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Characterization of Fish Glue from Croaker Wastes

N. K. Chandravanshi, S. Chowdhury, S. Nath

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Abstract Croaker fish (*Johnius belangerii*), one of the important landed species in West Bengal, contains 75% post-filleting waste of the weight of the total catch. About 2–5% of the processing waste of croaker consists of skin and swim bladder with high collagen content is excellent raw material for the preparations of natural and organic adhesive fish glue with attractive color, appealing flavor, aesthetic appearance and longer storage life due to lowered pH. Fish glue is known as value added product from fish processing by products as the adhesive agent. Thus, the objective of the study was to determine the volume of the wastes generated from croaker and to assess the suitability of different wastes parts (skin and swim bladder) for manufacturing fish glue in India. Moisture content of glue from fish skin and swim bladder were found to be 36.73±0.34% and 36.24 ± 0.90% respectively implies that, there is a significant ($p < 0.01$) positive correlation between raw material moisture and glue pH (0.926). The protein content of glue from croaker skin and swim bladder were found to be 55.32 ± 0.86% and 51.19 ± 0.51% implies that, there is a significant ($p < 0.01$) positive correlation between raw material protein and raw material ash (0.943). Lipid content was less in skin and swim bladder glue samples (1.70 ± 0.021% and 3.52 ± 0.05% respectively), which may be due to the soaking bath treatment of raw materials in 0.2% NaOH which helped the fiber bundle to open and subsequently removed the connective lipid. The glue yield from coraker skin was higher (25.742%) than to that of swim bladder (19%). So, in near future, there is a great potential for development croaker fish glue, the by product of fish skin and swim bladder, which will certainly put this fish species into suitable and profitable use, increasing the income of the farmers, creating employment opportunities and strengthen rural economy.

Keywords Croaker waste, Fish glue, Fish skin glue, Swim bladder glue.

Introduction

India is belonging as one of the top fish producing countries in the world. The flourishing fisheries contribute one of the lion shares in Indian agriculture with its varied resources and potentials having great economic importance (Sajesh and Suresh 2016). Globally, capture fishery is based on the catching or trapping of fish from marine, brackish or freshwater resources among which about one-third of the catch is used for production of fishery by-products (Shumaker 2012). The post-filleting waste from fish processing can account for as much as 75% of the weight of the total catch (Shahidi 1994). About 2–5% of such waste consists of skin and swim bladder with high collagen content which is excellent raw material for the preparations of glue.

One of the important species in India, croaker (*Johnius belangerii*), whose production in the fiscal

N. K. Chandravanshi*, S. Chowdhury
Department of Fish Processing Technology, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Kolkata, India

S. Nath
Department of Fish Processing Technology, College of Fisheries Science, Birsa Agricultural University, Ranchi, India
e-mail: chandravanshinilesh2@gmail.com
*Corresponding author

Table 1. Proximate composition of raw material and fish glue. SB–Swim bladder. Values represented as mean ±SD of triplicate determination. Values in the same rows with different superscript numbers differed significantly ($p < 0.05$). Values represented as mean ±SD of triplicate determination. Values in the same columns with different superscript alphabets differed significantly ($p < 0.05$).

		Raw material	Glue	Average % change
Protein	Skin	22.36 ± 0.47^{b1}	55.32 ± 0.86^{b2}	$147.59\% \pm 9.14^{a}$
	SB	17.54 ± 0.11^{a1}	51.19 ± 0.51^{a2}	$191.94\% \pm 4.52^{b}$
Lipid	Skin	8.10 ± 0.16^{a2}	1.70 ± 0.021^{a1}	$-78.81\% \pm 0.26^{a}$
	SB	14.04 ± 0.11^{b2}	3.52 ± 0.05^{b1}	$-75.03\% \pm 0.40^{b}$
Moisture	Skin	64.25 ± 0.15^{b2}	36.73 ± 0.34^{a1}	$-42.83\% \pm 0.65^{a}$
	SB	57.18 ± 0.71^{a2}	36.24 ± 0.90^{a1}	$-36.60\% \pm 0.65^{b}$
Ash	Skin	3.35 ± 0.06^{b2}	0.88 ± 0.01^{b1}	$-73.80\% \pm 0.29^{a}$
	SB	2.81 ± 0.06^{a2}	0.75 ± 0.01^{a1}	$-73.33\% \pm 0.87^{b}$
pH	Skin	6.23 ± 0.06^{b2}	4.3 ± 0^{b1}	
	SB	5.8 ± 0^{a2}	3.73 ± 0.06^{a1}	

year of 2013-14 was 3, 47,821 metric tons (CMFRI 2016), is increasing day by day. Fish glue is impure gelatin (collagen) prepared from fish heads, bones and skins. Fish glue is known as value added product from fish processing by-products as the adhesive agent (Akter et al. 2017). It is now possible to make glue from croaker skin and swim bladder as a by-product.

Collagen, the main component of fish glue, is a highly viscous liquid at room temperature. Although, fish glue and gelatin are synonymous, some differences exist between them (Akter et al. 2017). Fish glue is a natural product which is obtained by cooking fish skin, swim bladder and other body parts followed by evaporation (Kremer 2007). Fish glue is usually more expensive than animal glue, since fish glue is liquid and it is easy to use (Brody 1965). Tropical fish such as croaker waste are superior material for glue processing than other fishes (Cheow et al. 2007). Collagen itself is not soluble in water, but it can be broken down in heat in the presence of water and other chemicals to produce a water-soluble product, where the end product is glue. The conversion of collagen to glue involves the breakdown of hydrogen bonds which stabilize the triple-coil helix transforming it into the random coil configuration of glue (Adams 2005). The hydrolyzed products depend upon the crosslink's which remain between the peptide chains and reactive amino carboxyl-terminal groups that have been formed (Li et al. 2012). As a result of heating, physical and chemical changes such as the denaturation of protein, causing the color changes

Table 2. Correlation matrix of proximate compositions of both raw material and their glue. RM–Raw material. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

	Glue protein	RM protein	Glue lipid	RM lipid	Glue moisture	RM moisture	Glue ash	RM ash	Glue pH	RM pH
Glue protein										
RM protein	0.543									
Glue lipid	– 0.714	– 0.829*								
RM lipid	– 0.771	– 0.771	0.771							
Glue moisture	– 0.086	0.257	– 0.543	0.029						
RM moisture	0.771	0.771	– 0.600	– 0.657	– 0.200					
Glue ash	0.754	0.812*	– 0.986**	– 0.812*	0.464	0.638				
RM ash	0.600	0.943**	– 0.771	– 0.829*	0.086	0.829*	0.812*			
Glue PH	0.741	0.926**	– 0.833*	– 0.741	0.154	0.926**	0.845*	0.926**		
RM pH	0.833*	0.833*	– 0.833*	– 0.926**	0.031	0.833*	0.892*	0.926**	0.900*	

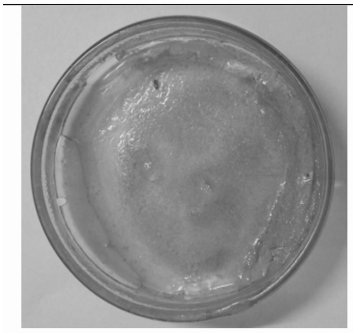

Figure 1

Fig. 1. Shows the color of fish skin glue.

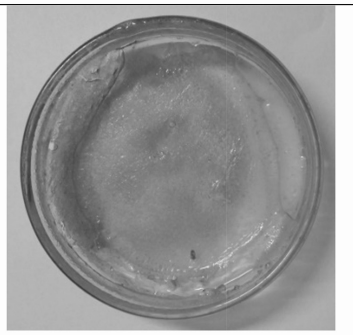

Figure 2

Fig. 2. Shows the color of fish swim bladder glue.

and the shrinkage of the molecule of amino acids take place (Lehninger et al. 1988, Skeist 1977). Thus, the objective of the study was to determine the volume of the wastes generated from croaker and to assess the suitability of different wastes parts (skin and swim bladder) for manufacturing fish glue in India.

Materials and Methods

The present study focusedon glue preparation from croaker fish (*Johnius belangerii*) wastes. Fresh whole fishes were purchased from Diamond harbour fish market in Kolkata, West Bengal and preserved at –20ºC until use. After thawing at room temperature, assessment of body parts was done. Skins and swim bladders were collected by filleting and evisceration respectively. The croaker fish skin and swim bladder were separately washed in clean tap running water for 1–2 h to remove odor and cut into small pieces and chilled at 2–4ºC until used. The cleaned skin and swim bladders were separately immersed in 0.2% NaOH (two volumes of raw materials) 23ºC in soaking bath for 2 h that help to open the fiber bundle and remove the connecting materials. After the alkali treatment, the skin and swim bladder were washed and both samples are separately neutralized with same concentration of HCL (0.1N) for 1 h and again washed with running water. For hot-water extraction, double volume of distilled water was added and both skin and swim bladder were heated at temperature ranges from 53–60ºC for 6 h. The extracted solution was filtered through muslin cloth and the filtered solution was heated to 90ºC for concentrating it to 45–50% solid followed by further preservation and assessment.

Proximate composition of fish skin and skin glue, fish swim bladder and swim bladder glue was analyzed according to AOAC (2012). pH of homogenized sample was estimated by using a calibrated glass electrode pH meter (Metrohm, 713 pH Meter-Herisau Switzerland) by method of AOAC (2005). After preparation of liquid glue it was evaporated in open pan and final glue sample was obtained. Sensory evaluation like color of each glue sample were assessed by putting them on white back ground and compared with each glue sample by referring organoleptic scales based on eye estimation using a scale from 1~5 with 1 being light and 5 being dark and keeping brown in the middle as standard preferred color. Flammability was measured using safe matches. Average mean values with standard deviation of 3 replicates were analyzed by using unpaired student t-test at the significance level of 95% ($p < 0.05$), using Statistical Packaging for Social Science (SPSS) software (version 22.0 ; SPSS Inc, Chicago, Illinois, USA).

Results and Discussion

Assessment of body parts of croaker were performed to know their relative weight age proportion, especially to know waste percentage (both qualitative and quantitative) for making glue. For larger fish sample (637.3 ± 62.5), flesh / muscle confined to 49.8 ± 1.06%, head 23.8 ± 0.26%, skeleton 10.2 ± 0.44%, skin 2.62 ± 0.33%, scales 4.5 ± 0.64%, fins 0.6 ±

0.07% and viscera / intestine 6.76 ± 0.65% including egg, milt and liver of its total body weight. About 70% of whole fish is processed before final selling, resulting in 20–80% of fish waste depending on the level of processing and type of fish (AMEC 2003). Waste percentage varies according to species and size. Higher the fish size, larger the volume of wastes.

The data for proximate composition are given in Table 1. Moisture content of glue from fish skin is found to be 36.73 ± 0.34% (42.83% ± 0.65% reduction from moisture percentage in skin) whereas moisture content of swim bladder glue was found to be 36.24 ± 0.90% (36.60% ± 0.65% reduction from moisture percentage in swim bladder). Likewise, Akter et al. (2017) reported % of moisture in skin glue was 30.35 ± 1.35%. The findings of the present study showed that, there is a significant ($p < 0.01$) positive correlation between raw material moisture and glue pH (0.926) (Table 2), which may be supported by the findings of Akter et al. (2017) acknowledging that there is a positive correlation between moisture and pH of fish glue.

The protein content of glue from croaker skin is found to be 55.32 ± 0.86% (147.59 ± 9.14% increment from protein present in skin), whereas protein content of swim bladder glue found to be 51.19 ± 0.51% (191.94% ± 4.52% increment from protein present in swim bladder) (Table 1). The respective increment of protein content was may be due to simultaneous moisture and lipid reduction during preparation of glue. Manjula et al. (2015) also reported high protein content (60.95 ± 0.047%) of fish skin glue. The significant ($p < 0.01$) positive correlation between raw material protein and raw material ash (0.943) (Table 2) justifies the findings of Dhaneesh et al. (2012) who reported a positive correlation between protein and ash ($r = 0.271$).

Lipid content was higher in croaker skin (8.10 ± 0.16%) and swim bladder (14.04 ±0.11%) than to that of glue 1.70 ±0.021% and 3.52 ±0.05% respectively (Table 1). The reduction in lipid content in glue samples was may be due to the soaking bath treatment of raw materials in 0.2% NaOH which helped the fiber bundle to open and subsequently removed the connective lipid.

The ash content of glue from croaker skin is found to be 0.88 ± 0.01% (73.80% ± 0.29% decrease from ash present in skin), whereas ash content of swim bladder glue found to be 0.75 ± 0.01% (73.33% ± 0.87% decrease from ash present in swim bladder) (Table 1).

Although both the glue samples from croaker skin and swim bladder were non-flammable and showed standard brown color (Fig. 1 and Fig. 2), the glue yield from coraker skin was higher (25.742%) than to that of swim bladder (19%). The pH of fish glue has important role in its stability during storage ; lower the pH longer the storage life of the product (Akter et al. 2017). In the present study, as the croaker skin glue and swim bladder glue had lower pH value (4.3 ± 0 and 3.73 ± 0.06 respectively), they may have longer storage life.

Conclusion

About 2–5% of the processing waste of Croaker, one of the important species in India, consists of skin and swim bladder with high collagen content is excellent raw material for the preparations of natural and organic adhesive fish glue with attractive color, appealing flavor, aesthetic appearance and longer storage life due to lowered pH. So, in near future, there is a great potential for development croaker fish glue, the by-product of fish skin and swim bladder, which will certainly put this fish species into suitable and profitable use, increasing the income of the farmers, creating employment opportunities and strengthen rural economy. Thus, there will be reduction in cost of garbage elimination that usually threats human civilization by causing environmental pollution.

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