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Composition, Textural Quality and Gel Strength of Surimi Prepared from Striped Catfish (*Pangasianodon hypophthalmus,* Souvage, 1878*)*

S. Tanuja[1*], P. Viji[2], A. A. Zynudheen[2], George Ninan[2] and C. G. Joshy[2]

[1] *Directorate of Research on Women in Agriculture, Nandan Kanan Khandagiri Road, Baramunda, Bhubaneswar - 751 003, India*

[2] *Central Institute of Fisheries Technology, P. O. Mastyapuri, Cochin - 682 029, India*

Abstract

Surimi was prepared from the meat of striped catfish *Pangasianodon hypophthalmus* using single wash and double wash method and the composition, gel strength and textural properties were compared. Crude protein and fat content of double wash surimi was significantly low ($p<0.05$). Both single wash and double wash surimi gels exhibited high expressible drip and low water holding capacity with double wash surimi gel showing significantly higher values ($p<0.05$). The gel strength, and textural parameter like hardness, and stiffness were significantly ($p<0.05$) higher for single wash surimi. The additional washing resulted in a significant decrease ($p<0.05$) in total pigment content of the surimi.

Keywords: Myofibrillar proteins, rheological property, total pigment, expressible drip, water holding capacity

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* *E-mail: tanujasomarajan@gmail.com*

Introduction

Surimi is the wet concentrate of the myofibrillar proteins of fish muscle (Okada, 1992). It is defined as a refined fish protein product prepared by washing mechanically deboned fish to remove blood, lipids, enzymes and sarcoplasmic proteins and minced and washed fish flesh that has been stabilized by cryoprotectants (Vilhelmsson, 1997). Surimi is light in color, bland in odor, low in fat and high in myofibrillar protein. It is extremely functional due to the unique gelling properties of the myofibrillar proteins. Hence surimi is an ideal ingredient for making imitation and analogue products (Lanier, 2000). The washing procedure is of great importance for surimi quality, not only for removing fat and undesirable materials, such as blood, pigments and odorous substances but, more importantly, for increasing the concentration of myofibrillar protein, thereby improving gel-forming ability (Lanier & Lee, 1992).

The suitability of freshwater species, particularly major carps for the preparation of mince and surimi have been reported by Sankar & Ramachandran (1998; 2002). Luo et al. (2001) reported that the surimi from freshwater fish species is inferior in gel properties than from marine species. However Nousad et al. (1999) has observed that surimi from tropical freshwater fish species *viz.*, snakehead, wild mullet and Nile tilapia showed good gel setting ability. The surimi from Black tilapia had significantly higher gel strength than that from the Indian major carps (Ninan et al., 2004). Chang et al. (1998) has observed that the gel forming ability of surimi from the freshwater fishes such as carps and rainbow trout was low but suitable for the preparation of kamaboko and comparable with sardine surimi. Although surimi from freshwater fish has moderate gel forming ability, it can be utilised by adapting the parameters of gelation process (Ganesh et al., 2006). Additives such as chitosan was found to improve the textural and sensory properties, prevent lipid oxidation and inhibits microbial growth in freshwater fish surimi (Hajidoun & Jafarpour, 2013; Amiza & Kang, 2013)

Presently catfish farming is gaining importance among Indian farmers as an alternative to carps in different parts of the country; accordingly its contribution to overall fish production is on the rise. *Pangasianodon hypophthalmus* popularly referred to as Pangasius or striped catfish is a prime species farmed in Vietnam and other Southeast Asian countries. It was first introduced to India in West Bengal in 1995. In 2000, the species was introduced into Andhra Pradesh. Because of its remarkable growth rate (almost one kg in 90 days), there has been much enthusiasm among fish breeders and farmers particularly in West Bengal and Andhra Pradesh for its culture and propagation. But recently, the farmers especially those of Andhra Pradesh (India) have faced a setback because of the low price realised for the fish in the market. One of the reasons attributed for the low price is the yellow colour of the meat. The removal of sarcoplasmic proteins, lipids, blood and other water soluble compounds during surimi preparation may improve the quality of the meat. The aim of the present study was to investigate the effect of number of washing cycles on the composition and quality of surimi prepared from *P. hypophthalmus*.

Materials and Methods

Mince was made from fillets of fresh *P. hypophthalmus* procured from a farm near Cochin, Kerala. The fish was killed immediately by keeping in ice water slurry and packed in flake ice with a fish: ice ratio 1:1 in insulated boxes and brought to the laboratory within two hours. For the preparation of surimi, the fish was filleted manually in post rigor stage and the fillets were minced using a mincer (Model Adlux, DMG 3460). The mince was divided into two portions for washing. The washing schedule consisted of single and double exchanges of water at 5°C for five min duration with constant stirring. Mince: water ratio was 1:2 (w/v). 0.2% w/w of sodium bicarbonate was added to the water to remove excess fat. The mince was drained. In case of double wash cycle, the mince was drained after the first wash and the drained mince was re-suspended in water for the second wash after which it was drained. The final removal of water from the drained single washed and double washed mince was carried out by stuffing the washed mince in fine meshed nylon cloth cover tied at both ends and then pressing it using a manual screw press until the mince began to force out through the fine mesh. Sucrose (4%), sorbitol (4%) and sodium tripolyphosphate (0.2%) were mixed with the washed and pressed surimi as cryoprotectants using a pre-cooled mixer grinder. The samples were packed in polythene bags, blast frozen in a blast freezer (Model T10, Castelmac SpA, Italy) and stored in deep freezer (Siemens, Germany) at -20°C until analyses.

Moisture, crude fat, crude protein and ash content was estimated using AOAC (2000) procedures. Washed mince was ground with 2% NaCl for 3 min in a precooled mixer grinder. Temperature was kept below 10°C during grinding. It was then stuffed manually in polypropylene casings of 32 mm Ø 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 (Julabo TW 20, JULABO Labortechnik GmbH, Germany) for 30 min. Gels thus formed were immediately cooled in ice and then kept at 5°C in refrigerator overnight before analysis.

The gel strength and texture profile analysis of the heat induced gels were determined using a Food Texture Analyser (Model LRX plus, Lloyds, U. K). Samples of 25 × 32 mm Ø were used for the analyses. The gel strength was determined by single hardness setup mode using a ball probe of 5 mm Ø and calculated as the peak force in g, multiplied by the distance to the rupture event measured in cm (Yamzawa 1990). For Texture Profile Analysis, a cylindrical probe of 10 cm Ø was used with a speed adjusted to 12 mm min^{-1} (Bourne, 1978).

Expressible moisture from surimi gels was determined according to the method of Ng (1987). Cylindrical gel samples were cut into a thickness of 5 mm, weighed and placed between 2 pieces of Whatman paper no 1 at the bottom and one piece on top of the sample. A standard weight (5 kg) was placed at the top and held for 2 min. Sample was removed from the paper and weighed again.

For determination of water holding capacity, gel was cut into 2 mm cubes and 2 g sample were centrifuged at 1000 g for 15 min. Exudate was collected on Whatman filter paper (Roussel & Cheftel, 1990). The total pigment content in the surimi and mince was determined according to the method of Lee et al. (1999). Washed mince (1 g) was mixed with 9 ml of acid acetone (90% acetone, 8% deionised water and 2% HCl). The mixture was stirred and allowed to stand for one hour at room temperature. It was filtered and the absorbance of the filtrate was measured at 640 nm in a Spectrophotometer (Model Spectronic, Genysis 5). Colour analysis was performed with a Hunter lab Miniscan ® XE plus spectro colorimeter (Hunter Associates Laboratory, Inc. Reston, Virginia, USA). Measurements were recorded using the L* a* b* colour scale [CIE, 1986].

The data were analyzed using parametric t-test to find the effect of treatments (*viz.*, SWS- Single wash surimi, DWS-Double wash surimi) on chemical composition, gel strength and textural characteristics of surimi prepared from striped cat fish meat. One way analysis of variance was performed to find the effect of treatments on colour parameters of surimi prepared from striped cat fish meat. All the statistical analysis was carried out using SAS 9.2.

Results and Discussion

Proximate composition of SWS and DWS is given in Table 1. The chemical compositions play an important role in surimi quality wherein the protein concentration greatly affects the gel properties of surimi (Luo et al., 2001). The fat content and protein content in DWS is significantly low ($p<0.05$) when compared to that of SWS (Table 1). Reduction of crude fat content in surimi is essential as lipids in surimi products may bring about an adverse effect on the surimi quality, by its oxidation and subsequent interaction with proteins, causing denaturation, polymerization and changes in functional properties (Smith, 1987). The decrease in protein content may be because of the removal of water soluble proteins during the additional washing. The crude fat content in DWS is comparable to that obtained in Alaska Pollack surimi (Jin et al., 2007). The moisture content in both SWS and DWS is higher than the standard water content of 78% (Uddin et al., 2006). The water content is also a critical factor which affects the quality of surimi products. The higher moisture content in both SWS and DWS may be due to the insufficient water removal by manual pressing.

The gels exhibited high expressible drip and low water holding capacity. There was significant difference ($p<0.05$) in the water holding capacity and expressible moisture of the SWS and DWS (Fig. 1). The water-holding ability of a gel is directly related to the gel-network formation: the firmer the gel, the lower the expressible moisture. But the values are high when compared to the results obtained with catfish surimi as reported by Kim et al. (1996). Insufficient removal of water by manual pressing can be attributed as the reason. The high expressible drip values can be also due to the direct heating of gels. On direct heating rapid unfolding of proteins results in more intense coagulation. More water is released from the gel, and the protein dispersion becomes very uneven (Niwa, 1992). Chaijan et al. (2010) have reported that kamaboko gels showed less expressible drip when compared to direct heated gels in mackerel surimi.

The gel strength of DWS is significantly ($p<0.05$) lower than SWS (Table 2). The textural parameters *viz.*, hardness, and stiffness are significantly ($p<0.05$) higher for SWS than DWS whereas better springiness was observed for DWS (Table 2). Hardness is directly related to the gel strength of the surimi. Cohesiveness was low for SWS and DWS indicating rupture of the sample gels. The water-soluble protein (sarcoplasmic protein) retards gel network formation by interfering with the actomyosin crosslinking process (Okada, 1964; Shimizu & Nishioka, 1974). Therefore, water washing during surimi preparation is necessary to remove sarcoplasmic proteins (Suzuki, 1981). But in the present study, the sarcoplasmic proteins might not have been

Table 1. Effect of washing cycles on the composition of *Pangasianodon hypophthalmus* surimi

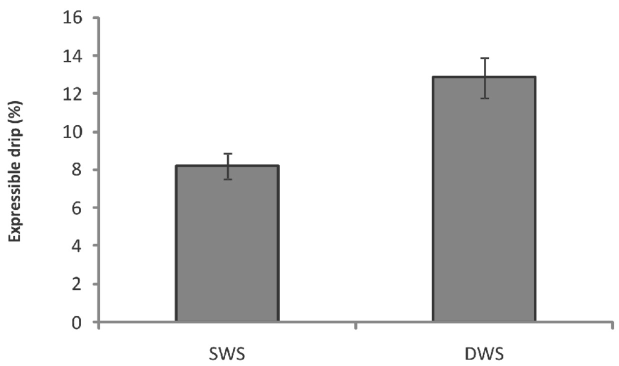
Parameters	SWS	DWS	t	df	P value
Moisture	83.51 ± 0.08^a	84.53 ± 0.16^b	-9.812	4	0.001
Crude protein	14.62 ± 0.11^a	13.67 ± 0.12^b	10.343	4	0.000
Crude fat	2.07 ± 0.05^a	1.67 ± 0.15^b	4.535	4	0.011
Ash	2.31 ± 0.21^a	0.76 ± 0.04^b	12.925	4	0.000

SWS-Single wash surimi, DWS-Double wash surimi
Values represent Mean±SD of 3 replications
*Treatment means with different superscripts in the same row differ significantly ($p<0.05$)

Table 2. Effect of washing cycles on the gel strength and textural characteristics of *Pangasianodon hypophthalmus* surimi

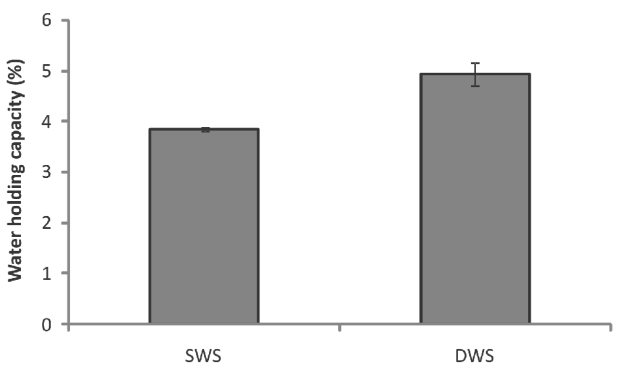
Parameters	SWS	DWS	t	df	P value
Gel strength (g cm)	617.33 ± 68.24[a]	423.67 ± 90.26[b]	2.972	4	0.041
Hardness (kgf)	1.75 ± 0.28[a]	1.15 ± 0.02[b]	3.611	4	0.023
Cohesiveness	0.13 ± 0.03[a]	0.09 ± 0.004[a]	1.864	4	0.136
Springiness (mm)	8.23 ± 0.21[a]	11.91 ± 0.19[b]	-22.813	4	0.000
Chewiness (kgf)	2.03 ± 0.78[a]	1.31 ± 0.11[a]	1.585	4	0.188
Stiffness (kgf mm^{-1})	0.23 ± 0.04[a]	0.14 ± 0.01[b]	4.253	4	0.013

SWS- Single Wash Surimi,DWS-Double Wash Surimi
Values represent Mean±SD of 3 replications
*Treatment means with different superscripts in the same row differ significantly ($p<0.05$)



SWS- Single wash surimi, DWS-Double wash surimi n=3

Fig. 1. Effect of washing cycles on the expressible drip of *Pangasianodon hypophthalmus* surimi

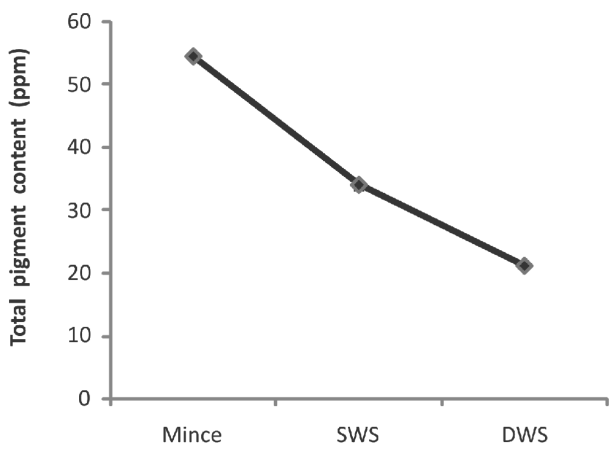


SWS- Single wash surimi, DWS-Double wash surimi n=3

Fig. 2. Effect of washing cycles on the water holding capacity of *Pangasianodon hypophthalmus* surimi

reduced to the desirable level by double washing. This might have contributed to poorer textural characteristics of DWS. Furthermore, mechanical disruption of cellular integrity during preparation of the frame mince might have enhanced the action of proteolytic enzymes on myofibrillar proteins leading to poorer textural characteristics of DWS.

For surimi processing, myoglobin plays an essential role in the whiteness (Chen, 2002) and whiteness is one of most important factor in quality of surimi. Ochiai et al. (2001) suggested that high-quality surimi with higher whiteness can be obtained when dark muscle is removed as much as possible. The total pigment content in Surimi prepared from the meat of *Pangasianodon hypophthalmus* significantly decreased with each washing (Fig. 3). Whiteness (L*)



SWS- Single wash surimi, DWS-Double wash surimi n=3

Fig. 3. Effect of washing cycles on the total pigment content of *Pangasianodon hypophthalmus* surimi

of mince increased significantly ($p<0.05$) with single washing (Table 3). But there was no significant increase in whiteness with the subsequent washing. Redness (a) decreased significantly ($p<0.05$) with each washing. This is in correlation with the decrease in total pigment content (Fig. 3). There was no significant decrease in yellowness when the mince was washed once. But with the subsequent washing the yellowness decreased significantly. This is of significance as the yellowness of *Pangasianodon hypophthalmus* meat is reported as the most important factor for the low market value of the fish. The whiteness of the striped cat fish surimi is low when compared to Alaska pollack surimi (Jin et al., 2007) and channel catfish surimi (Kim et al., 1996). Kim et al. (1996) reported that the colour of surimi can be improved by increasing the washing cycle and washing time. But the results of the present study indicate that washing more than once is not significantly affecting the whiteness of surimi. It would be useful from the point of view of reduction of the waste water.

Table 3. Effect of washing cycles on the L*, a, and b values *Pangasianodon hypophthalmus* surimi

Sample	L*	a	b
Mince	50.81[a]	4.31[a]	10.96[a]
SWS	54.72[b]	2.56[b]	10.07[a]
DWS	55.43[b]	1.39[c]	6.47[b]

SWS- Single wash surimi, DWS-Double wash surimi
Values represent Mean of 3 replications
*Treatment means with different superscripts in the same column differ significantly ($p<0.05$)

Surimi was prepared from the frame meat of *P. hypophthalmus* with single wash method and double wash method. Single wash surimi had lower expressible moisture content than double wash surimi. The gel strength and textural properties of single wash surimi was also better than that of double wash surimi. Since the yellowness of meat is significantly reduced in surimi preparation, the meat of *P. hypophthalmus* can be marketed at a higher price by converting it into surimi and surimi based products.

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