Fishery Technology
2004, Vol. 41(1) pp : 21 - 28

Properties of Washed Mince (Surimi) from Fresh and Chill Stored Black Tilapia, *Oreochromis mossambicus* (Peters 1852)

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

Surimi was prepared from black tilapia (*Oreochromis mossambicus)* after storing the fish in ice for different periods. Two washing cycles were given under two different mince / water wash ratios, viz., 1:2 and 1:3. The yield of surimi was lowest in 0 day-iced samples. Zero and 1 day iced fish were found to be ideal for the preparation of surimi, while an overall decline in the quality of the surimi prepared from 2 day iced specimens was noticed. The gel strength and compressibility of tilapia surimi were higher than that from Indian major carps and were comparable to that of surimi from marine species. Two successive washings at a mince: water ratio of 1:2 (w/v) for a period of 5 min. each was found to be ideal for optimum yield and quality of the surimi.

Key words : *Oreochromis mossambicus*, surimi, wash ratio, chilled storage, gel strength, texture profile

The suitability of several species of marine and fresh water fish for the preparation of mince and mince-based products has been investigated in detail. In India, the species of fish mainly used for surimi production are threadfin bream *(Nemipterus japonicus),* lizard fish (*Saurida tumbil*) and ribbon fish (*Trichiurus savala),* (Muraleedharan, *et. al.,* 1997). The suitability of freshwater species, particularly the major carps for the preparation of mince and surimi and the rheological properties of surimi from Indian Major Carps have been reported by Sankar & Ramachandran (1998, 2002).

Black 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 characteristics of washed mince from this species was reported by Gopakumar *et al.* (1992) and Hassan & Mathew (1999). Nowsad *et. al* (1999) reported that the surimi from Genetically Improved Farm Tilapa (GIFT) was better in quality than that from the wild strain of tilapia (*O.niloticus).* Heat induced gels prepared from the fish paste of 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 (Onibala *et. al.,* 1997). The effect of starvation and diet on the gel forming ability of tilapia (*O.niloticus*) was reported by Wendakoon & Shimizu (1991).

The objective of the present study is to examine the suitability of fresh and ice stored tilapia for the preparation of washed mince (surimi).

Materials and methods

Live tilapia (*O. Mossambicus*) was collected from a local brackish water farm. They were killed immediately by keeping in ice-water slurry, packed in flake ice with a fish to ice ratio of 1:1 in insulated thermocole boxes and brought to the laboratory within two hrs. Two portions of this fish were kept

in ice for one or two days while a third portion was used in fresh condition for surimi preparation. Re-icing was done every 24 hours.

For the preparation of surimi, medium sized fish of average length 22 cm and weight 200 g was used. About five kg of tilapia was filleted in pre rigor condition. The fillets were immediately washed with chilled water and kept in chilled condition using ice. The fillets were then made into mince using a hand-operated mincer. Two batches of 500 g. mince was washed with chilled water. The washing schedule consisted of two exchanges of water at 5°C for 5 min. each with constant stirring. Mince: water ratio was 1:2 (w/v) for one batch and 1:3 (w/v) for the second batch. After the first wash, the mince was drained using a nylon net. The drained mince was resuspended in water for second wash after which it was held in a nylon net and pressed using a manual screw press until the mince began to come out through the net. Sucrose (4%), sorbitol (4%) and tripolyphosphate (0.2%) were mixed with the washed and pressed surimi as cryoprotectants using a pre-cooled mixer grinder. It was then packed in polythene bags and frozen at –40°c for 4 hrs. in an air blast freezer (Model T10 Castel MAC SpA, Italy) and stored in deep freezer (Siemens) at –20°C until analysis. The samples were subjected to biochemical, rheological and sensory analyses. Surimi was prepared by the same method described above from tilapia iced for 1 and 2 days.

Yield of raw mince was calculated as the percentage weight of whole fish. The yield of surimi was calculated as the percentage weight of whole fish and raw mince. Moisture, fat, protein and ash of the samples were estimated according to AOAC (1990) and the bone content in the raw mince was determined by the method of Yamamoto & Wong (1974). The pH of the mince was determined as per the method described by Lanier (1992).

Rheological properties were studied on heat-induced gels. The washed mince was ground with 3% NaCl for 3 min. in a pre-cooled mixer grinder. The temperature was kept below 10°C during grinding. It was then stuffed manually in polypropylene casings of 37 mm dia. with minimum trapping of air inside the stuffed casings. The ends of the stuffed casings were then tied. The samples were cooked by immersing in water bath at 90°C for 30 min. The gels thus formed were immediately cooled in ice and then kept at 5°C in a refrigerator overnight and were analyzed.

A 3 mm slice of the gel was subjected to folding test (Lanier, 1992) by folding between the thumb and index finger and depending on the breakage, they were evaluated by a five-stage process as follows:

Point	Condition
5	No crack occurs after folding twice
4	No Crack occurs after folding half
3	Crack occurs gradually when folded half
2	Cracks immediately when folded half
1	Breaks by finger pressure

The compressibility (g) was determined using 'SUN' rheometer with a gel of 25 x 37 mm dia and a 5mm plunger with a round head. The compressibility is defined as the force (g) required to compress the sample by a known distance (4mm) (Lee, 1984). The gel strength and the texture profile analysis of the sample was determined using a Food Texture Analyser (Model LRX plus) of Lloyds, U.K. using cylindrical specimens of 25 x 32mm dia. For Texture Profile Analysis, a cylindrical probe of 10cm diameter was

used with a speed adjusted to 12mm per min. The four primary parameters viz., hardness, springiness, adhesive force and cohesiveness (Bourne, 1978) and three secondary parameters viz., gumminess, chewiness and resilience of the gel were measured. The gel strength was determined by single hardness setup mode using a ball probe of 5 mm dia. It was calculated as the peak force in g, multiplied by the distance to the rupture event measured in cm. (Yamazawa, 1990). The resulting value has unit of g.cm.

Washed mince samples of about 50g were packed in polythene pouches and steam cooked for 30 min. without pressure. The samples were then served to an experienced panel of 10 members to assess the colour & appearance, flavour and texture on a 5 to 1 point hedonic scale. Each attribute was depicted on the hedonic scale as follows:

Colour & appearance: 1- dull grey, 3- greyish white, 5- whitish.

Flavour: 1- muddy, 3- faint muddy, 5- bland.

Texture: 1-soft and pasty, 3-fibrous & firm, 5- firm & chewable.

Results and Discussion

Filleting and mincing of tilapia yielded 32% (0 day iced), 35.2% (1day iced) and 36.4% (2 day iced) raw mince based on the whole weight of fish (Table 1). Generally higher yields of mince were reported for marine fishes (Joseph & Perigreen, 1983; Muraleedharan *et. al.*, 1996).

Surimi was prepared using two exchanges of water in two different ratios. The yield of surimi based on whole fish was found to be increasing from 0 day sample to 2 day sample (Table 1). No noticeable difference in the yield was observed between surimi prepared using 1:2 and 1:3 wash ratio. The surimi yield was maximum for samples prepared from 2 day iced tilapia. Washing the mince using three exchanges of water in the above-mentioned ratios led to excessive hydration of the mince, which made the removal of the water very difficult.

Compositional changes, as a result of ice storage of tilapia are given in Table 2. The data showed that ice storage upto two days did not significantly affect the composition of the fish mince. The average bone content of the mince was 0.14% which was slightly higher than that reported by Gopakumar *et al.*, (1992).

Washing of the mince resulted in the increase of moisture content and a corresponding decrease in the protein content of the mince. The mince samples washed in 1:2 ratio showed an average increase of 6.52% moisture content after two wash cycles and those washed in 1:3 ratio, the increase was 10.03%.

Table 1. Yield of raw mince and surimi from whole fish

Storage Period of Tilapia in ice (days)					
0		1		2	
Raw mince (%)	Surimi (%)	Raw mince (%)	Surimi (%)	Raw mince (%)	Surimi (%)
Washing, mince to water, 1:2 (w/v)					
32.0	22.14	35.2	25.45	36.4	26.86
Washing, mince to water, 1:3 (w/v)					
32.0	20.99	35.2	24.71	36.4	26.31

Table 2. Proximate composition of mince prepared from iced tilapia*

Parameters	Storage Period of Tilapia in ice (days)		
	O	1	2
Moisture (%)	80.33	81.21	82.32
PH	6.55	6.50	6.62
Protein (%)	17.37	16.31	15.56
Fat (%)	1.57	1.69	1.52
Ash (%)	0.75	0.88	0.67
Bone content(%)	0.15	0.13	0.13

*The values are the average of two sets of experiments

The pH of the samples was in the range of 6.5-7.0, which can be considered as neutral. A neutral pH is optimum for the gel forming ability of the myofibrillar proteins. The gel forming ability decreases with decrease in pH (Shimizu *et. al.*, 1954).

The average loss of protein in the 1:2 washed samples after two wash cycles was 22.09% and for 1:3 washed samples it was 45.18%. In both the sets, increase in moisture was minimum in 0 day samples and maximum in 2-day samples. The average removal of fat in both types of samples was 44.5% after two wash cycles. Washing removed 60.65% of the ash content in 1:2 samples after two washes whereas for 1:3 samples, it was 66.34%. The cumulative loss of proteins was 5% higher in the 1:2 washed samples than that reported by Gopakumar *et al.*, (1992) which could be due to the prolonged washing time of the mince. (Table 3).

Unwashed tilapia mince had a muddy odour although it was not pronounced as in the case of major carps. In unwashed mince there is a gradual decline in the sensory qualities during storage in ice. The sensory characteristics of the mince improved by washing and the twice-washed samples were better in quality than the single washed ones

Table 3. Changes in the characteristics of tilapia mince during washing cycles*

	Ice storage, 0 day		Ice storage, 1 Day		Ice storage, 2 Day	
	No. Washing cycles		No. Washing cycles		No. Washing cycles	
	1	2	1	2	1	2
			Moisture (%)			
1:2 wash	82.98	85.23	85.21	87.32	86.18	87.22
1:3 wash	85.61	89.42	85.98	89.80	86.34	89.01
			pH			
1:2 wash	6.89	7.09	6.81	6.96	6.80	6.89
1:3 wash	6.91	7.10	6.91	7.07	6.88	6.92
			Protein (%)			
1:2 wash	16.01	14.2	12.44	12.10	13.11	12.10
1:3 wash	12.38	8.63	12.06	9.06	11.88	9.22
			Fat (%)			
1:2 wash	0.87	0.67	1.20	0.95	1.17	1.01
1:3 wash	1.26	1.12	1.49	0.91	1.22	0.62
			Ash (%)			
1:2 wash	0.41	0.24	0.56	0.35	0.35	0.31
1:3 wash	0.54	0.25	0.42	0.28	0.40	0.24

* The values are the average of two sets of experiments

(Table 4.). In the 2 day iced samples the colour was greyish white after two wash cycles. The twice-washed 0 day and 1 day samples (1:2 wash ratio) showed high overall acceptability. A 1:3 wash ratio did not improve the sensory properties of the surimi in any of the samples when compared to samples of 1:2 wash ratios. The second day surimi was inferior to 0 day and I day surimi but still can be considered as a medium quality product in terms of sensory characteristics.

Table 4. Sensory characteristics of tilapia mince*

	Ice storage, O day			Ice storage, 1 day			Ice storage, 2 day		
	A	B	C	A	B	C	A	B	C
Colour & Appearance	2.5	4.8	4.8	1.5	4.8	4.8	1.2	4.0	3.5
Flavour	2.0	4.5	4.8	1.5	4.5	4.5	1.5	4.2	4.0
Texture	2.0	4.8	4.0	3.0	4.8	3.5	3.0	4.0	3.2
Total Score	6.5	14.1	13.6	6.0	14.1	12.8	5.7	12.2	10.7

A- Unwashed mince. B-1: 2, double wash mince. C - 1:3, double wash mince
* Results are the mean of individual scores.
Colour & appearance: 1- dull grey, 3- greyish white, 5- whitish.
Flavour: 1- muddy, 3- faint muddy, 5- bland.
Texture: 1-soft and pasty, 3-fibrous and firm, 5-firm and chewable.

Table 5. Rheological properties of tilapia mince*

	Ice storage, 0 day			Ice storage, 1 day			Ice storage, 2 day		
	A	B	C	A	B	C	A	B	C
Compressibility (g)	85	297	294	158	266	215	132	156	150
Folding Test**	1	5	5	1	5	3	2	5	4

* Results are the mean of five estimations.
A- Unwashed mince. B-1: 2, double wash mince. C 1:3, double wash mince.
**5 – no crack occurs after folding twice; 4 – no crack occurs after folding into half;
3 –crack occurs gradually when folded half; 2- cracks immediately when folded half;
1- breaks by finger pressure.

Table 6. Texture Profile Analysis of Tilapia mince: Primary parameters.

Parameters	Ice storage, 0 day			Ice storage, 1 day			Ice storage, 2 day		
	A	B	C	A	B	C	A	B	C
Hardness I (kgf)	2.10	3.48	2.98	3.95	5.44	5.72	3.62	4.23	3.64
Hardness II(kgf)	1.87	3.19	2.74	3.63	4.97	5.09	3.26	3.90	3.31
Adhesive force (kgf)	0.03	0.04	0.02	0.03	0.05	0.05	0.03	0.04	0.04
Springiness (mm)	7.12	7.46	7.68	7.83	8.35	8.10	7.85	7.98	7.93
Cohesiveness (ratio)	0.46	0.49	0.49	0.45	0.48	0.48	0.45	0.47	0.47

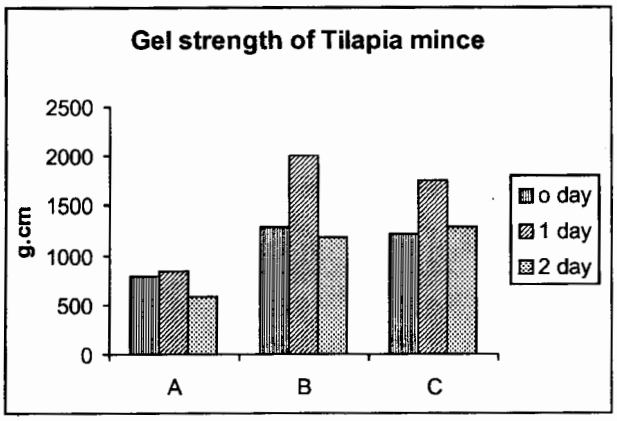
A - Unwashed mince. B - 1: 2/double wash mince. C - 1:3/double wash mince.

Table 7. Texture Profile Analysis of tilapia mince: Secondary parameters.

Parameters	Ice storage, 0 day			Ice storage, 1 day			Ice storage, 2 day		
	A	B	C	A	B	C	A	B	C
Gumminess (kgf)	0.96	1.70	1.46	2.12	2.60	2.71	1.59	2.04	1.73
Chewiness (kgf)	6.86	12.67	11.24	16.60	21.67	21.95	12.52	16.28	13.76
Resilience (ratio)	0.78	0.81	0.81	0.83	0.84	0.83	0.78	0.82	0.80

A - Unwashed mince. B - 1: 2/double wash mince. C - 1:3/double wash mince.

The rheological properties did not vary much between the samples of unwashed mince (Table 5) except compressibility. Most of the washed mince samples had a folding grade of 5. Compressibility of the samples showed a gradual increase in successive wash cycles. The twice washed 0 and 1 day mince had the highest values for compressibility. The 2 day washed mince also showed an increase in the values but its compressibility was lower than that of the other samples. Washing is known to enhance the gel forming characteristics and hydrophilic character of the proteins except in cases of fatty fish (Suzuki, 1981). The gel strength was above 1000 g.cm for the washed mince samples (Fig.1). Maximum gel strength was observed for 1 day stored twice washed (1:2 - w/v) minces. Lee (1992) has reported that in case of marine fish, after the second washing cycle, there was no further increase in gel strength. The gel strength and compressibility of tilapia surimi were significantly higher than that from Indian major carps, where the maximum values noticed for gel strength and compressibility under different heat setting conditions were 240 g.cm in the case of mrigal and 110 g.cm for catla, rohu &mrigal (Sankar & Ramachandran, 2002). The gel strength of the surimi from tilapia could be compared with that from threadfin bream, ribbonfish and lizard fish as reported by Muraleedharan *et al*, (1997).



Gel strength = Load (g) x Deformation from trigger (cm)
A - Unwashed mince. B-1: 2, double wash mice; C 1:3, double wash mince.

The results of texture profile analysis of surimi are given in Tables 6 & 7. One day samples gave highest values for all the parameters, which indicate that the best quality surimi can be prepared from fresh tilapia stored in ice for 24 hrs.

Surimi prepared from tilapia was therefore superior in quality than that prepared from other freshwater species, particularly from the Indian major carps. The yield of surimi was less in pre rigor condition. Fresh and 1 day iced fish was ideal for the preparation of surimi, while an overall decline in the quality of the surimi prepared from 2 day iced samples was noticed. For washing the mince a ratio of 1:2 (w/v) mince: water for two successive wash cycles of five min. each was found to be optimum. A wash ratio of 1:3 (w/v) resulted in 45% loss of proteins and a third washing resulted in the excessive hydration of the mince.

The authors are thankful to the Director, Central Institute of fisheries Technology, for

according permission to publish the paper. The technical assistance rendered by Smt. K.B. Beena, Smt. K.P. Leelamma & Shri Dinesh Prabhu is gratefully acknowledged.

References

AOAC (1990) Official Methods of Analysis, 15th edn., Association of Official Analytical Chemists, Arlington, Virginia.

Bourne, M.C. (1978) Texture Profile Analysis. *Food Tech.* **32**, pp 62-66.

Gleman, A. & Benjami, E. (1989) Characteristics of mince from pond bred Silver carp (*Hypophthalmichthys molitrix*) and preliminary experiments on its use in samples. *J.Sci.Food Agric.* **47**, pp 225-241.

Gopakumar, K., Muraleedharan, V. & Bhattacharyya, S.K. (1992) Preparation and properties of surimi from tropical fish. *Food Control* **3**, pp 109-112.

Gopakumar, K. (1997) *Tropical Fishery Products*, 491 p, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Hassan, F. & Mathew, S. (1999) Physico-chemical, Microbiological and Sensory characteristics of washed mince prepared from some selected species of fish. *J Food Sci.Technol.* **36**, pp 459-462.

Joseph, J. & Perigreen, P.A. (1983) Studies on frozen storage of mince from threadfin bream. *Fish Technol.* **20**, pp 6-13.

Lanier, T.C. (1992) Measurement of surimi composition and functional properties In: *Surimi Technology* (Lanier, T.C & Lee, C.M., Eds.) pp 138-144, Marcel Dekker Inc., New York

Lee, C.M, (1984) Surimi process technology. *Food Technol.*, **38**, pp 69-80.

Lee, C.M, (1992) Factors affecting physical properties of fish protein gel. In: *Advances in Seafood Biochemistry – Composition and Quality.* (George J.F Jr. & Roy E. Morton., Eds.) pp 43-67 Technomic Publishing Co Ltd., Lancaster –Basel.

Lin.T.M. & Park, J.W. (1996) Extraction of proteins from Pacific Whiting mince at various washing conditions. *J. Food Sci.* **61**, pp 432 - 438.

Muraleedharan, V., Perigreen, P.A. & Gopakumar, K. (1996) Chemical and taste panel evaluation of the mechanically separated flesh of six species of fish. In: *Proc. Second Workshop Scient. Resul. FORV Sagar Sampada*, pp 535-538.

Muraleedharan,V, Antony, K.P., Perigreen, P.A., & Gopakumar, K. (1997) Surimi from five Indian fish species *Trop.Sci.* **37**, pp 99-102.

Nousad, A.AKM, Khan, A.H. & Niwa, E. (1999) Five tropical freshwater fish species: setting ability and other characteristics of the minces. *Asian Fisheries Science* **12**, pp 175-186.

Onibala,H., Takayama T., Shindo, J., Hayashi, H. & Miki, H. (1997) Influence of Freshness on occurrence of setting and disintegrating in heat induced gels from Tilapia. *Fish.Sc.* **63**, pp 276-280.

Sankar, T.V. & Ramachandran, A. (1998) Utilization of fresh water catla (*Catla catla*) for preparation of myofibrillar protein concentrate In: *Proceedings of the Asia Pacific Fisheries Commission (APFIC) symposium*, Beijing, People's Republic of China, RAP Publication 1998/24, FAO, pp 135-139.

Sankar, T.V. & Ramachandran, A. (2002) Rheological characteristics of suwari and kamaboko gels made of surimi from Indian major carps. *J Sci.Food Agr.* **82**, pp 1021- 1027.

Shimizu, Y., Simidu, W. & Ikuchi, T. (1954) Studies on gelly strength of Kamaboko –III Influence of pH on gelly strength. *Bull. Jap. Soc. Sci. Fish.* **20**, pp 209-212.

Suzuki, T. (1981) *Fish and Krill Protein: Processing Technology*, Applied Science Publishers Ltd., London.

Wendakoon, C.N. & Shimizu, Y. (1991) Effect of starvation and diet on the gel forming ability of Tilapia (*O.niloticus*). *J. Sc. Food Agric.* **54**, pp 295-304.

Yamamoto, M. & Wong, J. (1974) Simple chemical method for isolating bone fragments in minced fish flesh. *J.Food Sci.* **39**, pp 1259-1262.

Yamazawa, M. (1990) Effect of high temperature heating on physical properties of kamaboko gel. *Nippon Suisan Gakkaishi* **56**, pp 497- 503.