SOME PHYSICO-CHEMICAL PROPERTIES OF SURIMI-LIKE MATERIAL MADE FROM GOAT MEAT AS AFFECTED BY SUCROSE LEVEL

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ABSTRACT

This experiment was carried out to study the effect of sucrose level on the physico-chemical properties of goat surimi. The muscle tissue of round meat of goat was separated from fat and connective tissue manually and then was cut into 3 cm size of meat for mincing by using meat mincer. Then, the minced meat was washed three times by using chilling water (5-10^{o}C) which the final washing used chilled 0.5% NaCl solution. The ratio of water to minced meat in washing was 3:1. The final step was dewatering by pressing washed minced meat in the screen of linen mesh manually. Finally, raw surimi was stirred with sucrose 3% (P1), 4% (P2) and 5% (P3) and added sodium tripolyphosphate 0.2% for each treatment. The result showed that both pH and Water Holding Capacity (WHC) increased significantly from P1 ($P<0.05$), whereas the gel strength was no different. The incline of WHC was followed by the incline of crude protein content. However, sucrose could not affect ash and fat content as well as salt-soluble protein. Sucrose supplementation at 4% in goat surimi produced the best characteristics of goat surimi.

Keywords: goat meat, physico-chemical, sucrose, surimi

INTRODUCTION

Surimi is a term denoting the ground fish meat paste formed during the manufacturing process of the traditional Japanese surimi-based product 'Kamaboko'. Currently, surimi and surimi seafoods are also produced and consumed in many countries (Manfield, 2003). The successful development of the fish surimi process and increasing market share of surimi-based seafoods throughout the world have led to studies aimed the use of red meat and poultry in surimi product to develop new products from chicken (Nowsad *et al*., 2000; Lee and Min, 2004), and sheep (Antonomanolaki *et al*., 1999). Reported studies have identified large variations in functional properties of myofibrillar proteins associated with muscle fiber types.

Surimi is light in color, bland in odor, low in fat, high in myofibrillar protein, and extremely functional due to the unique gelling properties of the myofibrillar protein (Jin *et al*., 2008). Frozen surimi is used as a starting material in the factory due to the advantages of it rather than whole fish (Suzuki, 1981). Unfortunately, frozen storage decreases the functional properties, mainly gel-forming ability of surimi (Lee, 1984). The loss of this property is due to the denaturation of protein. The freezing increases solute concentration and favors dehydration, both of which contribute to protein denaturation (McDonald and Lanier, 1991). To prevent protein from denaturation during frozen storage, utilization of cryoprotectant, such as sucrose, sorbitol and phosphate is applied (Nowsad *et al*., 2000). At first, cryoprotectant applied was sucrose 8%, but it caused the surimi taste too sweet and turned the finished product a brownish color. To reduce the sweetness of surimi, cryoprotectant used was sucrose 4% and sorbitol 4%. The effectiveness of this sugar effect was markedly enhanced by adding phosphate 0.2% (Lee, 1984). Eventough the formulation of cryoprotectant could not protect the gel strength, deformation was slightly improved, and water retention properties, elasticity and cohesiveness of gel were protected (Nowsad *et al*., 2000). Moreover, sorbitol utilization cause the surimi-based product texture is harder than the one with sucrose (Suzuki, 1981).

Due to the negative effect of sucrose 8% and sorbitol, the objective of this study was to investigate the effect of sucrose level under 8% as a single agent of cryoprotectant on the physico-

chemical properties of surimi-like product from goat meat.

MATERIALS AND METHODS

Surimi Preparation

The leg meat of goat was obtained from traditional market in Bengkulu. The muscle tissue was separated from fat and connective tissue manually and then was cut into 3 cm size of meat for mincing by using 7g meat mincer. Then, the minced meat was washed three times by using chilled water (5-10 ^{o}C) which the final washing used chilled 0.5% NaCl solution. The ratio of water to minced meat in washing was 3:1. The final step of surimi preparation was dewatering by pressing washed minced meat in the screen of linen mesh manually. Finally, raw surimi was stirred with sucrose 3% (P1), 4% (P2) and 5% (P3) and added sodium tripolyphosphate 0.2% for each treatment. Each treatment was replicated three times.

Measurement of pH

Surimi pH was measured by using pH-meter (TOA HM-11p). At first, the electrode of pH-meter was calibrated to pH 4 and 7. After calibrating, the electrode of pH-meter was inserted into sample and the pH indicator rose on the monitor of pH-meter.

Measurement of Water Holding Capacity (WHC)

WHC was determined by using Hamm method (Soeparno, 2005). A 0.3 g sample was placed on filter paper Whatman 41 and pressed at 3,000 psi for 3 minutes by using Carver Press. Two distinct areas were produced: a meat area and a water area, then those of areas were measured by using *block meter* paper The area between water and meat area is wet area (mm^2). The weight of free water (mg) was counted by using formula:

[(wet area (cm^2))/(0.0948) - 8]

The percentage of free water (% free water) was the ratio of mg of water to the weight of sample:

[free water (mg)/(sample weight) x 100%]

To determine WHC, the percentage of free water in the moisture of sample is counted by using formula:

[100/moisture] x % free water

WHC (%) was (100 – percent free water in the moisture).

Measurement of Gel Strength

Gel strength was determined according to method described by Tan *et al*. (1988). Surimi was mixed by 3% of smooth salt and 30% of chilled water by using food processor until sticky surimi formed. Then, the sticky surimi was cased and was heated with double step heating: 40^{o}C in 20 minutes and 90^{o}C in 20 minutes. This surimi's gel strength was measured by using anvil instron 1140 and expressed as gf/cm^2.

Measurement of Proximate Composition

Moisture was determined through oven drying method at 110 ^{o}C for 24 h; crude protein was determined by using Kjeldhal method; crude fat was evaluated by using the soxhlet method; and ash content was measured by ashing the sample in a muffle furnace at 600^{o}C.

Measurement of Salt Soluble protein

Salt-Soluble Protein was measured after it was homogenized by using 20 ml salt solution for a minute in an ice bath. Homogenate was centrifuged for 10 minutes at 3020 x g and the filtrate was separated. Filtrate was centrifuged for 10 minutes at 3020 x g and supernatant was decanted. A ml of supernatant was used to determined Salt-Soluble Protein by using Kjehdahl method (Park *et al*. 1996).

Color

Color [CIE L*(lightness), a* (redness), b* (yellowness)] was measured by using a Minolta colorimeter (CR-40 0, Tokyo, Japan) that was standardized with white calibration plate. Five readings were made from the surface of samples. Whiteness was determined using the following formula: 100 - $[(100 - L^*)^2 + a^*2b^*2]^{1/2}$ (Park *et al*., 1996).

Statistical Analysis

One-way analysis of variance was used to compare the treatments effects. Duncan's Multiple Range Test was used to determine significant differences between mean values (Steel and Torrie, 1991). The level of significance was $P<0.05$ which was calculated by using Costat software.

RESULTS AND DISCUSSION

Physical Characteristics

Duncan Multiple Range Test and standard error for the physical characteristics are presented in Table 1. Value of pH and WHC obtained tended to be lower from 3% to 5% sucrose supplementation ($P<0.05$). Honikel (1987) reported that pH has a profound effect on the physical properties such as WHC, tenderness and color in meat. In this study, the increase of pH was followed by the increase of WHC and gel strength. It was parallel to Kristinsson and Hultin (2003) that reported that an increment of surimi gel and pH led to a considerable increment of WHC. Various researchers have found that decrement of pH significantly correlated with the loss of textural qualities such as gel strength (Nowsad *et al*., 2000). Matsumoto and Noguchi (1992) stated that pH below 6.5 of myofibrillar proteins are unstable and rapidly lose the ATPase activity, an indicator of gel-forming ability. This research showed that there was no different gel strength value ($P>0.05$) because of the increasing of sucrose level.

In this study, sucrose as cryoprotectant had influenced WHC and pH of goat surimi ($P<0.05$) and did not influence gel strength. The increasing pH was followed by WHC's and gel strength's pattern which the WHC at P1 (46.27%±0.41) was significantly lower than P2 (52.33±0.64%) and P3 (50.98±0.32%), and between P2 and P3 was no statistically different. The pH of P1 (4.50) was no different from P2 (4.54) but significantly different from P3 (4.59), whereas the pH of P2 was significant from P3. Nowsad *et al*. (2000) reported that cryoprotectant could not protect the gel strength or breaking strength, but it could protect water retention of surimi. The cryoprotectant used by Nowsad *et al*. (2000) was combination of sucrose, sorbitol and Na-tripolyphospate. The difference result of these was probably affected by different cryoprotectant used. In this study was used sucrose as a single agent of cryoprotectant so that the effect of the cryoprotectant was different from Nowsad's study. The highest value of the physical variable was 4% sucrose added to the surimi material. No treatment differences were observed for gel strength. All gel strength levels were considered highly acceptable regardless of treatment and ranged from 475.55 gf/cm^2 to 611.33 gf/cm^2. With the appropriate washing, sarcoplasmic proteins could be removed, resulting in concentrated myofibrillar proteins and consequently increased breaking force of surimi gel (Yongsawatdigul and Park, 2004). In this study, salt soluble protein or myofibrillar protein content (Table 2) were not significantly different, this caused not different significantly in gel strength. Huda *et al*. (1999) reported that the addition of sucrose and polyphosphate as cryoprotectant to surimi resulted in an improved functional properties such as increased solubility, better emulsification, and foaming abilities. However, gel forming ability was greatly affected. Kamal *et al*. (2005) suggested that a severe denaturation occurred in the myofibrillar protein during frozen storage and changes in intermolecular conformation, such as salt-soluble protein, pH and ionic-strength. The deterioration of proteins during frozen storage as reflected by their sharp decrease in gel forming ability, water holding capacity and fat emulsifying capacity. Katayama *et al*. (2006) suggested that surimi gel quality, the elastic texture and white color mainly, can be influenced by many factors affecting protein structure. Severe proteolysis of myofibrillar proteins, caused by the endogenous proteinases in muscle is directly associated with poor gel quality.

Chemical Characteristics

The chemical compositions are an important role in surimi quality. Luo *et al.* (2004) reported that the protein concentrate on greatly affected the gel properties of alaska pollack and common carp

Tabel 1. The pH, Water Holding Capacity (WHC) and Gel Strength of Goat Surimi

Variabels	Sucrose Level		
	3% (P1)	4% (P2)	5% (P3)
pH	4.50±0.05^b	4.54±0.08^b	4.59±0.04^a
WHC (%)	46.27±0.41^b	52.33±0.64^a	50.98±0.32^a
Gel Strength (gf/cm^2)	476.55±5.95	591.68±4.15	611.33±12.15

Different superscript in the same row indicates significantly different ($P<0.05$)

Tabel 2. Proximate Composition and Salt-Soluble Protein of Goat Surimi

Variabels	Sucrose Level		
	3% (P1)	4% (P2)	5% (P3)
Moisture (%)	76.02±0.64[a]	75.59±0.40[b]	74.89±0.27[b]
Ash content (%)	0.77±0.02	0.64±0.01	0.70±0.02
Crude fat (%)	4.31±0.09	5.60±0.12	6.14±0.26
Crude protein (%)	14.24±0.86[a]	16.37±1.3[b]	15.47±0.77[a]
Salt-Soluble Protein (%)	1.86±0.03	1.85+0.04	1.73±0.04

Different superscript in the same row indicates significantly different (P<0.05)

surimi. The lipids in surimi products may bring about an adverse effect on the surimi quality, because the oxidized lipids interact with proteins, causing denaturation, polymerization and changes in functional properties (Smith, 1987). The water content is also a critical factor in surimi products (Uddin *et al*., 2006), and Uddin *et al*. (2006) suggested that the standard water content of surimi is 78%. In general, high protein, high myofibrillar, high collagen, low crude fat and adequate water are required to make a high quality of surimi. In this study, goat surimi had higher protein and lipid contents, whereas water content of samples were more closely reached standard water levels as 74.89-76.02%. Mizuta *et al*. (2007) reported that collagen or connective tissue may play some important roles also in the textural development of processed foods such as surimi-based products.

The effect of sucrose level on the chemical characteristics is presented in Table 2. The moisture of surimi was significantly decreased. In the contrary, crude protein tended to increase markedly. However, sucrose could not affect ash and fat content as well as salt-soluble protein.

Moisture expressed the water content of surimi. Water content of material is not parallel with the WHC value. In the various cases, the higher of water content the lower of WHC value. In this study, WHC of the surimi increased (Table 1), while the moisture of surimi decreased significantly (Table 2). The moisture of surimi at P1 was 76.02±0.64% which was significantly different from P2 (75.59±0.40%) and P3 (74.89±0.27%), but P2 was no different from P3. The average of the moisture of the study was matching to the normal moisture of fresh meat which contains 68-80% (Aberle *et al*., 2001). Ash content, crude fat and salt soluble protein were no significant response.

The interesting here was crude protein and salt-soluble protein of surimi. The crude protein between P1 (14.24%) and P3 (15.47%) was not different, while P1 and P2 (16.37%) was different, whereas the salt-soluble protein response was no different. This fact indicated that the increment of sucrose added could not protect protein content of the surimi although it was no change the salt soluble content of the surimi. The incline of the crude protein corresponded to the increment of the WHC. One of the factor affecting WHC is protein content which the protein molecules bind the water molecule (Aberle *et al*., 2001). This study showed that 4% sucrose treatment group had the highest value of the variables.

Surimi-like colors

The surimi color is presented in Table 3. The color of surimi at P1 had lower lightness (L*) than other surimi samples significantly, whereas P2 and P3 surimi samples did not significant in lightness (L*). Redness (a*) color of surimi was

Table 3. Changes of Meat Color in Surimi Made from Goat Meat

Sucrose level	L*	a*	b*	W
P1 (3%)	65.15±0.64[b]	11.98±0,20	7.38±0.09[a]	60.40± 0.90[b]
P2 (4%)	66.06±0.40[a]	11.50±0.13	7.20±0.12[a]	61.49±0.92[a]
P3 (5%)	66.26±0.27[a]	11.44±0.11	6.75±0.26[b]	61.96± 0.75[a]

Different superscript within column are significantly different (p<0.05)

not significantly different between P1, P2 and P3, whereas the color of surimi at P2 was lower in yellowness (b*) than P1 and P2 significantly.

For surimi processing, myoglobin plays an essential role in the whiteness (Chen, 2002), whiteness is one of the most important factor in the quality of surimi. Ochiai *et al*. (2001) suggested that high-quality of surimi with higher whiteness can be obtained when dark muscle is removed as much as possible. In this study, P3 surimi showed higher whiteness (W) and lightness (L*). It may be due to the myoglobin content of P3 surimi being lower than other surimi samples. Thus, it was assumed that the increasing of sucrose level until 5% did not cause surimi color darker (more brown). Kim *et al*. (1996) reported that the color of surimi can be improved by the increasing of washing cycle and washing time.

CONCLUSION

Sucrose added to goat surimi was able to improve pH, Water Holding Capacity, gel strength and crude protein. However, it could not change the responses of ash content, crude fat and salt-soluble protein. The suitable sucrose level for the best characteristic of goat surimi was 4% sucrose as a single agent of cryoprotectant.

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