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Application of Cryoprotectants for Surimi Production from Tra Catfish (*Pangasius hypophthalmus*)

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Abstract.

Pangasius is a fish with low cost and round the year availability. Broken meat from *Pangasius hypophthalmus* was considered as by-product discarded during slaughtering process. In order to improving the added value of this fish, there is need for alternate methods of its utilisation and surimi preparation from the species can be one of the best alternatives. The aim of this research was to utilize broken meat from *Pangasius hypophthalmus* combined with different cryoprotectant agents to process surimi. Effect of different cryoprotectants such as sucrose, sorbitol, tripolyphosphate, carrageenan, modified starch, xanthan gum on the physico-chemical, microbiological, and sensory characteristics of surimi were investigated. Results from this study revealed that carrageenan was the most suitable agent for utilization. Broken meat from *Pangasius hypophthalmus* could be utilized to process into surimi to enhance the added value of this species in production.

Keywords: *Pangasius hypophthalmus, surimi, cryoprotectant, utilization*

I. INTRODUCTION

Tra catfish (*Pangasius hypophthalmus)* is an important food fish species in Vietnam. Production of this species from Vietnam is also increasing tremendously. Pangasius catfish is one of the world‟s fastest growing fresh water species in aquaculture. Pangasius is now traded to well over 100 countries worldwide as skinless and bone less fillets popularly along with portions, steaks, fillets and its added value products (Thi et al., 2013). Different research findings have revealed development of various value added products from pangasius having global acceptance and commercial potential. The industry has expanded in terms of production and trade (N.B. Rathod et al., 2018). The Pangasius attains body weight of 1.2 to 1.3kg rapidly within a short span of 6 months but usually harvested after 8 months depending on marketability (Gurung et al., 2016). It is characterised by tender and white flesh, absence of fishy odour, firm cooked texture and high nutritive value with excellent sensory attributes has expanded consumer preference for Pangasius (Rao et al., 2013).

Surimi is deboned fish meat that has been subjected to leaching and dewatering processes to remove sarcoplasmic proteins and concentrate myofibrillar proteins (Lee, C. M.). In production of surimi, fresh fish is skinned, deboned, and washed. Cleaned fish flesh is then minced, washed in iced water, dewatered by filtration and pressing, blended with cryoprotectant, wrapped, and stored in freezer. Cryoprotectants protect surimi from protein dehydration, so as to prevent protein freezedenaturation of myofibrillar proteins during frozen storage, hence preserving the gel-forming ability of surimi. Sucrose, sorbitol, and sodium tripolyphosphate (STPP) are food additives often used with different concentrations in the production of surimi. Concentration of myofibrillar proteins is one of the important factors for improving gel strength and elasticity of surimi. A reduction in water soluble protein increases the concentration of myofibrillar proteins, thus enhancing the functional properties of surimi. The gelling process entails the association of long myofibrillar protein chains which produces a continuous three-dimensional network in which water and other components are trapped. As a result, a visco-elastic gel is obtained (SánchezGonzález et al., 2008).

There were few studies mentioned to the Tra catfish (*Pangasius hypophthalmus)* surimi processing.

Restructured products were prepared from pangasius surimi and their qualities were analysed under chilled storage. Restructured products were prepared in three different formulations by incorporating corn starch (10 %) and chitosan (0.75 %). Formulation containing only corn starch (10 %) was served as control (Jeyakumari A et al., 2016). Effect of different mince to water ratios i.e., 1:1, 1:2, 1:3 and 1:4 with 3 washing cycles on the quality of pangasius surimi was investigated. From the results, it was found that among the different mince to water ratios, 1:3 and 1:4 were better as these gave high gel strength and low expressible moisture to the surimi as compared to other ratios (M. A. Hassan et al., 2017). Effect of different washing cycles i.e., one, two, three and four washes with 1: 3 mince to water ratio on the quality of Pangasius surimi was investigated. Three washing cycles with 1:3 mince: water ration can be optimum for making good quality surimi from *Pangasius* (M. A. Hassan et al., 2017). A production of surimi from broken meat of Tra catfish was investigated. The aim of this work was to study the feasibility of utilization of broken meat from Tra catfish (*Pangasius hypophthalmus)* to create a new surimi. This research focused on the effect of effect of different cryoprotectant agents such as sucrose, sorbitol, tripolyphosphate, carrageenan, modified starch, xanthan gum to physico-chemical, microbiological, and sensory qualities of surimi.

II. MATERIAL AND METHOD

2.1 Material

Broken meat from Tra catfish (*Pangasius hypophthalmus)* was collected seafood factories from Dong Thap province, Vietnam. They must be raised following Global GAP without using antibiotic to ensure food safety. Apart from Tra catfish, we also used other ingredients such as sucrose, sorbitol, tripolyphosphate, carrageenan, modified starch, xanthan gum.

Figure 1. Tra catfish (*Pangasius hypophthalmus)*

2.2 Researching method

Broken meat from Tra catfish (*Pangasius hypophthalmus)* were obtained from seafood factories in Dong Thap province, Vietnam. Broken meat that has been minced was washed 3 times using ice water with a ratio of fish and water 1: 4. During the last washing, salt (NaCl) was added as much as 0.15% of the weight of the minced fish. Then the washed minced fish was wrapped using a filter cloth and pressed by using a hydraulic press. Minced fish then mixed with combination of cryoprotectants such as sucrose, sorbitol, tripolyphosphate, carrageenan, modified starch, xanthan gum in the same supplementation 0.2%. The optimal cryoprotectant agent was selected by measured different values such as physico-chemical (moisture content %, crude protein %, yield %, chewiness (kgf), water holding capacity (%), microbiological (total plate count cfu/g), and sensory characteristics of the dry fermented sausage.

Moisture content (%) was determined by comparing the weights of the sample with the electronic balance. Crude protein (%) was measured by by AOAC (2000). The yield of the treatments (%) was calculated by the ratio between the weight of the raw muscle used and the weight of the final surimi. Chewiness (kgf) was determined Texture Analyzer. Water holding capacity (%) was measured by by the method of Himonides and others (1999) with slight modifications. For each treatment, three samples of 5 g each were separated. Samples were wrapped in individual Whatman filter papers and centrifuged at 2000x g for 20 min at 8°C. The amount of water drained from the surimi was estimated from the weight difference of the filter paper before and after centrifugation. The total plate count (cfu/g) was enumerated during the storage period by Petrifilm - 3M. The sensory attributes such as visual appearance, color, taste, flavor and acceptability was carried out by selected panel of judges (9 members) rated on a nine point hedonic scale.

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

III. RESULT & DISCUSSION

The use of cryoprotectants for the surimi production is important to keep the gel stability during freezing and thawing (Kuhn & Soares, 2002). They avoid the proteins denaturation during freezing by binding water and proteins and support the gel structure afer thawing by diminishing the intermolecular aggregation of the proteins. Additionally, moisture can be affected by the presence of salts and metal ions in the washing solution because they interfere in the formation of hydrogen bounds between proteins and water. the water binding provided by the cryoprotectants could increase the yield. A research aimed at studying the effects of cryoprotectants (NaCl + saccharose x sorbitol + sodium tripolyphosphate) for the production of tilapia surimi (Dayse Licia de Dliveira et al., 2017).

Table 1. Effect of different cryoprotectant (sucrose, sorbitol, tripolyphosphate, carrageenan, modified starch, xanthan gum) in the same supplementation 0.2% to physico-chemical, microbiological, and sensory qualities of surimi

Cryoprotectant	Sucrose	Sorbitol	Tripolyphosphate	Carrageenan	Modified starch	Xanthan gum
Moisture (%)	75.29 $\pm0.02^{d}$	75.44 $\pm0.01^{c}$	75.59 $\pm0.00^{bc}$	76.04 $\pm0.03^{a}$	75.78 $\pm0.01^{b}$	75.92 $\pm0.00^{ab}$
Crude protein (%)	12.14 $\pm0.01^{a}$	12.03 $\pm0.00^{b}$	11.98 $\pm0.01^{bc}$	11.95 $\pm0.02^{c}$	12.01 $\pm0.00^{bc}$	12.09 $\pm0.03^{ab}$
Yield (%)	58.41 $\pm0.01^{d}$	60.44 $\pm0.03^{c}$	62.39 $\pm0.02^{bc}$	65.43 $\pm0.01^{a}$	63.29 $\pm0.02^{b}$	64.11 $\pm0.00^{ab}$
Chewiness (kgf)	5.22 $\pm0.02^{c}$	5.25 $\pm0.03^{bc}$	5.29 $\pm0.00^{b}$	5.38 $\pm0.03^{a}$	5.29 $\pm0.03^{b}$	5.33 $\pm0.02^{ab}$
Water holding capacity (%)	42.36 $\pm0.01^{d}$	46.64 $\pm0.02^{c}$	50.44 $\pm0.01^{bc}$	57.45 $\pm0.02^{a}$	51.23 $\pm0.01^{b}$	53.11 $\pm0.03^{ab}$
Total plate count (cfu/g)	$4.2x10^{2}$ $\pm0.02^{a}$	$2.2x10^{2}$ $\pm0.01^{c}$	$2.4x10^{2}$ $\pm0.03^{bc}$	$1.3x10^{2}$ $\pm0.00^{d}$	$2.7x10^{2}$ $\pm0.02^{b}$	$2.1x10^{2}$ $\pm0.02^{cd}$
Sensory score	7.15 $\pm0.01^{c}$	7.18 $\pm0.02^{c}$	7.26 $\pm0.00^{bc}$	7.89 $\pm0.01^{a}$	7.32 $\pm0.02^{b}$	7.41 $\pm0.04^{ab}$

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2. Effect of different concentration of carrageenan (0.1%, 0.15%, 0.20%, 0.25%, 0.30%, 0.35%) to physico-chemical, microbiological, and sensory qualities of surimi

Carrageenan	0.1%	0.15%	0.20%	0.25%	0.30%	0.35%
Moisture (%)	75.46 ±0.01^{d}	75.94 ±0.02^{c}	76.04 ±0.03^{bc}	76.13 ±0.01^{b}	76.56 ±0.02^{ab}	77.13 ±0.03^{a}
Crude protein (%)	12.02 ±0.02^{a}	12.00 ±0.03^{ab}	11.95 ±0.02^{b}	11.93 ±0.03^{bc}	11.90 ±0.01^{bc}	11.88 ±0.01^{c}
Yield (%)	63.97 ±0.00^{d}	64.84 ±0.01^{cd}	65.43 ±0.01^{c}	66.77 ±0.02^{bc}	67.11 ±0.01^{b}	68.02 ±0.02^{a}
Chewiness (kgf)	5.21 ±0.03^{c}	5.27 ±0.01^{bc}	5.38 ±0.03^{bc}	5.49 ±0.02^{b}	5.54 ±0.01^{ab}	5.61 ±0.01^{a}
Water holding capacity (%)	54.02 ±0.02^{d}	55.28 ±0.01^{c}	57.45 ±0.02^{bc}	58.11 ±0.01^{b}	59.04 ±0.02^{ab}	59.15 ±0.01^{a}
Total plate count (cfu/g)	1.2x10^{2} ±0.01^{c}	1.2x10^{2} ±0.02^{c}	1.3x10^{2} ±0.00^{bc}	1.4x10^{2} ±0.01^{b}	1.5x10^{2} ±0.01^{ab}	1.7x10^{2} ±0.02^{a}
Sensory score	7.49 ±0.00^{d}	7.64 ±0.01^{c}	7.89 ±0.01^{bc}	8.24 ±0.02^{a}	7.94 ±0.01^{ab}	7.92 ±0.02^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

From table 1, the optimal cryoprotectant was noticed at carrageenan so this value was selected for further experiments.

From table 2, the optimal concentration of carrageenan supplemented into surimin should be 0.25%.

Starch is an important ingredient in surimi seafood products since it would affect textural and physical characteristics of surimi fish protein gels. For instance, it can improve surimi gel strength, modify texture, reduce cost (L. Ma et al., 1996), and improve freeze-thaw stability (C. M. Lee, 1994). The starch could replace a portion of the fish protein while maintaining desired gel properties due to its water-holding ability (D. J. Mauro, 1996). A study investigated the effect of overdrying potato starches on surimi products. The chemical composition of protein and chemical interactions, gel solubility, and protein conformation of the mixture of surimi gel protein, respectively, with 8% native potato starch and with 8% overdrying potato starch were investigated (Tangfei Li et al., 2017).

The oscillations in the texture parameters may be due to the breaking of myosin, which leads to an increase in the semi gel fluidity, causing the separation of some protein grids already existent. Still, according to the author, the air inside the gel interferes on the attainment of the texture since the increase of the pressure accomplished during the test causes the disruption of the structure (Visessanguan et al., 2000).

The effect of egg white powder (EWP), potato starch (PS) and soy protein isolate (SPI) at different levels on texture, color and sensory evaluation properties of surimi prepared from common carp was investigated. EWP was added at 1%, 2% and 3%, PS was added at 3%, 6% and 12%, and SPI was added at 10%, 20% and 30%. The analyses indicated that the additives enhanced the functional properties of surimi gel prepared from common carp. EWP significantly improved texture properties at the greatest level (3%), whereas for color the best results came from the lowest level (1%). Conversely, PS showed its most significant effect on the surimi texture at the lowest (3%) level, but the surimi color was changed drastically at higher levels. In the case of SPI, only the lowest level (10%) did not significantly reduce the texture qualities and color of the resulting surimi gel and greater levels were detrimental to surimi gel characteristics. Finally, the best score by the panelists for overall liking was for the surimi gel containing 3% EWP (Ali Jafarpour et al., 2012). A study was undertaken with the aim of reducing the concentration of cryoprotectants in surimi without adversely affecting frozen storage stability. Minced meat from a tropical fish, *Nemipterus japonicus,* was strained, water leached and mixed with different levels of sucrose-sorbitol (1:1) mixture (henceforth called sugar mixture), quick frozen at −35 °C and frozen stored at −20 °C. The surimi samples were subjected to storage stability studies for a period of 5 months. Water leaching resulted in slight absorption of water by meat and reduction in protein, fat and mineral contents. Surimi was found to have moderately white colour. A concentration of 2 to 4% sucrose-sorbitol mixture is well-accepted by the consumers in products—surimi sausage, patty and cake and at this range of concentration surimi could be well-preserved at −20 °C for at least 5 months (Parvathy U. and Sajan George, 2014). Study to improve adding additives and washing step on surimi processing from moontail bigeye was examined. Additives were used, including sugar 3.5%, sorbitol. 3.5%, 0.2% sodium tripolyphosphate 0.2%, caragin 0.3%. Gel strength of moontail bigeye surimi can be reached to 740g.cm, whiteness was 80.25% and black spot with 2 spots/10g (Nguyen Thi Le Phuong et al., 2015). Changes of the water-holding capacity and microstructure of panga and tilapia surimi gels using different stabilizers and processing methods was examined. The objective of this study was to evaluate and compare the effect of the ultrasound extraction protein method and different stabilizers on the water-holding capacity (WHC), texture, and microstructure of surimi from panga and tilapia to potentially increase the value of these species. The results showed that the ultrasound method and the sodium citrate can be used to obtain surimi gels from panga and tilapia with optimal textural properties such as the hardness and chewiness (Annamaria Filomena-Ambrosio et al., 2015). The effects of sodium replacement on the textural properties and water-holding capacity (WHC) of heat-set freshwater surimi gels were examined. Potassium chloride and calcium chloride were chosen as salt substitutes. The surimi gels presented better water-holding capacity with potassium chloride than the treatments containing calcium chloride. Gel strength and rheological properties indicated that monovalent metal ions could improve surimi gel properties. The contents of chemical interactions, especially disulfide bonds, nondisulfide covalent bonds, and hydrophobic interactions of surimi gels, varied with the addition of salt type and concentration (Nannan Yu et al., 2017).

IV. Conclusion

There is a need to develop an alternative ways of utilizing *Pangasius* and making surimi is one of the alternatives. Therefore attempts have been made in the present investigation to optimize the process of surimi preparation from Pangasius hypophthalmus. Surimi is rich in myofibrillar protein obtained by mechanically deboning and repeatedly washing with chilled water, refined and mixed with cryoprotectants for better-frozen shelf life. We have successfully investigated the surimi production from broken meat of Tra catfish (*Pangasius hypophthalmus*) by combination with carrageenan 0.2% as cryoprotectant.

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