisms and high keeping quality due to the clean preparation methods than the other traditional methods. Therefore in our region it is essential to improve the dry fish preparation techniques by adopting the suggested methods. The present study will lead further studies on low cost economically benefit fish drying systems in Sri Lanka.

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