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IMPROVED METHODS FOR THE PREPARATION OF FISH BALL FROM THE UNWASHED MIXED MINCES OF LOW-COST MARINE FISH

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ABSTRACT

Fish ball was prepared from the unwashed mince blend of 5 low-cost marine fishes (LMF) viz., red jewfish (*Johnius argentatus*), sea cat fish (*Tachysurus thalassinus*), jeweled shad (*Ilisha filigera*) horse mackeral (*Megalaspis cordyla*) and skipjack tuna (*Sarda orientalis*) of the Bay of Bengal. Six different blends composition from 5 individual minces of Low-cost Marine Fish (LMF) were prepared by blending 15 to 30% of the individuals minces. Fish ball was prepared from such mince blends by improving the textural strength of the products through different cooking process, ingredients and spices. Textural quality was determined in terms of softness/firmness (S/F) and chewiness/ rubburiness (C/R). Gel forming ability of the individual minces varied in great extent due to their compositional differences. Among the six blends tested, blend C with higher proportion of mince had come from red jewfish, sea cat fish and horse mackerel showed highest gel strength. In mince blend C, composition of red jewfish, sea cat fish, horse mackerel, jeweled shad and skipjack tuna were 30, 20, 20, 15 and 15%, respectively. Unwashed and washed individual minces and the mince blend C were incubated at different temperature regime from 35° to 55° and then cooked at 90° or 100°C. Among the different heating regimes, unwashed mince blend C showed the highest gel strength at 50°C for 1 hr incubation temperature. Further cooking of the incubated gel at 100°C optimally increased the gelling ability. The quality attributes of fish ball prepared under different cooking process (two-step heating, boiling, broiling and autoclaving) were analyzed. In two-step cooking, fish ball heated at 50°C for 30 minutes and further cooked at 100°C for 30 minute obtained a very good textured and nice mouth-felt fish ball. Texture and flavor of ball was affected by washing of mince but sensory qualities were unaffected.

Key Words : Low-cost marine fish, Unwashed mince, Mince blend, Fish ball, Two-step heating

INTRODUCTION

In recent days, marine catch has declined with concomitant increase of domestic consumption as wet or processed fish in Bangladesh. There are, however, significant quantities of low-priced marine fish (LMF), those should receive adequate attention for value-addition. Individual catch size of these small meso-pelagic/pelagic species (small red jewfish, skipjack tuna, jeweled shad, horse mackerel, skipjack tuna) is too small to run a sustainable process line, but their mixed catch can provide a substantial volume of mince. The utilization of mixed mince for a quality product is rather difficult as proteins of different origins and natures with associated glycolytic and proteolytic enzymes are cocktailed. In this study, initiatives were taken for more valuable use of LMF by developing fish ball from unwashed mince blend. To minimize post-harvest loss and to comply with the recent global concept of 'total utilization' of resources in order to ensure food security, unwashed mince of LMF, in stead of washed mince or surimi, may be used for fish ball manufacture.

Fish ball is a very popular seafood product in Southeast Asia. Pilot market testing of the product showed that the consumer's preference for this tasty product was encouraging (Nowsad *et al*., 2000a). Upon boiling, broiling or dip-frying, the fish ball attains an elastic texture and a nice mouth-feel that can conceal the fishy odor. One can hardly recognize fishy element in fish ball. A known taste according to local taste preference can be incorporated into fish ball (Nowsad *et al.,* 2000a). Manufacture of fish ball from mixed mince of LMF will improve utilization status, reduce post-harvest loss encountered due to washing of mince or surimi preparation and increase the value of harvest. It is, therefore, felt necessary to prepare fish ball from the mixed minces of LMF by using local ingredients and spices. Earlier, fish ball was introduced in Bangladesh and produced from different fishes (Nowsad, 2000a), but this is perhaps the first investigation elsewhere on the manufacture of fish ball from the unwashed mince blend of LMF.

MATERIALS AND METHODS

Experimental fish

Five LMF viz., small red jewfish (*Johnius argentatus*), small sea catfish (*Tachysurus thalassinus*), horse mackerel (*Megalaspis cordyla*), jeweled shad (*Ilisha filigera*) and skipjack tuna (*Sarda orientalis*) were used to prepare unwashed mince blend.

The fishes were purchased from the Kawran Bazar wholesale fish market in Dhaka. The fishes were in iced condition during purchase. Immediately after purchase the fish were re-iced with new crushed ice in an insulated ice box. They were then brought in the laboratory of Fisheries Technology, BAU, and frozen stored at -20°C. The average weight of red jewfish, sea catfish, horse mackeral, jeweled shad and skipjack tuna were 0.34 ± 0.04, 2.60 ± 59, 0.44 ± 0.04, 1.11 ± 0.25 and 1.80 ± 0.52 kg and average length were 12.05 ± 1.5, 45.0 ± 3.74, 12.40 ± 2.4, 20.3 ± 4.22 and 26.52 ± 2.1 cm, respectively.

Preparation of mince blend

The fishes were washed, deheaded and eviscerated. The skinned fishes were filleted and deboned manually in iced condition. The minces were prepared by a mechanical mincer (MK-G3NS, Matsushita Electric Industrial Co. Ltd., Japan) through a 1mm orifice diameter so that all bones and connective tissues were removed from the muscles. Six mince blends (A, B, C, D, E and F) were prepared with blending composition given elsewhere (Nowsad *et al.,* 2007).

All the procedure from the mincing of raw fish to fish ball manufacture were done at about 5 to 8°C. This low temperature was ensured by keeping sufficient ice around fish, flesh and mince. A portion of the mince blend was washed with chilled 0.1% NaCl (Nowsad *et al.*, 2000a) to see the washing effect of the mince on the quality of fish ball.

Selection of mince blend

Six mince blends were separately ground with 2.5% NaCl, stuffed into plastic casings, cooked at 90°C for 30 min and gels thus formed were evaluated for the gelling performance of the blends. Blend C where minces from red jewfish, sea catfish, horse mackerel, jeweled shad and skipjack tuna were blended at a rate of 30, 20, 20, 15 and 15% gave the best quality gel. In the following experiments for the preparation of fish ball, blend C was used.

Preparation of fish ball

Fresh unwashed mince blend C was used for the preparation of fish ball. Various ingredients were incorporated into mixed mince to prepare a good quality fish ball. For these purpose various local spice like onion, garlic, ginger, cinnamon, clove, red piper, black piper were dried in hot air oven at 60°C for 24 hr. The dried spices were ground with a mechanical grinder to make powder and sieved by a fine meshed metallic sieve (Nowsad *et al.*, 2007). The mince blend C was ground with 2.0% NaCl, 1.6% sugar, 1.0% spices (ginger, garlic, onion and chilly powder), 0.1% MSG, 10% starch soluble and 2% vegetable oil. Grinding was done for a total period of 16 min. At first, minces were pounded with salt for 5 minutes, then sugar, spices and starches were added and ground for 4 minutes. Finally, ground again for another 7 minutes after incorporating vegetable oil. The ground paste was shaped into ball and dip-fried in oil. Prepared fish ball was kept at room temperature for 2 hours before any quality analysis. Performance of fish ball was determined under different cooking like, two-step heating (incubation at 35-55°C for 60 min. and then heating at 90-100°C for 30 min); boiling (20-60 min); broiling/steaming (20-40 min); and autoclave cooking (110-125°C at 15 Ibs.inch^{-2} for 10 to 20 min.).

Fig. 1. Fish ball prepared from mince blend C

Quality tests of fish ball

Fish ball prepared from the mince blend C of Low-cost marine fish (Fig.1) was subjected to instrumental gel quality analysis through the puncture test. Puncture test was carried out by a food rheometer (Nowsad *et al.*, 2000a) on the test sample (2.0 cm height) at a table speed of 10 cm per min. with a spherical plunger (6 cm diameter). The breaking force (BF) in g was calculated from the chart of a potentiometric recorder.

A panel of nine-person of students, teachers and staff of the Department of Fisheries Technology provided the sensory assessments of the products (Nowsad *et al.* 2000a). Prior to testing, panelists were familiarized with the properties of meat gel and the instructions relating to the scoring of the sample. Pretests were done with selected samples to familiarize the panelists with the measurement procedure. Three discs of gel (0.5 cm thick) were supplied to each panelist to recognize every attribute. Softness/firmness (S/F) was defined as the amount of force required to bite through the sample with incisors and chewness/rubbriness (C/R) was defiend as the amount of effort the panelist had to exert in chewing to prepare the sample for swallowing. The quality was evaluated by the numerical scores up to 10, where for S/F, 1 = very soft; 10 = extremely firm and for C/R, 1 = not chewy/rubbery; 10 = extremely chewy/rubbery.

A folding test was carried out by folding a 2mm thick sample disc of fish ball into halves and quarters as per the method developed by Nowsad *et al.* (2000a). The scale was A^{++} = no crack when folded into quarters, A^{+} = no crack when folded into half but crack when folded in quarter, A = crack when folded into half, B^{+} = broke and split into halves.

Cooking loss (CL) values of the cooked fish ball was measured by the method developed by Nowsad *et al. (*2000a).

Biochemical test

The mince blend and fish ball homogenate were prepared by blending 10g of mince or fish ball with 40 ml of chilled water each. The pH values were measured by using a pH meter. Average of the readings from three different measurements for each of the samples was taken and is reported in Table 1.

For proximate composition, samples in triplicate from each of unwashed and washed minces and cooked fish ball were analyzed on wet weight basis according to standard procedure of the Association of Official Analytical Chemists (AOAC, 1990) Table 1.

RESULTS AND DISCUSSION

Low-cost marine fishes used in this study had moderate moisture content (Table 1). Protein content showed a moderate level in sea catfish and red jewfish, while jeweled shad, horse mackerel and skipjack tuna showed higher lipid content. An inverse relationship was found between the protein and lipid contents. Size variation and seasonal differences of the fish taken might be cause for such variation. Many authors found lipid content as absolutely depended on season and bigger size fish contained more lipid (Bertak *et al.*, 1995; Reppond *et al.*, 1995; Shimizu *et al.*, 1981). Compositions of mince blends as analyzed might be influenced by individual proximate composition of fish (Table 1). The results supported the findings of Nowsad *et al.* (2000a) who observed a significant loss of lipid in washed mince. pH was always >6.0 in both minces. Washing of the mince blend improved the pH but reduced the protein content due to high moisture reduction.

Table 1. Proximate composition (wet/wt) and pH of mince blend[1] No. C

Source	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	pH
Mince blend					
UM	76.12 ± 2.03	17.50 ± 0.88	5.21 ± 0.48	1.48 ± 0.05	6.3 ± 0.10
WM	82.22 ± 1.67	17.17 ± 2.21	0.91 ± 0.04	0.37 ± 0.01	6.7 ± 0.08

[1]Results are the mean ± S. E. of 3 individual measurements. UM = unwashed mince; WM = washed mince

To draw a maximum possible benefit for any product, total utilization of the resource is very important. Studies showed that about 40-50% of the unwashed mince could be obtained from the whole fish, depending on the type of species, after reducing the loss due to dressing, heading and mincing (Table 2). It was found that in commercial practice, separated head could be sold in the market for consumption. The frame provided a 3-5% more mince to the total mince. The remaining bone of the frame could be used in animal feed. Washing process eliminated gel-interfering substances those interfered with the polymerization of protein, sarcoplasmic proteins, enzymes, lipid, blood, minerals and other organic and nitrogenous compounds from the mince, thus improved the textural quality by concentrating myofibrillar protein (Lee, 1984; Russel and Cheftel, 1988). Similar results have been reported by many authors working with other fish species (Nowsad *et al.*, 2000a; Babbitt *et al.*, 1985; Webb *et al.*, 1985). As in Table 2, percent solid content decreased in washed mince than the unwashed mince, which caused a substantial loss of total protein in the mince. Though the total protein and percent solid were decreased but the total mince weight was increased in washed mince due to high degree of water retention by the protein. Use of unwashed mince in fish ball could be able to minimize such huge unwanted loss of valuable nutrients. This would also substantially reduce the cost of production by increasing the weight of final products, while materials loss would be very low. The utilization of unwashed mince in mince based heat processed products will commensurate with the global noble concept of 'total utilization' of the resources.

Individual gel forming ability of the minces in terms of breaking force also varied in great extent due to their compositional differences. Individual gelling performances of six different compositions of mince blend were presented in Fig. 2. It was observed that blend C showed maximum gelling performance, where higher proportion of minces came from red jewfish, sea catfish and horse mackerel that gave the best gel. Individually red jewfish and sea catfish had higher gelling ability. The results reflected well with the better individual gelling performance of jewfish mince as also confirmed by other authors (Holmes *et al.,* 1992).

Table 2. Benefit of total utilization of fish in terms of mince recovery (g)

Fish	Unwashed mince						Washed mince	
	Whole	Dressed[1]	Head	Frame	Mince	% solid	mince	% solid
Sea catfish	2300	1786 (82%)	660 (28%)	208 (9%)	918 (40%)	18.1	1135 (49%)	10.5
Bombay Duck	230	182 (79%)	45 (20%)	27 (12%)	110 (48%)	15.2	142 (62%)	8.2
Skipjack Tuna	2250	1800 (80%)	484 (21.5%)	211 (9.4%)	1125 (50%)	19.6	1260 (56%)	12.2

[1] Dressed, eviscerated and skinned; Figures in parenthesis show percent yield

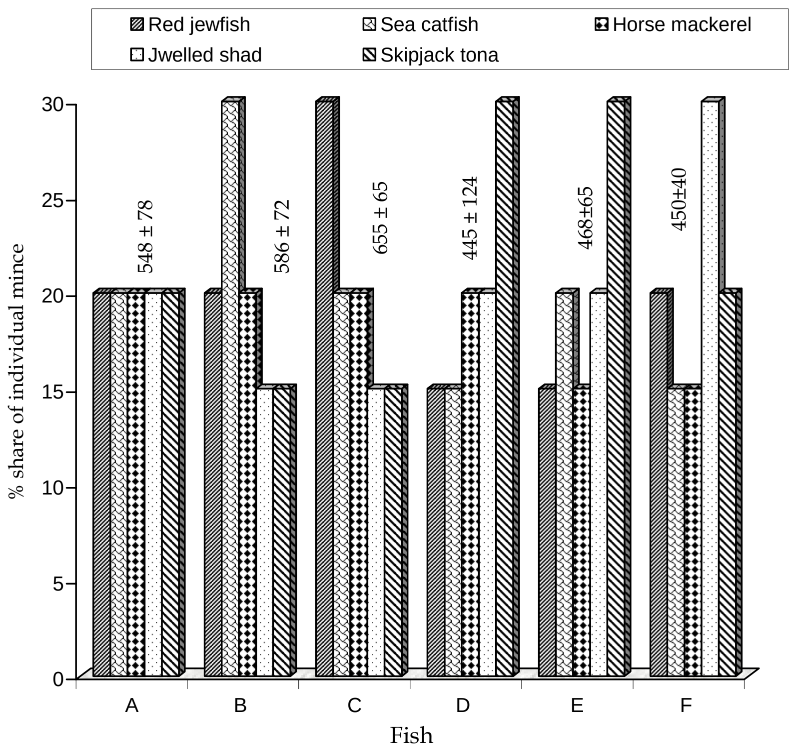

Fig. 2. Ratio of mince blends. Gel strength were given at the top of each blend composition

Gel strength of the mince blend C was compared with the gelling performance of the individual minces. The results have been presented in the Tables 3 and 4. This experiment was conducted to find out the optimum heating schedule for attaining maximum textural quality of the product using which good quality fish ball would be prepared. The unwashed and washed mince blend C were shaped into ball and incubated at different temperature regime from 35° to 55°C and then cooked at 90°, 95° or 100°C. Most of the individual unwashed (Table 3) and washed (Table 4) minces showed optimum gelling ability at 50°C for 1 hour incubation and further cooking the incubated gel at 100°C optimally increased the gelling ability, as generally seen in the two-step heated gel (Niwa, 1992). The gelling performance of the mince blends were significantly low in all heating regimes compared to the individual fish minces. But the gel strength of the blend C was still strong enough to be formulated into heat processed fish ball if compared to the mince of other meat sources like poultry or spent hen (Nowsad *et al.*, 2000a). Like wise the individual minces, unwashed and washed mince blends also showed optimum gelling ability at 50°C for 1 hr incubation and 100°C or 90°C cooking for 30 minutes, respectively. Therefore, during subsequent preparation of fish ball from the unwashed mince blend C, this optimized heating schedule (50°C for 1hr. 100°C for 30 minutes) was applied.

Table 3. Breaking force (BF) in g of different unwashed minces and unwashed mince blend under various heating regimes

Fish	Incubation temperature (°C)*1					Cooking temp (°C)*2		
	35	40	45	50	55	90	95	100
Red jewfish	440	500	560	620	580	650	740	700
Sea catfish	380	380	400	570	550	600	600	670
Horse mackerel	320	300	470	500	490	570	580	625
Jeweled shad	180	200	210	370	360	400	410	450
Skipjack tuna	170	180	200	325	300	560	550	480
Mince blend	210	300	375	410	400	500	540	560

*1 The gels were incubated at above mentioned temperatures for 1 hr.; *2 Incubated gels were further cooked at above mentioned temperature for 30 min

Table 4. Breaking force (BF) in g of different washed minces and washed mince blend under various heating regimes

Fish	Incubation temperature (°C)*1					Cooking (°C)*2	
	35	40	45	50	55	90	100
Red jewfish	400	700	660	600	544	820	800
Sea catfish	410	650	600	600	455	711	765
Horse mackerel	310	300	450	515	421	680	642
Jeweled shad	250	300	325	455	412	600	590
Skipjack tuna	200	200	318	423	324	670	655
Mince blend	300	420	500	524	494	670	600

*1 The gels were incubated at above mentioned temperatures for 1 hr.; *2 Incubated gels were further cooked at above mentioned temperature for 30 min

The quality attribute of fish ball prepared under different cooking processes like, two-step heating (incubation at 45°, 50° and 55°C for 60 min. and then cooking at 100°C for 30 min); boiling (20, 30 and 60 min); broiling (20, 30 and 40 min); and autoclave cooking (110-125°C at 15 Ibs.inch^{-2} for 10 to 20 min) were shown Table 5. For autoclave cooking of the fish ball a laboratory autoclave (Autoclave, YX280A, Sunshen Medical Instrument Co. Ltd., Shanghi China) was used. Textural quality was measured in terms of sensory methods. The quality of the fish ball was analyzed through sensory softness/hardness (S/H) and chewiness/rubberiness (C/R) values and FT and CL values. Two-step cooking obtained better texture and mouth feel and reduced cook loss of fish ball compared to other cooking process. Direct boiling, steaming or autoclave cooking could not add any benefit to the texture development of fish ball. Boiling, broiling or autoclave cooking reduced the textural FT values and increased the CL values. In two step cooking, fish ball heated at 50°C for 60 minutes when cooked at 100°C for a further 30 minute obtained a very high textured and good mouth feel fish ball (Table 5).

Table 5. Quality attributes of fish ball prepared by different cooking regime

Attributes	2-step heating*1 (°C)			Boiling (min)			Broiling (min)			Autoclaving (°C)			
	45	50	55	20	30	60	20	30	40	110	115	120	125
S/H	6.9	8.5	8.0	5.2	7.3	7.2	6.1	7.3	7.0	7.0	6.9	7.2	7.3
FT (Scale)	A+	A++	A++	B+	A	A	B	A	A	A	A+	A	A
CL (%)	14.0	12.5	12.5	15.8	14.1	13.8	16.1	14.4	14.5	14.6	12.0	13.0	12.2
C/R	5.9	8.2	7.4	5.3	6.6	5.0	4.2	6.8	6.2	6.0	6.5	7.1	7.2

*1After incubating shaped into ball were cooked at 100°C for 30 min

Low textural quality of fish ball prepared from unwashed mince blend C in terms of GFA, folding test (FT) and cook loss (CL) was improved further by incorporating different gel enhancing ingredients, like soybean protein isolate, potato starch, local starch based vegetables and grains and spices. The optimum indices for the preparation of fish ball from the mince blend C have been presented in Table 6. As stated before the two-step heating produced better fish ball compared to other cooking (boiling, broiling, autoclaving). Washing of mince affected texture and flavor of ball but sensory quality was unaffected. Starch sources affected ($p<0.05$) instrumental attributes but sensory attributes were unaffected ($p>0.05$). Potato starch and mashed potato at 10% and boiled rice at 10% gave the best quality ball as will be presented in another report, which is now under preparation.

The present study, thus revealed the possibility of using unwashed mince in fish ball manufacture. Use of unwashed mince saved a 40-50% of the total solid of the whole mince in the form of sarcoplasmic protein and minerals along with valuable lipids those are enriched with n-3 fatty acids. Further investigation is required to assess the frozen storage quality and microbiological properties of new fish ball.

Table 6. Optimum indices for fish ball

Cooking type	H/Schedule (^oC/hour)	Texture (FT)*	Cook loss (%)	Ingredient combination (%)
Heating	50/0.5,100/0.5	A++	12.6	Potato starch (10%), vegetable oil (2%), MSG (0.1%), local spice (1.0%) (pepper, onion garlic, ginger), sugar (1.6%).
Boiling	100/0.5	A	13.8	
Broiling	100/0.6	A	14.5	
Steaming	115/0.4	A	12.0	

* FT- Folding test score

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REFERENCES

AOAC. 1990. "Official Methods of Analysis." 15th edn. Association of Official Analytical Chemists, Washington, DC.

Babbitt, J., Reppond, K., Andrew, H., Thoms, Z. and Swafford, T. C. 1985. Effect of washing on the composition and functional stability of minced pollack flesh. In, Proc. of the International Symposium on Enginered Seafood Including Surimi. Martine, R. E. (ed.) National Fisheries Institute, Washington, DC.

Bertak, J. A. and Karahadian, C. 1995. Surimi-based imitation crab characteristics affected by heating method and end point temperature. *J. Food Sci.*, 60 : 292-296.

Holmes, K. L., Satoshi, F. N. and Grant, A. M. 1992. The Alaska pollack resource and other species used for surimi. In, Surimi Technology. Lanier, T. C. and Lee, C. M. (ed.) Marcel Dekker Inc. New York. 528 p.

Lee, C. M. 1984. Surimi process technology. *Food Technol.*, 38 (11) : 69-80.

Niwa, E. 1992. Chemistry of surimi gelation. In, Surimi Technology. Lanier, T. C. and Lee, C. M. (edn.). Marcel Dekker Inc. New York. 528 p.

Nowsad, A. A., Hoque, M. E. and Sarker, F. C. 2000a. First report of the formulation and development of fish ball from underutilized marine fish in Bangladesh: fish ball from sea catfish and Bombay duck. *Bang. J. Fish.*, 23(1) : 75-79.

Nowsad, A. A., Kanoh, S. and Niwa, E. 2000b. Thermal gelation characteristics of breast and thigh muscles of spent hen and broiler and their surimi. *Meat Sci.*, 54 : (2000) 169-75.

Nowsad, A. A , Hoque, M. S. and Hossain, M. I. 2007. Improved method for the preparation of fish sausage from the unwashed mixed minces of low cost marine fish. *Prog. Agricult.* MS.

Reppond, K. D., Babbitt, J. K., Berntesen, S. and Tsuruta, M. 1995. Gel properties of surimi from Pacific herring. *J. Food Sci.*, 60(4) : 707-710.

Roussel, H. and Cheftel, J. C. 1988. Characteristics of surimi and kamaboko from sardine. *Int. J. Food Sci. Technol.*, 23 : 607-623.

Shimizu, Y., Machida, R. and Takenami, S. 1981. Spcecies variation in the gel forming characteristics of fish meat paste. *Bull. Japan Soc. Sci.*, 47(1) : 95-104.

Webb, N. B., David, L. and Webb, F. 1985. Functionality of surimi in processed meat systems. In, Proc. of the International Symposium on Engineered Seafood Including Surimi. Martin, R. E. (ed.). National Fisheries Institute, Washington, DC.