Fishery Technology
2008, Vol. 45(1) pp : 35 - 42

Frozen Storage Studies of Mince Based Products Developed from Tilapia (*Oreochromis mossambicus*, Peters 1852)

George Ninan*, J. Bindu and Jose Joseph
Central Institute of Fisheries Technology,
Cochin - 682 029, India.

Tilapia (*Oreochromis mossambicus*) is a relatively abundant, low value fish that has wide distribution in India due to its adaptability to different environments. In India, the fish has limited scope for consumption in the fresh form. This study is an attempt to explore the possibilities of better utilization of this species by development of mince-based value added products and the evaluation of shelf life during frozen storage. Mince from Tilapia was used for the preparation of value added products viz., chilly fish, fish cutlet and fish balls. The biochemical and sensory parameters were analysed to study the quality changes and shelf life of these products in frozen storage at - 20 ^{0} C. The products had a good shelf life of 18 to 21 weeks in frozen storage.

Key words: Tilapia, mince, value addition, chilly fish, fish cutlet, fish balls, frozen storage.

Tilapia (*Oreochromis mossambicus*) is considered as a "weed fish" in fish farms and is characterized by its fast growth and adaptability to different environments. The total world production of this species from both wild capture and aquaculture increased from 3,73000 Tonnes in 1980 to 1.85 million tonnes in 2000 (Roderick & Gillespie, 2003). Tilapia is mainly marketed as fresh and found to have a storage life of 10-14 days in chilled condition (Shenoy & James, 1972). It is reported to be a suitable candidate species for the production of surimi (Gopakumar, 1997) and the properties of surimi is comparable to that from marine species (Gopakumar *et al.*, 1992, Hassan & Mathew, 1999). Surimi prepared from this species was superior in quality to that from Indian Major carps (Ninan *et. al.*, 2004).

Although several marine and freshwater species have been investigated for the suitability of mince and mince-based products, reported works on Tilapia in these aspects are few. Onibala *et.al.* (1997) reported that heat induced gels prepared from Tilapia (*O.niloticus*) was found to have a desirable texture with high elasticity corresponding to that of surimi based product (kamaboko) available in the market. The effect of starvation and diet on the gel forming ability of Tilapia (*O.niloticus*) was reported by Wendakoon & Shimizu (1991). Preparation of spice-minced fish from Tilapia was reported by Zain (1979). Ninan *et al.* (2004) reported that Tilapia in fresh condition can yield 32 – 36% raw mince. The mince is white in colour, has low fat content and no pronounced odour which makes it an ideal raw material for the preparation of value added products. The objective of the present study is to evaluate mince based products viz.,

* Corresponding Author. Email : george66jiji@rediffmail.com

chilly fish, fish cutlet and fish balls from Tilapia and to assess the quality during frozen storage.

Materials and Methods

Fresh medium sized Tilapia of length 22 ± 1.5 cm and weight 200 ± 5 g in post rigor condition collected from the local market near Cochin was used for the study. The fish brought in iced condition was processed manually into skinless, boneless fillets. The fillets were then washed with chilled water, drained and immediately converted to mince using a hand-operated mincer. The fresh mince was used for the preparation of the chilly fish, fish cutlet and fish balls. The recipes for the products were selected by comparing the acceptability of different formulations of ingredients by sensory evaluation.

Preparation of Chilly fish

The ingredients used for the preparation of chilly fish are given in Table 1. Mince was mixed well with glycerophosphate, sodium tripolyphosphate and salt and was spread in aluminium trays at about 1 cm thickness. It was then kept at -20°C for one hour in a deep freezer for partial setting and then cut into uniform cubes of about $1cm^3$ size. The cubes were then seasoned with half the quantities of sauces, ginger paste, garlic paste and salt for one hour. It was then dipped in the batter made of beaten egg, corn flour and maida, deep fried in oil at 180 - 200°C for five minutes. The rest of the ingredients viz., chopped onion, chopped green chilli, capsicum and celery leaves were fried in the same oil and mixed with the fried cubes. Red chilli powder, pepper and the remaining quantity of sauces were added and the preparation was again mixed well. After cooling for 30 minutes, approximately 140 g was packed in co- extruded pouches of 12 m PE/ cast PP (20 x 17 cm) and sealed.

Preparation of Fish balls

The ingredients used for the preparation of fish balls is given in Table 1. For coating, batter mix in the ratio of 1: 1.5 (batter mix: water) (W/V) was used. The compositor of batter is given in Table 2.

The mince was blended with corn flour and spices. It was then made into balls of approximately 15 g and cooked in 1% boiling brine for eight minutes and cooled. The balls were then pre-dusted, battered and breaded.

Table 1. Ingredients used for product preparation

Chilly fish	
Fish mince	1 kg
Glycerophosphate	1 g
Sodium tripolyphosphate	1 g
Salt	10g
Chopped onion	500g
Chopped Green chilli	20 g
Ginger paste	30 g
Garlic paste	30 g
Corn flour	30 g
Refined wheat flour	50 g
Egg	4
Capsicum	1 no.
Soya sauce	30 ml
Chilli sauce	30 ml
Tomato sauce	200 ml
Celery leaves	10 g
Pepper	2 g
Red chilli powder	2 g
Salt	15g
Refined sunflower oil	200 ml
Fish balls	
Fish mince	1 kg
Corn flour	50g
Salt	1%
Salt	1%
Garlic paste	20g
Ginger paste	20g
Pepper	2g
Bread crumbs	200g
Batter mix	500ml

Table 2. Composition of batter

Refined wheat flour	1kg
Corn starch	100g
Bengal gram	100g
Salt	15g
Trisodium polyphosphate	5g
Turmeric	5g
Guar gum	5g
Black gram	200g

Fish balls were packed in co-extruded pouches with identical specifications as described in the case of chilly fish with ten pieces in each pouch.

Preparation of Fish Cutlets

Fish cutlets were prepared as described by Joseph *et al.* (1984). The process was slightly modified by using steam cooked mince instead of cooked meat. Besides, batter mix used in the preparation of fish balls was used instead of egg white to coat the cutlet. Each piece of fully formed cutlet weighed 35–40g.Four cutlets each was packed in co-extruded pouches with identical specifications as described in the case of chilly fish and fish balls.

The packed products were immediately frozen at - 40°C in an air blast freezer (Model T 10 Castel MAC SpA, Italy) for 90 minutes and then stored in a Siemens cabinet freezer (ModelGS26 B2) at - 20°C. Weekly samples were drawn for quality analyses.

Biochemical analyses

Crude protein (TN × 6.25) and fat contents were determined by the micro-Kjeldahl and Soxhlet method of AOAC (2000) respectively. Moisture content was determined using the standard hot air oven (100°C for 18 h) method of AOAC (2000) and crude ash was determined by heating an incinerated sample in a muffle furnace (550°C for 10 h) as per AOAC (2000) method. Total Volatile Base Nitrogen (TVBN) was determined by the microdiffusion method of Conway (1962) and Alpha Amino Nitrogen (AAN) by the method of Pope and Stevens (1939). Thiobarbituric Acid value (TBA) was determined by the method of Tarladgis *et al.*, (1960), Peroxide Value (PV) and Free Fatty Acid (FFA) were determined according to Jacobs (1958) and AOCS (1989) respectively. The bone content in the raw mince was determined by the method of Yamamoto & Wong (1974) and the pH of the mince was determined by method described by Lanier (1992). Microbiological examinations were carried out as per APHA (1976) methods.

For sensory evaluation a trained panel of six members was constituted. Frozen fish ball and cutlet samples were thawed and deep fried in refined vegetable oil at 180 - 200°C for 1-2 minutes until the coated surface became uniform brown in colour. The frozen chilly fish pouches were thawed and emptied into a glass bowl; the contents were then warmed in a microwave oven for one minute. The panel members were asked to give scores of each product for sensory attributes such as appearance, colour, flavour, taste, and texture on a scorecard of nine-point hedonic scale as described by Peryam and Pilgrims (1957). Table A score of 4 was taken as the borderline of overall acceptability.

Results and Discussion

The yield of mince was 33.2% from the whole Tilapia. The mince yield was comparatively low since it was produced manually. The characteristics of Tilapia mince are given in Table 3. The low fat content and bone content of the mince makes it suitable for the preparation of products.

The proximate composition of the products is given in Table 4. The crude protein of the products was in the range of 17.5 – 18.7%. Chilly fish had high quantity of fat due to deep-frying of fish cubes and other ingredients in oil, which is the reason

Table 3. Characteristics of raw mince from Tilapia*

Moisture (%)	80.33 ± 1.21
Protein (g% wwb)	17.37 ± 1.08
Fat (g% wwb)	1.57 ± 0.47
Ash (g% wwb)	0.75 ± 0.12
Bone content (%)	0.15 ± 0.02

*Values are the mean ± standard deviation of five analyses

Table 4. Proximate Composition of the mince based products from Tilapia*

	Chilly fish	Fish balls (Raw)	Fish cutlets (Raw)
Moisture (%)	57.05±1.38	66.34±1.22	65.10±1.57
Protein (g% wwb)	18.10±1.33	18.78±1.09	17.51 ±1.14
Carbohydrate (%)**	12.50±1.83	11.06±1.66	13.47 ±1.52
Fat (g% wwb)	10.6±1.11	2.0±0.56	2.14 ±0.42
Ash (g% wwb)	1.73±0.22	1.82±0.16	1.78 ±0.18

* Proximate composition values are the mean ± standard deviation of five analyses for each product.
** Carbohydrate % = (100%) – [(% Protein) + (% Fat) + (% Moisture) + (% Ash)]
Woods and Aurand (1977)

for its low moisture content compared to other products. Carbohydrate content was highest for fish cutlet since potato constitutes 25% of the ingredients.

The moisture content of the products (Fig. 1) did not show much variation during the frozen storage. The change in TVB-N content of the products during frozen storage is given in Fig. 2. TVB-N values were generally higher for frozen chilly fish than for other products. with the highest value of 26.8 mg% at the 9th week. The TVB-N was in the range of 20.4 mg% to 26.8 mg% in chilly fish, 8.4 mg% to 25.2 mg% in fish balls and 12.4 mg% to 20.2 mg% in fish cutlets during the period of storage. TVBN has shown gradual increase in products upto 12 weeks of frozen storage except in the case of fish balls where a sharp increase was observed from the 6th to 9th week. After 12 weeks there was gradual decline in TVB-N values of all the products till the end of storage period. For all the products, the TVB-N value did not exceed the acceptable limit during frozen storage.

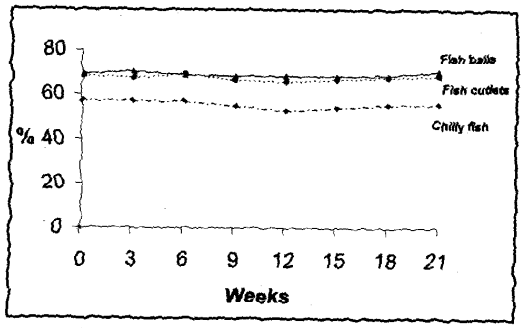

Fig. 1. Change in moisture of mince based products from Tilapia during storage at -20°C

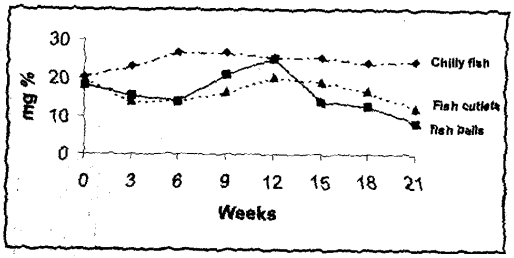

Fig. 2. Change in TVBN content of mince based products from Tilapia during storage at -20°C

Fig.3 illustrates the change in Peroxide Value. Among the frozen products, chilly fish had the lowest peroxide value (PV) in the range of 0.52 to 5.53 mEq/kg during frozen storage. In chilly fish, the reason for the low peroxide value could be due to the

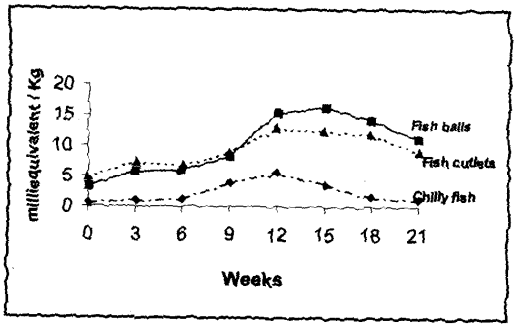

Fig. 3. Change in Peroxide Value of mince based products from Tilapia during storage at -20°C

sunflower oil used and the presence of natural antioxidants in vegetables added in the preparation. For fish balls the peroxide value was 16.29 mEq /kg by 15 weeks of frozen storage and for fish cutlets it was 12.88 mEq / kg by 12 weeks. PV showed a gradual increase for the products upto 12 – 15 weeks in frozen storage and thereafter decreased. Production of peroxides reaches a peak and tapers off as lipid oxidation proceeds (Labuzza, 1971). Battering and breading of the products can act as oxygen barrier, which will prevent oxidation. The incorporation of spices viz., clove, cinnamon and pepper, which has a strong anti-oxidant effect in the mince for the preparation of the products can increase the frozen storage stability of the mince (Joseph *et al.*, 1992).

TBA values (Fig. 4) were comparatively higher for frozen fish balls and cutlets than for chilly fish. In the case of frozen chilly fish TBA showed an increase upto 15 weeks and thereafter it decreased. In frozen fish balls and cutlets, TBA increased upto 9 and 12 weeks of storage respectively after which there was a gradual decrease in both products. The highest value for chilly fish after 15 weeks of storage was 1.28 mg MA/ kg. For fish balls, it was 1.96 mg MA/kg in 9 weeks and for fish cutlets it reached 1.91 mg MA/kg by the 12th week. The decrease in TBA could be due to the retardation of lipid oxidation by products of lipid hydrolysis and interaction of malonaldehyde / aldehyde with proteins (Castell *et al.*, 1966). Reddy *et.al.* (1992) reported an increase in TBA upto 14 weeks of storage and decrease thereafter for frozen fish fingers.

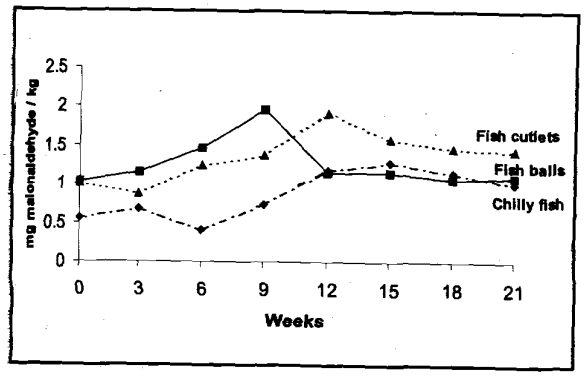

Fig. 4. Change in TBA of mince based products from Tilapia during storage at -20°C

Change in FFA values of the products during frozen storage is given in Fig. 5. FFA content was generally low for all the products during the frozen storage. However, an initial increase up to twelve weeks was observed and thereafter it gradually decreased. In the case of fish balls the change was significant. Cooking of the mince deactivates the lipolytic enzymes, which could be the reason for low FFA formation in the products (Lall *et. al.*, 1975). The decrease in FFA at later stages of frozen storage could be due to its interaction with proteins.

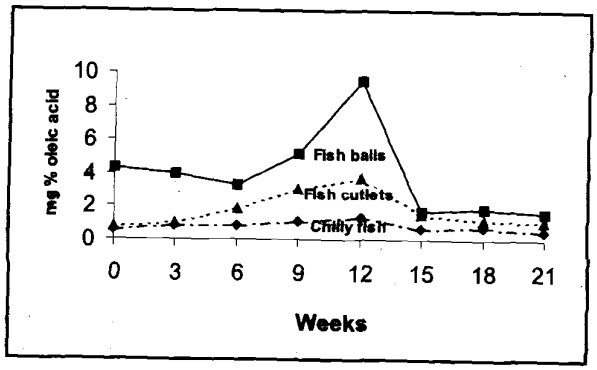

Fig. 5. Change in Free Fatty Acid of mince based products from Tilapia during storage at -20°C

Changes in AAN values of the products during frozen storage is given in Fig. 6. AAN values were highest for fish cutlets during frozen storage. However, the rate of change was similar for all the products during the study. The increasing trend of AAN in frozen products could be attributed to the sustained activity of hydrolytic enzymes during storage.

Changes in the log of bacterial count of the products during frozen storage is shown in Fig. 7. Initial Total Plate Count (TPC) was highest for fish cutlets, which was a raw product. Chilly fish had the least bacterial

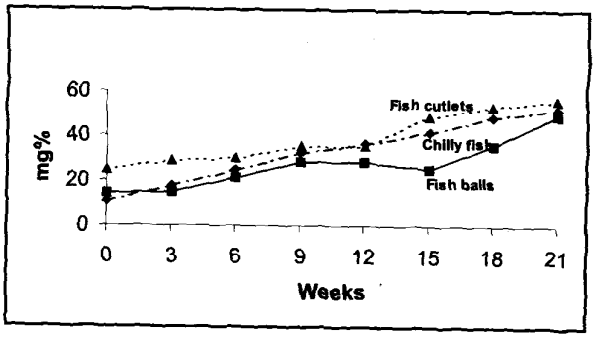

Fig. 6. Changes in Alpha Amino Nitrogen of minced products from Tilapia during storage at -20°C

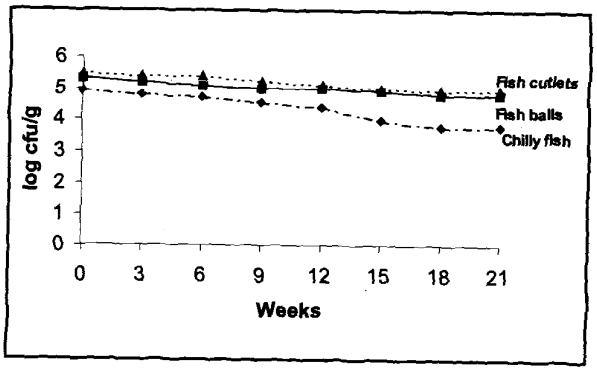

Fig. 7. Changes in Total Plate Count of mince based products from Tilapia during storage at -20°C

count. The frying of the fish cubes and ingredients could have caused a reduction in the bacterial count in chilly fish. For all the products,a marginal reduction in TPC was observed during frozen storage and it was within the acceptable limits. Liston (1980) observed that freezing generally cause a reduction in bacterial count and the number will continue, in most cases to fall, during frozen storage. The products were found to be free from *E.coli, Coagulase positive staphylococci, faecal streptococci, Salmonella* and *Vibrio cholera* throughout the study.

Fig. 8 shows the change in sensory scores of the products during frozen storage. Sensory evaluation was based on the attributes like appearance, flavour, odour and texture for which scores were given by the panel and the overall score was calculated. Fresh products had initial sensory scores

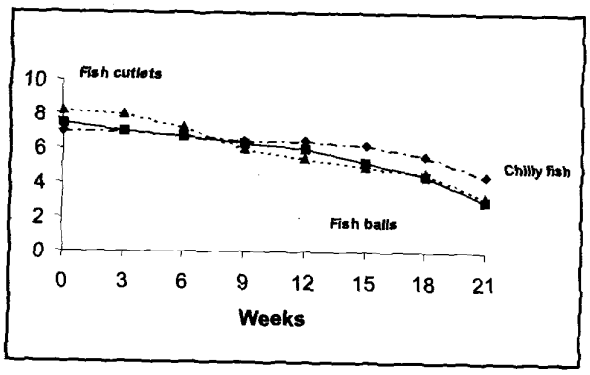

Fig. 8. Change in sensory evaluation scores of mince based products from Tilapia during storage at -20°C

above 7, rated as good to excellent. Fish cutlets and fish balls remained acceptable upto 18 weeks of storage after which loss in flavour and texture was noticed. The texture has become rubbery for fish balls and cutlets developed a prominent fishy odour. Joseph *et al.*, (1984) has reported a shelf life of 19 weeks for raw cutlets in frozen conditions prepared from the cooked mince of different marine fishes. Chilly fish remained acceptable for longer period in frozen condition which could due to firm texture and low moisture content of the product. By the 21st week, chilly fish cubes started disintegrating in the medium indicating loss of texture. However the product had acceptable flavour and odour.

The above study outlines the scope for the development of mince based products from Tilapia, which is a relatively abundant, low value fish. The products have good shelf life of 18 – 21 weeks in frozen condition. Since the fish has only limited scope for consumption in the fresh form, development of mince-based products is a better option for the utilization of this species.

The authors are thankful to the Director, Central Institute of Fisheries Technology, for according permission to publish the paper. The technical assistance rendered by the staff of the Fish Processing Division of the Institute is gratefully acknowledged.

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