Development of soy protein fortified fish sticks from Tilapia

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Abstract

The objective of this study was to develop soy protein fortified fish sticks from Tilapia. Two preliminary studies were conducted to select the best fish-soy protein-spice mixture combination with four treatments to develop breaded fish sticks. Developed products were organoleptically assessed using 30 untrained panellists with 7-point hedonic scale. The product developed with new combination was compared with market product. Sixty percent of Tilapia fish mince, 12% of Defatted Textured Soy protein (DTSP), 1.6% of salt and 26.4% of ice water (<5°C) and Spice mixture containing 3g of garlic, 2g of pepper 2g of onion and 1.6g of cinnamon were selected as the best formula to manufacture the product. There was no significant difference when compared with market samples in relation to the organoleptic attributes. Proximate composition of the product was 25.76% of crude protein, 2.38% of crude fat, 60.35% of moisture and 2.75% of ash. Products were packaged in Poly Vinyl Chloride clear package (12 gauge) and were stored at -1°C and changes in moisture content, peroxide value, pH value and microbiological parameters were assessed during five weeks of storage. Organoleptic acceptability was not changed significantly in all parameters tested ($p>0.05$). Total aerobic count and yeast and mould count were in acceptable ranges in frozen storage for 5 weeks. Data were analyzed using ANOVA and Friedman non-parametric test.

Keywords: defatted textured soy protein, peroxide value, Tilapia fish mince, proximate composition, sensory parameters

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Introduction

Fish occupies a unique position in the Sri Lankan diet as a source of protein. The main reasons are that it is not expensive and is readily available compared to the meat products. In addition to that, there is little or no religious rejection of it which gives an additional advantage over meat products. Consumption of fish prevents coronary heart diseases due to the presence of w(omega)-3 fatty acids. Therefore, introduction of fish to the diet can make a well balanced diet by increasing its biological value. Considering the fact that fish is economically cheaper and nutritionally higher in value, it is the most suitable source of protein for Sri Lanka.

The reservoir fishery of Sri Lanka depends mainly on the exotic Tilapia species *Oreochromis mossambicus* (Peters, 1852) and *O. niloticus*. The introduced Tilapia accounts for a major part of the commercial catches and there by contribute significantly to the reservoir fishery of Sri Lanka (Fernando, 2000). Though Tilapia is the main component in inland fishery harvests, it has low acceptability among people due its muddy flavour, smell and slimy outer cover with a large number of scales and the high bone content.

To increase the demand for fresh water species like Tilapia, the image of the consumers should change towards the international acceptance as a food fish commodity. The one best solution is to produce value-added convenient food for consumers, as the present market trends reflect rapidly growing market potential for ready to eat convenient food products. In Sri Lanka, there is a big demand for the marine fishery products but not for the fresh water fish products. But in the recent past, a number of new products have been developed from Tilapia have emerged such as fish fillet, sausages and ***ambultiyal***. Therefore, to increase the consumer acceptance for tilapia products value addition is very much needed. Therefore, this study attempts to develop soy protein fortified fish sticks from Tilapia as a value added product.

Materials and Methods

Pre-processing

Purchased Fresh Tilapia was immediately transported to the NARA laboratory stacked with ice in ice boxes. All fish were headed, gutted, and skinned manually and washed thoroughly using ice water (<5°C) and were subjected to steam for two minutes in order to make deboning easier. Subsequently deboned fish were minced by using a mechanical grinder and weighed into 1 kg parts. They were packaged in sealed polythene bags as 1 kg blocks and then immediately stored at -18°C until used.

Preparation of DTSP powder

DTSP, which is commercially called "soya meat", packets which contains 50% protein on dry basis and cholesterol free Harvest soya meat regular were purchased. Then it was ground using the mechanical grinder, sieved and used in a powdered form.

Spice mixture preparation

Garlic powder and onion powder were prepared, slicing into 2mm thick slices, and spread on an aluminium tray at 0.5 mm thickness and air dried using hot air in a cabinet dryer at 60°C for 8 hours. They were ground using a mechanical grinder and sieved. Quality pepper powder was purchased and cinnamon powder was prepared by grinding and sieving.

Batter mixture preparation

Industrial batter mixture was used.

Fish stick preparation

Frozen mince was half thawed and the first preliminary study was conducted with four different treatments to find out the best fish soy protein combination. Ingredients in Table 1 were mixed separately using a mechanical grinder and then pressed into an aluminium tray and cut into sticks of 7 cm x 2 cm x 0.8 cm using a mould. Cut fish sticks were battered using industrial batter and then coated with bread crumbs and deep fried with coconut oil for one minute until golden brown. Thereafter, organoleptic acceptability of four treatments was tested using 30 in-house untrained panellists in NARA with 7-point hedonic scale for appearance, taste, odour, juiciness and overall acceptability. To select the best fish-soy flour and spices combination, a second preliminary study was conducted. Based on the results of the preliminary test, four treatments were carried out with different amounts of spices. Then fish sticks were prepared and organoleptic acceptability was tested as previously done in the preliminary test. Based on the results of the second test the best product formulation was selected for fish sticks preparation.

Table 1. Preliminary Study 1 to find out best combination of Tilapia fish mince and DTSP

Ingredients (%)	Treatments			
	1	**2**	**3**	**4**
Tilapia Fish Mince	60	60	60	60
DTSP	20	15	12	10
Salt	1.5	1.6	1.7	1.7
Ice Water (< 5°C)	18.5	23.4	26.3	28.3

Market fish sticks and developed fish sticks

Market fish sticks that were prepared from marine fish (Tuna fish) and developed fish sticks were compared using a sensory evaluation for appearance, taste, juiciness, odour and overall acceptability using 7-point hedonic scale.

Table 2. Preliminary Study 2 to find out best spice mixture for selected best combination of Tilapia fish mince and DTSP

Ingredients	**Treatments**			
	1	**2**	**3**	**4**
Tilapia fish mince (g)	60	60	60	60
DTSP (g)	20	15	12	10
Salt (g)	1.5	1.6	1.7	1.7
Ice water (< 5°C)	18.5	23.4	26.3	28.3
Garlic (g)	2.0	2.3	2.6	3.0
Pepper (g)	4.0	3.6	3.0	2.0
Onion (g)	1.3	1.6	1.6	2.0
Cinnamon (g)	0.6	1.0	1.3	1.6

(Spices are based on 100 g of minced fish, DTSP, salt and water)

Packaging of fish sticks and storage

Breaded fish sticks were packaged in PVC clear packages (12 gauges) and stored at -1°C.

Proximal analyzes for developed fish sticks

Moisture (Association of Official Analytical Chemist AOAC, 1996), ash (AOAC, 1996), crude fat (Bligh and Dyer method, 1963) and crude protein (AOAC, 1996) were determined.

Shelf life evaluation

At two week intervals two samples were withdrawn at a time and analyzed for total aerobic plate count and yeast and mould count (Manual of Food Quality Control,1979), pH value (Cyberscan pH Meter, 2000), peroxide value (Lea,1952) and moisture content. Sensory properties of the product for appearance, taste, odour juiciness and overall acceptability were also assessed using 7-point hedonic scale at the fifth weeks of storage.

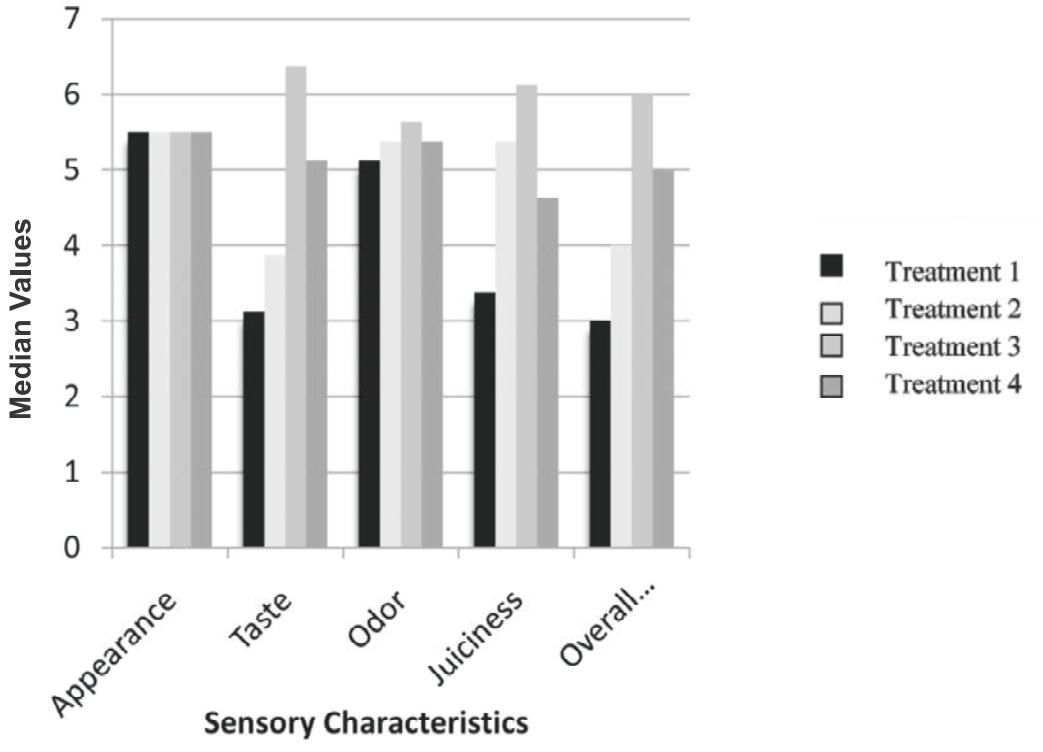

Fig. 1. Estimated median values for organoleptic properties of sensory evaluation in four treatments to select best fish mince DTSP combination

Statistical analysis

A non parametric ranking procedure was used with the Friedman rank sum test for the evaluation of sensory properties. Data was analyzed by using the MINITAB computer software. A significant level of 0.05 was used for the analysis. Shelf life results were analyzed by the general linear model (SAS statistical software) and means were separated by using the least significant difference. Difference were considered significant at $p<0.05$.

Results

Proximate composition of the final product was 60.35% of moisture, 2.27% of ash, 25.76% of crude protein and 2.38% of crude fat.

Sensory evaluation results of preliminary study 1 and 2

According to the figure 1 and 2, treatment 3 in study 1 was selected as the best fish mince-soy protein combination with highest median values for all sensory characteristics whereas treatment 4 in study 2 was selected as best final product formula.

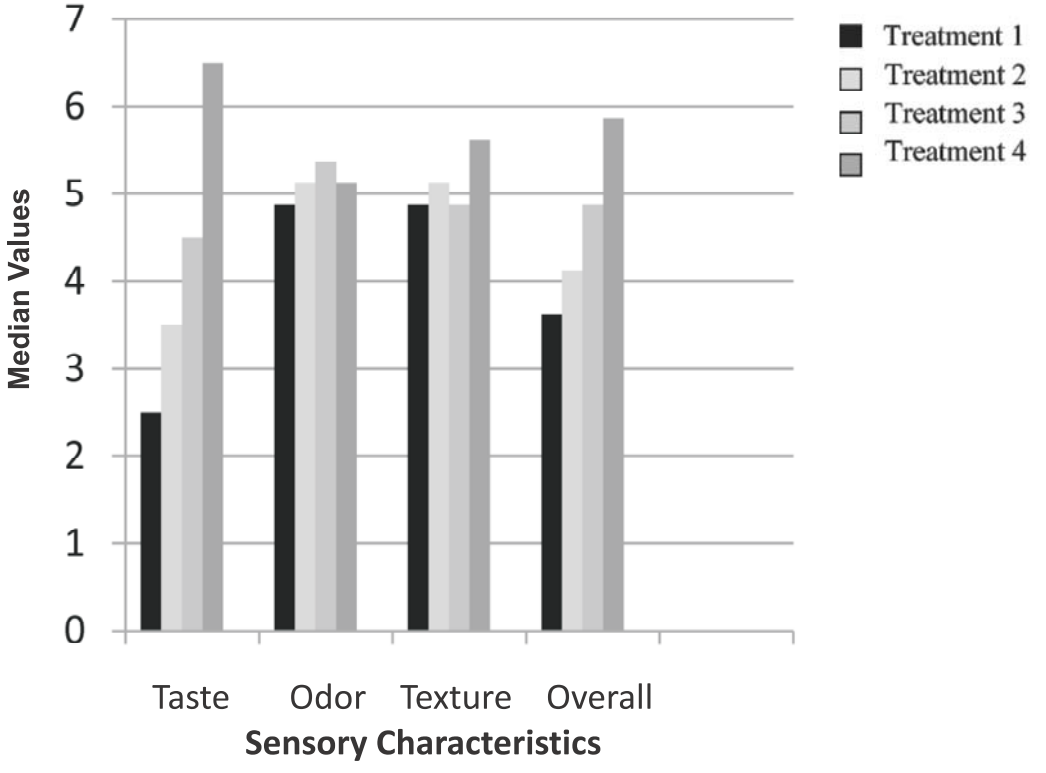

Fig. 2. Estimated median values for sensory characteristics of four treatments in the final product formulation

Market fish sticks and new Tilapia fish sticks

According to the estimated median values, there was no significant difference between developed fish sticks and market fish sticks ($p>0.05$). Developed fish sticks have high median values for taste than market fish sticks. Considering the odour character, market fish sticks have high median value than the Tilapia fish sticks. Considering the overall acceptability of two products there was no significant difference in two products.

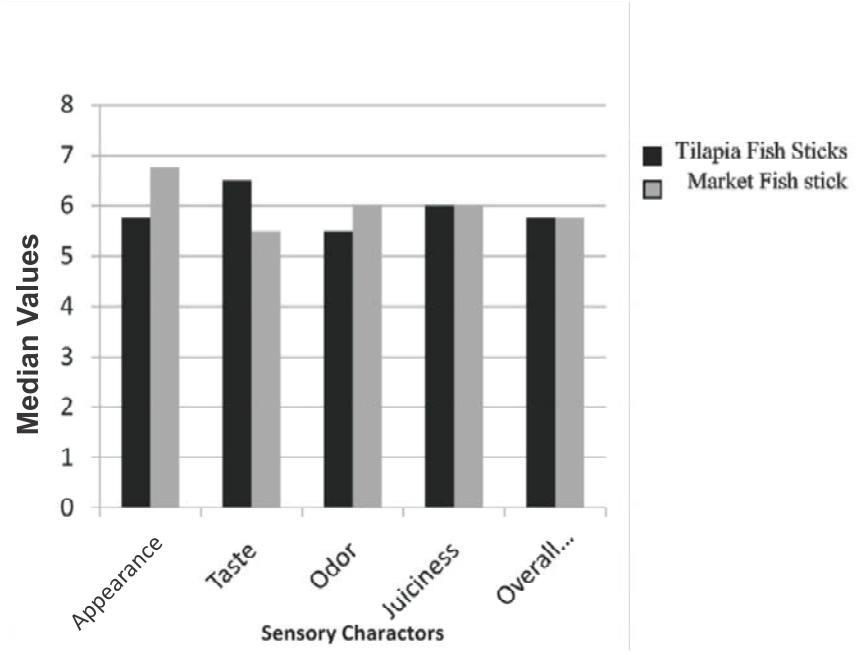

Fig. 3. Estimated median values for organoleptic characteristics of sensory evaluation among developed product and market product

Results of shelf life studies

There were no significant changes in peroxide value, moisture content and pH value.The peroxide value had increased during five weeks of storage but was within the acceptable range (Less than 100milli-equivalent/1000g of oil) and there was no significant change in the product for all sensory characters compared to the initial stage. The overall acceptability of the product has not changed significantly after five weeks of storage.

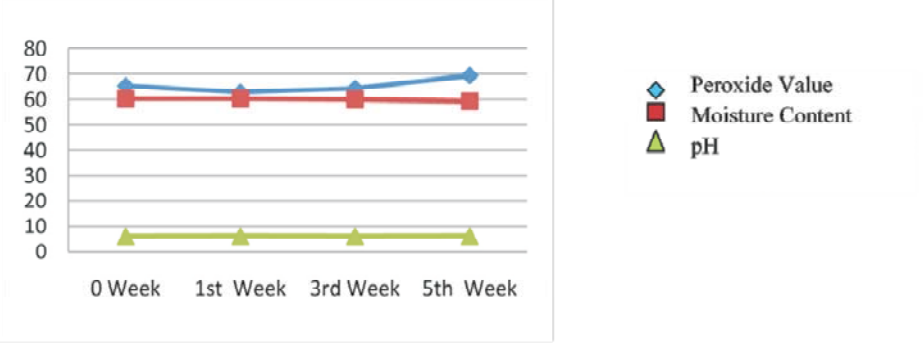

Fig. 4. Changes in product pH value, moisture content and peroxide value during five weeks of frozen storage

Result of microbiological studies

Total plate count (CFU/g) and yeast and mould count (CFU/g) were at acceptable levels within the 5 weeks of storage according to the Sri Lanka standards (SLS).

Table 3. Total plate count and yeast and mould count during 5 weeks of storage

Storage Time (Weeks)	Total plate Counts (CFU/g)	Yeast and Mold (CFU/g)
Initially	8.6×10^4	less than 3×10^2
5	1.8×10^5	less than 3×10^2

Discussion

Though Tilapia has a characteristic unpleasant odour, muddy flavour and a large amount of bones, it is considered as a high protein food commodity. By incorporating DTSP, the muddy flavor and the unpleasant odour can be overcome to a certain extent while increasing the protein content. As DTSP has a characteristic pleasant odour and taste, the muddy flavour and odour of fish flesh are masked. DTSP has improved organoleptic properties such as water binding capacity and textural properties (Porcella *et al*., 2001). In consumer food products textured plant protein is used in meat and fish products, which improves their quality by reducing shrinking and the drip of water or fat during cooking (Linko and Harper 1989). Therefore, incorporating DTSP into Tilapia fish mince improves the flavour, texture, slicing characteristics and masks the muddy flavour. According to the study, the shelf life of the developed product was approximately five weeks. The developed fish sticks were not incorporated with chemical preservatives and flavourings agents but were only seasoned with spices. Therefore, the shelf life was restricted to a shorter period of time and the product got less taste after five weeks of storage. Moisture content of the final product remained fairly stable after the five weeks of storage. The pH value of the product was not significantly changed and a slight increase was shown. This may be due to the denaturation of protein in freezing storage which enhances the production of ammonia volatile compounds (Lawrie, 1991).

This study has several limitations. First, all processing steps were carried out manually due to lack of facilities in the research institute. Therefore, product quality could have been affected in terms of taste, texture and colour. However, maximum precautions were followed during the processing steps in order to minimize contaminations and to keep the quality.

Tilapia has a similar nutritional composition to marine fish. To popularize different types of tilapia among consumers, new products must be produced to increase their demand as

well as to utilize our own inland fishery resources. Moreover, self-employment opportunity will arise through these product developments in areas where there are more resources, contributing to the development of the socio-economic status of the fishery community in Sri Lanka.

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