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Preparation of dessert fish cake from Siganids and Mullet species and its preservation in refrigerated storage

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Abstract:

Fish are rich in protein for the development of human body. Unfortunately, some fish are neglected to consume as raw fish due to their unacceptable characteristics. Cakes are highly acceptable products preferred all the age group of people. Therefore, the main objective was to produce consumable baked cake incorporated with fish mince. The fish cake was prepared using two different species with 45% of boiled fish mince. Selection of fish cake was evaluated through the sensory panelists using 9 points hedonic scale. Finally, mullet fish mince incorporated cake was selected. And all the types of cake were evaluated for physicochemical and microbial characteristics. It was observed that the developed fish cake was found better quality with respect to nutritional content than the egg cake. Shelf-life of fish cake was evaluated for 13 days of refrigerated storage.

Keywords —mullet, siganid, fish cake, shelf life

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I. INTRODUCTION

Fish flesh has some unique characteristics of having high protein content with balanced profile of amino acids, polyunsaturated and essential fatty acids with less harmful cholesterol and saturated fat (*Pal et al., 2018*). By the way, malnutrition is a serious issue which is caused by animal protein deficit in the diet. Women and children are the first victims of malnutrition. Fish provides more than one billion poor people's daily animal protein (*NARA, 2016*). It provides nutrients which are essential to cognitive and physical development of the body. It is affordable animal source of protein in most developing countries. Upon successful marketing of the tasty products, low priced fish species contribute protein supplementation in malnourished population(*Pal et al., 2018*). However, fish supplies are failing to meet demand and there are major shortages in some critically poor countries (*NARA, 2016)*. A large coastal population is engaged in fishing activities in Jaffna region of Sri Lanka (*Sivalingam, 2005*).There are different varieties of edible fish species whereas some species are neglected by people due the low acceptability and low economic value due to its strong smell and softening of its flesh. *Mugil* and *Siganus(Chitravadivelu, et al., 1984*) species are selected in this study because these have less consumer demand in the fresh form due to numerous bones penetrating the flesh, less tastiness and bad smell that cause to sell with a lower price(*Jaikumar, 2012*). For effective production and utilization of diversified products, processing underutilized fish species into value added products with satisfactory organoleptic propertiesprovide economic benefit to the existing fish processing industries.

Therefore, there is a need to develop new processing techniques to make them useful, ready to eat products and palatable for human consumption in Sri Lanka. Value added products need to be maintained for low value species for sustainable market. The demand for ready to eat products is higher among consumers because of their convenience (*Muhsine,2003*). Fish cakes are highly produced and consumed in Korea and Japan. Fish cakes are prepared by frying, broiling and baking process (*Hwang et al.,2013*). Several studies have been conducted on quality changes of fish cake prepared from different fish species. The present study was carried out to prepare fish cake with acceptable organoleptic properties through investigating biochemical composition and consumer acceptance. And it is used to assess the storage stability in terms of biochemical quality. It can be pointed out that the fish processing industries in Sri Lanka accelerate domestic market and the export of fish cake to other countries.

II. METHODOLOGY

Formulation of fish cake

The research work was conducted in the Laboratory of Department of Fisheries, University of Jaffna, Sri Lanka. Siganid and Mullet fish were selected as the main raw materials needed for this study. Sugar, flour, margarine, baking powder, pineapple essence and cocoa powder were also used as other ingredients for dessert cake preparation. All the materials were collected from the local market with good qualityand suitable for human consumption. A weight of 500g capacity High Density Polyethylene HDPE pouches were used for packaging of fish cake.

For fish cake processing, 45% of boiled fish mince, flour, sugar, margarine, egg white, baking powder, cocoa powder and pineapple essence were added. Ingredients (*Minh et al., 2018*) were mixed into a smooth cream using processor. Cream was turned into already oiled baking pan. Then it was placed in a pre - heated oven and baked at 190^0C for 45min. It was packed in HDPE pouches, sealed and labelled.

Table 1: Ingredients of fish cake preparation

Ingredients	Percentage (%)
Fish meat	45
Wheat flour	10
Egg	12
Sugar	20
Margarine	10
Baking powder	1.5
Pineapple essence	1
Cocoa powder	0.5

The products were stored at temperatures of 4^0C for quality evaluation.Fish cake samples were drawn randomly on every alternate day up to 11-15 days, to analyze proximate, sensory and microbiological and biochemical parameters for refrigerated storage. During sampling, two packs of each product were taken out randomly from refrigerator.

Analysis

1) Sensory Analysis

The descriptive test for a quantitative sensory profiling was used to establish the sensory characteristics. The consumer's acceptability of fish cake was evaluated through a taste testing panel of 25 semi trained testers selected from university students and staff in University of Jaffna. All the panelists were briefed with sensory attributes before evaluation. The test was conducted while the samples were fresh. Fish cake was evaluated for their appearance, odour, Texture, taste and overall acceptability. The samples were coded with different numbers and served to the panelists at random to avoid bias. The panelists asked to rate the given samples a nine point hedonic scales with the ratings (*Watts et al, 1989*). The results were analyzed by the Friedman test of the MINITAB statistical package.

Sweet fish cake was prepared using 45% of fish mince of siganid and mullet fish without changing the other ingredients. Then all samples were subjected to sensory evaluation by the panelists. Paired comparison test (*Goranova et al., 2015*)was conducted to determine which of two samples

given to the panelists is identified as having a greater intensity than other. It was used to select the best fish cake of two species. Samples were presented in plain white tray with labelling. They were instructed to taste each one and record the perception of having greater or lesser intensity based on overall acceptance. They drank water in between to testing each sample.

2) Proximate analysis

Proximate analysis (*AOAC, 2000*) was done for fresh fish and fish cake prepared by using boiled fish mince. The moisture content was determined by using a hot air oven. Ash content was incinerated in a muffle furnace (*AOAC, 2000*) at 550^0C for 5 hours. Lipid was measured using Bligh and Dyer method (1959). Crude protein was estimated through the Kjeldahl method. Incinerated ash was dissolved in 5N HCl solution and acid insoluble ash was estimated using muffle furnace at 550^0C for 3 hours. And finally, carbohydrate was determined by difference. It was calculated by subtracting moisture, fat, protein and ash from 100.

3) Quality changes during storage

The Total volatile base nitrogen (TVB-N) is an index of spoilage, (*TionciNgeiKok, 2005*) of all the samples were determined by the method recommended by EIC (1995) using distillation and titration. The TVB-N of samples was expressed as mg/100g of sample.

The peroxide value (PV) of the lipid was determined from the lipid extract as described by Jacobs (1958) iodometric (*IFRA,2011*).The peroxide value was a parameter specifying the content of oxygen as peroxide, especially hydro peroxides in a substance. The peroxide value is a measure of the oxidation present. And pH of fish cake was measured directly by the using pH meter.

4) Microbiological analysis

The microbiological analysis was carried out according to (*U.S. Food and Drug Administration, 2001*). Total plate count (TPC) was determined at 1^{st}, 3^{rd}, 7^{th}, 9^{th}, 11^{th} and 13^{th} days of storage at refrigerated temperature. Pour plate method was carried out for total plate count using agar medium. Agar plates were incubated at 37°C for 48 hoursand colonies seen were counted. Number of CFU was counted and reported as log CFU/gm.

Yeast and mould determination was conducted using potato dextrose agar. These plates were incubated at 25°C for 3-4 days. Yeast and mould were determined at 1^{st}, 3^{rd}, 7^{th}, 9^{th} and 13^{th}days of storage at refrigerated temperature.

5) Determination of calorific value of fish cake

Energy value (total calorie) of fish cake was calculated by the addition of carbohydrate, protein and fatcalorific value. High amount of energy could be supplemented in the fish cake than other food items effectively.

6) Statistical analysis

Analysis of Variance (ANOVA) was calculated to find out the significant difference in the sensory characteristics of samples. To find out the relationship between various methods used to assess the quality changes during storage, correlation coefficient (r) was also calculated.

III. RESULTS AND DISCUSSION

The physical characteristics of fresh fish such as average length and weight of Siganus species used in this study 18.43 ± 1.02cm and 150.25 ± 11.82 respectively. The average length and weight of mullet species were 22.5± 1.05cm and 496.8 ± 23.87g. The proximate composition of both fish minces were shown in Table 4.2. The compositionindicates raw material had a good condition and nutritional value.

Table 2: The proximate composition of both fish minces

Parameters	Siganussp	Mullet sp
Moisture	72.63± 0.49	62.64 ± 0.4
Protein	22.14 ± 0.87	29.82 ± 0.29
Fat	3.77 ±0.09	4.76 ± 0.62
Ash	1.07 ± 0.06	1.11 ± 0.1

Quality Evaluation of fish cake

1) Sensory Evaluation

Preliminary experiments were conducted to standardize the various levels of ingredients required for the development of fish cake from mullet and Siganid fish and to optimize processing conditions.Based on the highest organoleptic median scores for all attributes, the best recipe was selected, and then sweet dessert fish cake was prepared using 45% of Siganid fish and mullet fish.

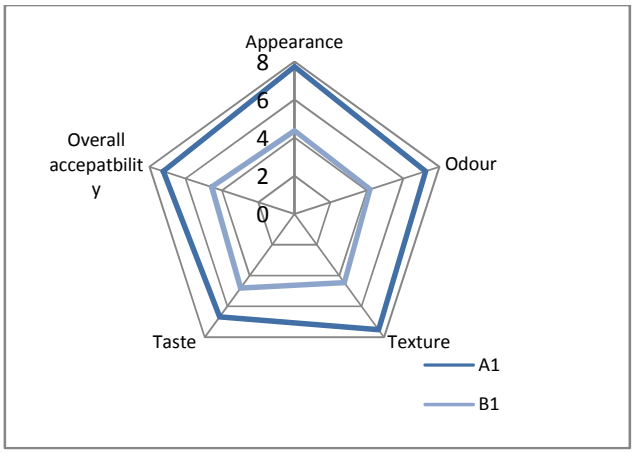

Fig 1: Mean scores for sensory attributes different types of fish cakes

As shown in the graph showed that there is a difference between the median scores of organoleptic properties between the different types of fish cake. It was confirmed that mullet fish cake (MFC) has higher preferability than siganid fish cake(SFC).

Table 3: Mean values for sensory attributes of cake samples prepared using mullet and siganid fish mince

Sensory attributes	MFC	SFC
Appearance	7.720±0.891[a]	436±1.729[b]
Odour	7.240±1.052[a]	4.160±1.405[b]
Texture	7.520±1.229[a]	4.440±1.530[b]
Taste	6.680±1.069[a]	4.800±1.118[b]
Overall acceptability	7.240±0.663[a]	4.560±1.193[b]

Means that share the same letter in column wise are not significantly different.

Paired comparison test was conducted by using one way ANOVA in MINITAB 2017 for Siganid and mullet fish cakes. This table shows that all sensory attributes of cake prepared of different type of species are significantly differed and the higher score was obtained for mullet fish cake. According to the result p value is less than 0.05. Therefore, there is a significant difference between those fish cakes. So,mullet fish dessert cake was selected as best combination of fish cake.

2) Microbial analysis

Total plate count of fishery products is the useful tool for quality evaluation of shelf-life and post-processing contamination (*David B. Fankhauser., 2010*). The initial total plate count of sample was 3 log CFU/g. low count indicated very good quality. Total plate count and yeast and mould count were increased during the storage. The microbial count was indicated in the table 3.

Cakes packed in HDPE were going to start deterioration. Microorganism count was reached unsatisfactory level after 11 storage days. Microorganism in food produce acidic compound due to anaerobic respiration which leads to spoilage.

According to the food regulation, the microbial count of ready to eat foods should be less than 10^4 are considering as satisfactory. If the microbial level is in between 10^4 and 10^5, it is considered as marginal and more than 10^5 as unsatisfactory (*Millard, 2001*), but the yeast and mould count was in satisfactory level for all samples in HDPE packs.

Table 4: Microbial count for better combination of cakes

Cakes	Storage Days	Total Plate counts Yeast and Mould	
		HDPE	HDPE
45% Mullet Fish cake	1	0	0
	3	3.7×10^1	< 1
	7	$2.0*10^2$	$4*10^1$
	9	$3*10^2$	$5*10^2$
	11	$4*10^3$	NC
	13	$5*10^4$	$5*10^3$
45% Siganid Fish cake	1	0	1
	3	$4.2*10^1$	< 1
	7	$2.3*10^2$	$4*10^1$
	9	$3.4*10^2$	$5.5*10^2$

11	$4.5*10^3$	NC
13	$5.2*10^4$	$6*10^3$

3) Proximate composition

Proximate compositions of fish cake prepared from different species were given in Table 5 during the storage at refrigerated temperature.

Table 5: Proximate composition of fish cake with different species

	Moisture	Ash	Protein	Lipid
Mullet	24.7599	1.8123	8.2842	12.7832
Siganid	41.5235	1.8756	7.7435	14.7973

According to the table 5, moisture content of Siganid fish cake was higher than SLS limit. This cake will be spoiled easily than other cakes. Ash and protein content of both fish cakes are little similar. Lipid content of Siganid fish cake was also little higher than mullet fish cake.

The ash, lipid and crude protein content of 35% fish cake were 1.81%, 12.78% and 8.28%. The ash, lipid and crude protein content of 235% fish cake were 1.85%, 13.03% and 5.33%. There were no any significant changes in the ash, lipid and protein content during refrigerated storage of 14 days. The pH of fish cake has shown in between from 7.93 to 6.24 in 13 days of storage of 35% mullet fish cake.

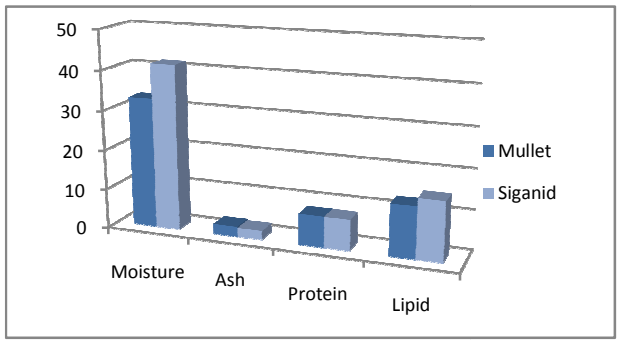

Fig 2: Proximate composition of fish cake with different fish species

Preliminary experiments were conducted to standardize the various levels of ingredients required for the development of fish cake from mullet and Siganid fish and to optimize processing conditions. Boiled fish is preferred for fish caking making process instead of raw fish. It was used for easiness of preparation and improvement of the organoleptic properties of fish cake. Fish cake was separately prepared using 45% ofWhite spotted spine foot (Siganid fish) and Buchanan's blue tail mullet fish. According to the paired comparison result, mullet fish cake was selected as best combination of fish cake with respect to the sensory characteristics such as appearance, odour, texture, taste and overall acceptability.

A statistical analysis was conducted to compare the chemical composition of both cakes. There was a significant difference shown in fat, protein, ash and carbohydrates content in between both sweet dessert cakes. Average moisture content of mullet and Siganid fish cakes were 24.76% and 41.52%. Moisture content of fish cake is higher in Siganid than mullet cake. Therefore, there was a significant difference between those cakes. Moisture content of cake should be 20- 27% according to the Sri Lanka standard specification (SLS 1074: 1995). Boiled fish mince has more water than wheat flour. However, moisture content of Siganid fish cake was not acceptable to the specification of standard.

Fat content of mullet and Siganid fish cakes were 12.78 and 14.79% respectively.Because fish constitutes low fat. Therefore, there was no significant difference between both cakes Ash content of fish cake and control cake were 1.81 and 1.17% respectively. Ash content of mullet and Siganid fish cakes was higher and little same as both. Due to the higher percentage of inorganic content of fish, ash content may be higher in fish cake.

Protein content of mullet and Siganid fish cakes were 8.28 and 7.27 respectively. Fish cake protein

was little higher than control cake. This is due to the higher percentage (29.2%) of mullet fish than Siganid fish (22.4%). Carbohydrates content of mullet and Siganid fish cake were 52.37 and 34.07 respectively. There was significant difference in between those cakes.

The processing of fish species into fish cakes on cottage industry level can be encouraged to reduce poverty. In this study, the blender and Beaker was able to grind the boiled or cooked fish into boneless slurry. The blender and beaker are the equipment that can be affordable and readily available.

Fish cakes could provide a viable livelihood, especially to women entrepreneurs. The advantage of the low-cost technology is that it attuned to the needs of a developing country. It is also gender-friendly, since women easily operate the blender, thus ensuring that they are not displaced from their traditional role of fish processing and marketing.

IV. CONCLUSION

The organoleptic properties of the baked cakes indicated that the products were acceptable according to the panel's evaluation, though statistically there was significant difference ($P < 0.05$) in the sensory evaluation based on the panel's score, comparisons being made using paired test.

The present study aimed at production of a potential new fishery product in the form of fish cakes from unacceptable fish species with reasonably good nutritive value for human consumptions. Fish cakes were found to be microbiologically safe for a minimum of 11 days of refrigerated storage temperature of 4°C.

The findings in this study indicated that fish cake from is feasible, and nutritionally high in protein. However, further study is required to assessthe commercial potential of the fish cake product.

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