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

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ABSTRACT

Fish sausage was prepared from the unwashed minces of 5 low-cost marine fishes (LMF) viz., red jewfish (*Johnius orgentatus*), sea cat fish (*Tachysurus thalassinus*), jwelled shad (*Ilisha filigera*) horse mackeral (*Megalaspis cordyla*) and skipjack tuna (*Sarda orientialis*) of the Bay of Bengal. Six different blend compositions from 5 individual minces of LMF were prepared by blending 15 to 30% of the individuals minces. Sausage 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 gel strength, cook loss, sensory softness/firmness (S/F) and chewiness/rubburiness (C/R). Proximate composition and gel forming ability of individual mince blend varied with compositional differences of individuals species. Among the six blends tested, blend C showed highest gel strength which constituted with higher proportion of mince from red jewfish, sea cat fish and horse mackerel. 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 temperatures from 35° to 55°C and then cooked at 90° or 100°C. Among different heating regimes, unwashed mince blend C showed the highest gel strength at 50°C for 1 hr incubation. Further cooking of the incubated gel at 100°C optimally increased the gelling ability. Among the four cooking methods tested, (boiling, two-step heating, broiling and autoclaving) autoclave cooking at 115°C obtained best textured sausage with significantly increased breaking force, folding test score and chewiness/rubberiness values and decreased cook loss values. Sausages prepared at 115° and 120°C, however, showed almost identical textural quality. Texture and flavor of sausage was affected by washing of the mince but the sensory qualities were unaffected.

Key Words : Low-cost marine fish, Unwashed mince, Mince blend, Fish sausage, High temperature-high pressure gel

INTRODUCTION

Bangladesh is diverse in marine fish species but lacking of mono-species fishery in large quantity to be used as raw material for a particular product (Nowsad *et al*., 2004). Individual catch size of small meso-pelagic/pelagic species like small sea catfish, jewfish, skipjack tuna, jwelled shad, horse mackerel etc. is too small to run a sustainable product line, but their mixed lot can make a significant volume to produce any value added product. Blending of different fish minces often produce low quality products because of interactions of proteins, lipids and enzymes of different origin and nature. Therefore, a mechanism should be developed first to improve the gel quality of such blended mince before going to manufacturing any value added product from it.

Fast foods are being popularized and the business is expanding in the country very fast (Nowsad, 2006). Fish sausage is a major item of new generation fast food, because of overwhelming young generation craze for its superb taste, fabricated texture, brilliant colour and high nutritional quality. As a convenient food, it is becoming increasingly popular to the working people too. Fish sausage prepared from the mixed mince of underutilized fishes would be able to serve a good taste and nutrition to such people in cheaper price. Good quality fish sausages would have good sensory taste that can be obtained by mixing with various spices ingredients.

Value-added products are generally prepared from the washed mince or surimi to achieve high elasticity in the product. Washing of mince eliminates gel interfering elements like sarcoplasmic proteins, lipids, bloods, enzymes and minerals (Lee, 1884; Rappond *et al*., 1995; Roussel and Chfhtel, 1988). During this washing process more than 50% of the mince are lost which are valuable proteins and lipids, very useful for the consumer (Nowsad, 2006). Removal of such valuable nutrients for the improvement of gel elasticity is considered to be a wastage of resource in a poor country like Bangladesh. Therefore, in this study, efforts will be made to utilize unwashed mince in fish sausage production, in stead of washed mince or surimi.

Considering the above facts, it is felt necessary to formulate and develop fish sausage from the unwashed mixed minces of low-cost marine fishes by using local ingredients and spices. This is the first investigation elsewhere on the manufacture of fish sausage from the unwashed mixed minces of LMF.

MATERIALS AND METHODS

Species of fish

Five low-cost underutilized marine fish species (LMF) like small red jewfish (*Johnius orgentatus*), small sea catfish (*Tachysurus thalassinus*), horse mackerel (*Megalaspis cordyla*), jeweled shad (*Ilisha filigera*) and skipjack tuna (*Sarda orientialis*) were selected for this study. These marine fish species have limited use in commercial production, low price on the fresh fish market and are abundantly available in Bangladesh marine water.

Collection of raw materials

Iced fishes were purchased from the Kawran Bazar wholesale fish market in Dhaka. Immediately after purchase the fish were re-iced with new crushed ice in an insulated ice box. The average weight of red jewfish (*Johnius orgentatus*), sea catfish (*Tachysurus thalassinus*), horse mackeral (*Megalaspis cordyla*), jwelled shad (*Ilisha filigera*) and skipjack tuna (*Sarda orientialis*) 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 (Fig. 1). After brought to the laboratory the raw materials were frozen stored in a freezer (-20°C).

Preparation of mince blend

The fishes were washed, deheaded and eviscerated. The skinned fishes were filleted and deboned manually in iced condition. Then mince were prepared by a mechanical mincer (National Meat Grinder, MK-G3NS, Matsushita Electric Industrial Co. Ltd., Osaka, 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 in Table 1.

Table 1. Composition of mince blends

Species	Composition (%) mince					
	A	B	C	D	E	F
Red jewfish	20	20	30	15	15	20
Sea catfish	20	30	20	15	20	15
Horse mackerel	20	20	20	20	15	15
Jwelled shad	20	15	15	20	20	30
Skipjack tuna	20	15	15	30	30	20
Total	100	100	100	100	100	100

All the procedure from the mincing of fish to filling of paste in the casing were done at around 5 to 8°C. This was ensured by keeping sufficient ice around fish, flesh and mince. Ice was made available through an ice maker (Lab Tech Ice Macker, Series L cm-200m, R4044A, UK). A portion of the mince blend was washed with chilled 0.1% NaCl to see the washing effect of the mince on the quality of fish sausage.

Selection of mince blend

Six mince blends were separately ground with 2.5% NaCl, stuffed into sausage casings, cooked at 90°C for 30 min and gel thus formed were evaluated for the gelling performance of the blends. Blend number 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 sausage, blend number C was used.

Preparation of fish sausage

Fresh unwashed mince blend C was used for the preparation of fish sausage. Various ingredients were incorporated into mixed mince to improve the textural quality fish sausage. For these purpose various local spice like onion, garlic, ginger, cinnamon, clove, red pepper, black pepper etc. were purchased from the local market. The spices were dried in hot air oven at 60°C for 24 hr. The dried spice were ground with a mechanical grinder to make powder and sieved by a fine mesh metallic sieve. Mince blend C was ground with 2.5% NaCl, 1.6% Sugar, 0.1% monosodium glutamate (MSG), 1.5% various spices, 2% vegetable oil, 10% mashed potato and starch (pure extract). Grinding was done for a total period of 20 min. The ground paste was stuffed into a sausages casing (Krehalon casing, 2.8 cm diameter, 8 cm long with Kureha Chemical Co., Tokyo, Japan) by a manual stuffer, both ends of the casing was sealed with cotton twine after removing any air baubles from the casing. Performance of fish sausage was determined under different cooking process like, two-step heating (incubation at 35° to 55°C for 60 min. and then cooking 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. 2.

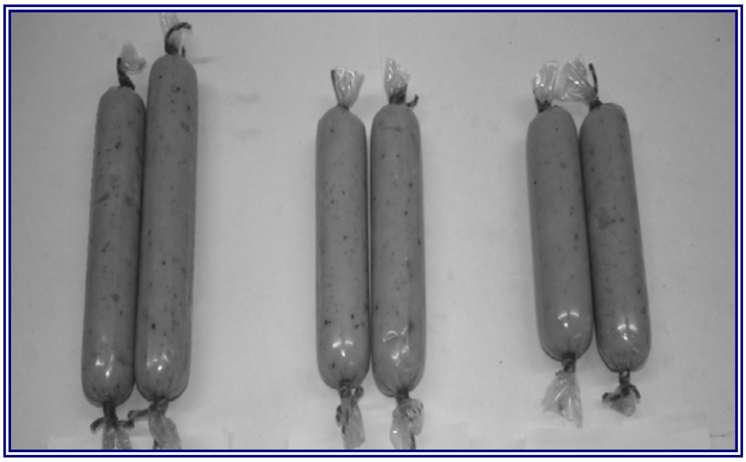

Fig. 1. A nice looking fish sausage prepared from mince blend C

Quality of the fish sausage

Instrumental gel strength

Fish sausage prepared from the mince blend C of LMF 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 strength (BS) in g and the breaking deformation (BD) in cm were calculated from the chart of a potentiometric recorder. Gel strength (GS) denotes the product of breaking strength and breaking deformation, expressed as g × cm.

Sensory test

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 defined 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 (Szczesniak *et al*., 1963).

Folding Test

A folding test was carried out by folding a 2mm thick sample disc 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.

Biochemical test

For pH, the mince blend and fish sausage homogenate were prepared by blending 10g of mince or sausage with 40 ml of chilled water each. The pH values were measured by using a laboratory pH meter. Average of the readings from three different measurements for each of the samples was taken. Three samples from each of unwashed and washed minces and cooked fish sausages were analyzed for proximate composition such as crude protein (Kjeldahl), crude lipid, moisture and ash content. The proximate composition in triplicate from each of unwashed and washed minces and cooked sausage samples were analyzed on wet weight basis according to AOAC (1990).

RESULTS AND DISCUSSION

Although data not shown here, but the analysis of proximate composition showed that the fishes had moderate moisture content. Protein content showed a moderate level in sea catfish, red jewfish and jeweled shad, while jeweled shad, horse mackerel and skipjack tuna showed higher lipid content. There was an inverse relationship found between the protein and lipid contents. It might be due to size variation and seasonal differences of the fish taken. Various authors (Bertak and Karahadian, 1995; Reppond *et al.,* 1995; Shimizu *et al*., 1981) found that lipid content was absolutely depended on season and bigger size fish contained more lipid. Compositions of mince blends as analyzed (Table 2) were significantly influenced by such individual proximate composition of fish shown elsewhere (Nowsad *et al*., 2007). Table 2 shows the proximate composition and pH of unwashed and washed mince blend No. C and sausage prepared from it. When sausage was prepared from such unwashed blend, both protein and lipid content were reduced, while ash content was increased than washed mince blend. The results supported the findings of Nowsad *et al.* (2000a) who observed a significant loss of lipid in cooked sausage. The pH was always above than 6.0 in both minces and cooked products. Washing of the mince blend improved the pH condition but reduced the protein content due to high moisture reduction.

To draw the maximum possible benefit from a resource for any product, total or whole utilization of the resource is obviously important. Various studies showed that about 40-

50% of the unwashed mince could be obtained from the whole fish, depending on the species, after reducing the loss due to dressing, heading and mincing (Table 3). The suitability of frames, bones and heads in the production of fishmeal was tested. In commercial practice head could be sold in the market for human consumption. The frame might again provide a 3-5% more mince to the total mince. The remaining bone of the frame could be used for animal feed production. Washing process eliminates gel-interfering substances those interfere with the polymerization of protein, such as sarcoplasmic proteins, enzymes, lipid, blood, minerals and other organic and nitrogenous compounds from the mince, thus improves the textural quality by concentrating gel strengthening myofibrillar protein (Lee, 1984). Similar results have reported by many authors working with other fish species (Nowsad *et al*., 2000b; Babbitt *et al.,* 1985; Webb *et al.,* 1985). This study showed that percent solid content decreased in washed mince than the unwashed mince, causing a substantial loss of total protein in the mince. Though the total protein and percent solid were decreased, the total mince weight was increased in washed mince due to absorbance of water. Using of unwashed mince 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, where materials loss would be very low. Obviously, this utilization of unwashed mince in heat processed products will enhance the noble initiative of 'total utilization' of the resources.

Table 2. Proximate composition (wet/wt) and pH of mince blend C and fish sausage[1]

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
Cooked[2] Sausage					
UM	77.34±2.22	16.14±1.56	2.67±0.03	3.62±0.05	6.2±0.11
WM	82.89±2.52	14.49±1.13	0.48±0.02	2.44±0.06	6.4±0.12

[1] Results are the mean ± S.E of 3 individual measurements. UM = unwashed mince; WM = washed mince; [2] Mince paste added with ingredients was cooked at 50°C for 60 min. and at 100°C for 30 min.

Table 3. 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

Individual gel forming ability of the minces in terms of gel strength varied in great extent due to their compositional differences. Individual gelling performances of six different composition of mince blend were presented in the Table 4. It was observed that blend number C showed maximum gelling performance, where higher proportion of minces came from red jewfish, sea catfish and horse mackerel that gave the best gel. We found that, 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 4. Ratio of mince blends and their gelling performance

Fish	% share of individual mince in the mince blend					
	A	B	C	D	E	F
Red jewfish	20	20	30	15	15	20
Sea catfish	20	30	20	15	20	15
Horse mackerel	20	20	20	20	15	15
Jeweled shad	20	15	15	20	20	30
Skipjack tuna	20	15	15	30	30	20
Gel strength (g × cm)	548±78	586±72	655±65	445±124	468±65	450±40

*[1] Mince blends were ground with 2.5% NaCl, stuffed into casing, cooked at 90°C for 30 min and the gel thus formed were subjected to puncture test

Gel strength in terms of breaking strength × breaking deformation of the mince blend number C was compared with the gelling performance of the individual minces. The results have been presented in the Fig. 2, 3 and 4. This experiment was conducted to find out the optimum heating schedule for attaining maximum textural quality of the product. The unwashed and washed mince blend C were stuffed into sausage casing and incubated at different temperature regimes from 35° to 55°C and then cooked at 90°, 95° and 100°C. Most of the individual unwashed (Fig. 2) and washed (Figs. 4 and 5) 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 gel strength 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 products if compared to the mince of other meat sources like poultry or spent hen (Nowsad *et al.* 2000b). 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 sausages from the unwashed mince blend No. C, this optimized heating schedule (50°C for 1hr.; 100°C for 30 minutes) was applied.

The quality attribute of sausage 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/steaming (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. In case of two-step heating all the incubation temperatures showed more or less similar gel quality in both instrumental and sensory analysis. Cooking the product at 100°C for 30 minutes after incubation at 50°C for 1 hour although gave higher breaking force (BF) but the folding test (FT) and the sensory chewniness/rubberiness (C/R) values were identical in all cases. Cooking loss (CL) was decreased with the increment of incubation temperature. CL values were substantially decreased in direct boiling. Sausages prepared with steaming had lower BF, CR and FT values with corresponding higher values of CL. A good textured sausage was prepared by cooking the stuffed casing in the autoclave at higher temperatures. Among the four higher temperatures tested, autoclaved cooking at 115°C for 15 min. obtained best textured sausage with significantly increased BF, FT and C/R values and decreased CL values. Sausages prepared at 115° and 120°C, however, showed almost identical textural quality. Various authors (Victor and Chandasekhar, 1986) observed the substantial increment of textural quality in pressure induced high temperature cooked gels.

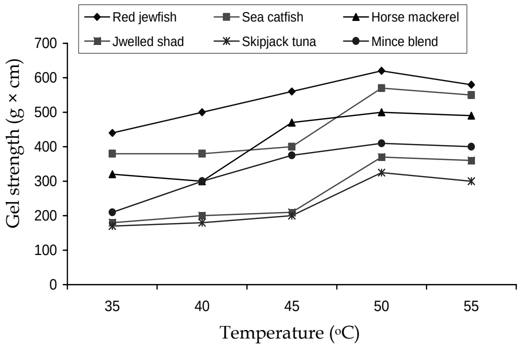

Fig. 2. Gel strength of different unwashed minces and unwashed minces blend during incubation for 1 hr.

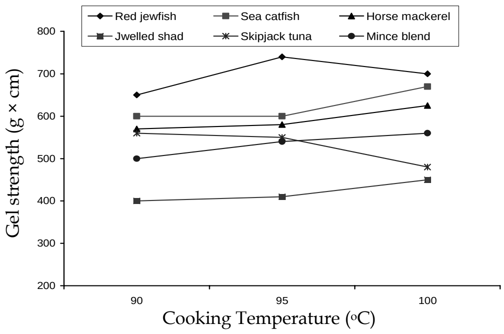

Fig. 3. Gel strength of different unwashed minces and unwashed minces blend at cooking for 30 min. after incubation

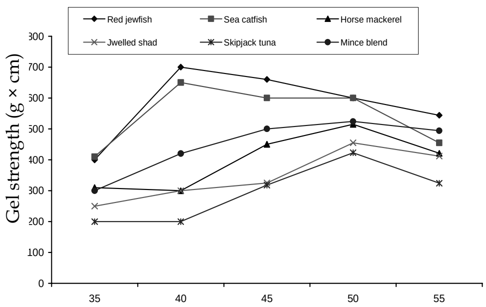

Fig. 4. Gel strength of different washed minces and

washed mince blend during incubation for 1 hr.

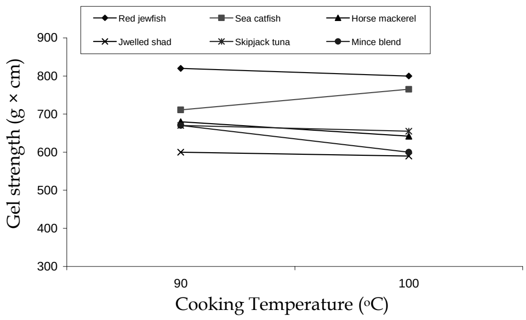

Fig. 5. Gel strength (BF in g) of different washed minces and washed mince blend at two step heating

Table 5. Quality attributes of sausage 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
BF (g)	510	550	490	455	524	500	322	428	400	620	645	684	620
FT (Scale)	A+	A+	A+	A	A+	A+	B++	A	A	A	A++	A++	A++
CL (%)	16.2	15.8	15.5	13.5	13.3	13.9	16.1	15.8	16.0	12.0	11.9	11.3	11.5
C/R	7.1	7.2	6.9	6.2	7.5	7.0	5.8	7.1	6.2	7.9	7.8	8.2	8.5

*1After incubating stuffed sausage were cooked at 100°C for 30 min

Low textural quality of unwashed mince blend No. C in terms of GFA, folding test (FT) and cook loss (CL) was improved by incorporating different gel enhancing ingredients, like soybean protein isolate, potato starch, local starch based vegetables and grains and spices. The present study showed that the 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. Therefore, unwashed mince blends of low-cost marine fish could be used in the value-added product formulation. Further research is, however, needed to assess the keeping quality in terms of chemical and microbilogical properties of new sausage.

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