Nutritional and sensory properties of shrimp analog made of fresh and saltwater fish surimi and tapioca

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Abstract. Fish spoilage can be prevented by processing, such as to process them into surimi. Surimi is utilized as a base material for manufacturing various kinds of processed products including shrimp analog. Shrimp analog can be used as an alternative food for those who are allergic to seafood, especially shrimp. This research studied the processing of surimi made into shrimp analog that has characteristics resembling natural shrimp. The purpose of this study was to determine the quality of shrimp analog made from surimi of some fish species and tapioca with different concentrations. This study used a randomized block design (RBD) factorial consisting of two factors. The first factor was surimi of various fish species (I) which were I₁ = trigger fish, I₂ = sardines, I₃ = tilapia, and I₄ = snakehead fish. The second factor was the concentration of tapioca (T) comprised T₁ = 6% and T₂ = 8%. The shrimp analog samples then were analysed their water content, protein content, fat content, hedonic sensory test on color, aroma, texture and taste. The best treatment was obtained from shrimp analog made of tilapia surimi with tapioca concentration of 8% (I₃T₂) which had water content of 51.97%, protein content of 15.17%, fat content of 0.45%, hedonic sensory value (scale 1-5) color of 3.69 (neutral-like), aroma of 2.77 (not like-neutral), texture of 3.31 (neutral), and taste of 3.37 (neutral).

1. Introduction

Seafood analog can be an alternative food for people who have allergies to seafood, especially shrimp. Thus, a study is needed to make shrimp analog made from surimi with the characteristics resembling shrimp. Making shrimp analog from surimi with several types of fish and increasing the concentration of tapioca flour are expected to add economic value to product development and can enjoyed by people who have allergies to shrimp. Surimi based product has gained popularity and studies on surimi and surimi-based products have been done by many researchers [1,2,3].

Surimi is a concentrate of fish meat myofibril protein that is in the form of an intermediate product which can later be used as a base for making various kinds of processed products. Various kinds of processed products that can be made with surimi raw materials include meatballs, nuggets, sausages, kamaboko and various other analog (imitation) products, such as shrimp analog [4]. The use of surimi for food material for 3D printing has been also investigated [5].

Surimi-minced and washed fish meat has primarily been produced from white-muscled fish species, since the desirable odor, light color and gel-forming characteristics of the resultant surimi are...
very important to enable further processing to heat-induced gel products such as crab leg analog. The production of low-fat surimi with desirable gel-forming characteristics from sardine and mackerel by conventional processing methods has had only limited success; however, recent developments have opened the way to the utilization of red-meat fish for surimi production. Furthermore, surimi can be manufactured from underutilized or low-valued fishes with the addition of cryoprotectants for stable and extended storage. The textural properties of seafood analog product can be increased by adding other ingredients, such as starch [6]. This study aims to manufacture shrimp analog made of surimi from various fish species and different tapioca concentrations.

2. Materials and method
2.1. Preparation of surimi
Surimi for shrimp analog was made from salt and fresh water fishout of the water around Banda Aceh Indonesia. The saltwater fish were triggerfish (Chantidermis maculatus), and sardine (Sardinella longiceps), while the fresh water fish were tilapia (Oreochromis niloticus), and snakehead fish (Channastriatus). Surimi was made based on [7] procedure. Surimi was mixed with blended cryoprotectant of 5% sucrose, 5% sorbitol, and 0.4% STTP (sodium tripolyphosphate) and then it was stored at -20°C.

2.2. Preparation of shrimp analog
Shrimp analog was manufactured using frozen surimi that was thawed in refrigerator overnight. Each of the frozen surimi made out of the four fish species was then added with 0.5% saltand mixed for 3 minutes. After that, tapioca was added in 2 concentrations, namely T1 = 6% and T2 = 8%. Later, 3% egg white and finely ground seasoning containing 0.1% ginger, 2% onion, 1% garlic, 0.3% nutmeg and 0.4% pepper, and also 2% shrimp essence were added and mixed. After mixing thoroughly, the paste was manually for medinto shrimp shape and brushed with food grade coloring. The prepared shrimp analog was further steamed for 30 minutes, cooled and analyzed using standard procedures.

2.3. Experimental design and statistical analysis
A Randomized Block Design of 2 factors was applied. The first factor was fish species to prepare surimi which consisted of triggerfish (I1), sardine (I2), tilapia (I3), and snakehead fish (I4). The second factor was the concentration of tapioca, comprised 6% (T1) and 8% (T2). Data were analyzed using two-way analysis of variance which was carried out on SPSS version 17.0 for Windows. Significant difference between the treatments was determined by Least Significant Difference (LSD) test.

2.4. Nutritional and hedonic sensory analysis
The shrimp analog was analyzed for water, protein, and fat contents using the SNI method [8]. The sensory quality of the shrimp analog was assessed by 25 semitrained panellists. Hedonic sensory attributes consisted of color, aroma, texture, and taste. Shrimp analog samples were served to the panellists and water was used to restore the panellist palate. The panellists scored the samples from 1 to 5, where score 1 was for dislike very much, 2 was for dislike, 3 was for neither dislike or like, 4 was for like, and 5 was for like very much.

3. Results and Discussion.
3.1. Water content of shrimp analog
Based on data analysis, the value of water content in shrimp analog with various levels of treatment ranged from 51.97 - 67.72% with an average of 61.55%. Whereas the water content of surimi which was a raw material for making shrimp analog ranged between 66.38 - 83.81% [9]. Shrimp analog water content had a lower value than the initial surimi raw material, this was due to the addition of tapioca flour in the process of making shrimp analog that can bind water.

Figure 1 showed that the highest water content was obtained from shrimp analog made of surimi trigger fish species with a value of 67.45% and the lowest water content was obtained in the tilapia.
surimi species with a value of 53.37%. This difference in value was thought to be caused by differences in protein content and protein functional properties in materials that had function to bind water. The ability of proteins to form a gel greatly influences the binding capacity of water during the treatment process [10]. The more protein content and the better the functional properties of protein possessed by fish species, the less water content contained in these fish.

![Figure 1](image1)

**Figure 1.** Effect of surimi from various fish species on the shrimp analog water content.

3.2. **Shrimp analog protein content**

The results of data analysis indicated that the value of protein content in shrimp with various levels of treatment ranged from 7.88 to 16.34% with an average of 12.26%. Protein levels were almost the same as previous studies on the characteristics of artificial shrimp meat from red tilapia which ranged from 7.42 - 11.12% [11]. According to [12], levels of surimi protein from by-catch fish ranged from 11.91 - 16.08%. With the addition of other additives such as egg whites in making shrimp analog, the protein content contained in shrimp analog will increase.

![Figure 2](image2)

**Figure 2.** Effect of surimi from various fish species on the shrimp analog protein content.
Figure 2 showed that high protein levels were obtained in surimi sardine and tilapia with values of 14.59% and 15.76%, respectively. Low protein levels were obtained in species of surimi trigger and snakehead with values of respectively 9.63% and 9.05%. This difference in value was thought to be caused by the different protein content of each fish so that the percentage of protein left behind after the fish was washed in the process of making surimi was not the same based on the type of fish.

3.3. Shrimp analog fat content
Fat content of shrimp analog ranged from 0.44% to 0.48% with an average of 0.46%. In the process of making surimi that is applied in making shrimp analog, the fat content must be removed as much as possible because it can inhibit the process of gel formation. The less fat was contained in surimi, the better the surimi was produced. The fat contained in minced fish can be reduced with the washing process. The analysis of variance on fat content of shrimp analog showed that shrimp analog made from surimi of various fish species, tapioca flour concentrations, and the interaction had no significant effect (P > 0.05) on fat content.

3.4. Hedonic sensory value of shrimp analog
3.4.1. Color hedonic value of shrimp analog. The hedonic sensory value (likeness) of shrimp analog color is ranged from 1.21 to 3.37 with an average of 2.49 (dislike-neutral). Figure 3 showed that tilapia shrimp analog had the highest color hedonic sensory value with scale of 3.71 (neutral-like). Whereas, trigger fish shrimp analog had the lowest color hedonic sensory value with scale of 1.33 (very dislike – dislike). According to [13], differences in the types of fish have an effect on color in the process of making pempek and have significant differences between each type of fish.

![Figure 3. Effect of surimi from various fish species on the color hedonic sensory value of shrimp analog.](image)

Hedonic value of 1 = dislike very much, 2 = dislike, 3 = neutral/just right, 4 = like, 5 = like very much. Different letters above the bars indicates statistically significant difference.

3.4.2. Aroma hedonic value of shrimp analog. Consumer tastes can be enhanced by the delicious and distinctive aroma of a product. The level of panelist acceptance of a product is largely determined by the aroma. The aroma can determine the deliciousness of a product and can also describe the ingredients contained in the product. The data analysis signified that the hedonic sensory value of
aroma shrimp analog ranged from 1.09 to 2.77 with an average of 1.66 (dislike). Figure 4 showed the effect of surimi from various fish species on aroma of shrimp analog.

*Figure 4. Effect of surimi from various fish species on the aroma hedonic sensory value of shrimp analog.*

Figure 4 showed that the highest aroma preference value of 2.76 (dislike-neutral) was found in shrimp analog made of the tilapia surimi. The shrimp analog from trigger fish, snakehead fish, and sardines gained hedonic values of dislike very much with score of 1.47, 1.33, and 1.09 respectively. According to the test hedonic, sardines obtained the lowest value of aroma. This was presumably caused by the stronger fishy odor of sardine, snakehead, and triggerfish than tilapia.

Figure 3 showed that tilapia shrimp analog had the highest color hedonic sensory value with scale of 3.71 (neutral-like). Whereas, trigger fish shrimp analog had the lowest color hedonic sensory value with scale of 1.33 (very dislike – dislike). According to [13], differences in the types of fish have an effect on color in the process of making pempek and have significant differences between each type of fish.

### 3.4.3. Texture hedonic value of shrimp analog

The texture hedonic sensory value of shrimp analog ranged from 1.16 to 3.31 with an average of 2.16 (dislike). Figure 5 showed that tilapia surimi shrimp analog with 8% tapioca flour concentration had the highest texture preference value with scale of 3.31 (neutral). In contrast, the sardine surimi shrimp analog with 6% tapioca concentration had the lowest texture preference with hedonic value of 1.49 (dislike very much - dislike). This is presumably because each type of surimi made of different fish has different textures. Thus, when processed into shrimp analog, the resulting texture varies which resulted in differences panelists’ preference.

The high value of texture preference on the addition of 8% tapioca flour concentration is suspected because higher concentration of tapioca flour produce a denser product which highly preferred by consumers. Tapioca flour can absorb water from minced fish during heating. The more tapioca flour is added to the ingredients, the chewier and harder the texture of the product is formed.
3.4.4. Taste hedonic value of shrimp analog. The taste hedonic sensory value of the shrimp analog ranged from 1.21 to 3.37 with an average of 2.00 (dislike). The results of various surimi treatments of several types of fish and the interaction between the two treatments had very significant effect ($P \leq 0.01$), while the treatment of adding tapioca flour concentration had a significant effect ($P \leq 0.05$) of the shrimp analog produced.
Figure 6 showed that the highest taste preference value was obtained from the type of surimi tilapia with tapioca flour concentration of 6% and 8% which had neutral hedonic values (3.32 and 3.37), while the lowest taste preference was obtained at surimi trigger fish species with tapioca concentration of 6% (1.25) and 8% (1.21) which hedonic values are very dislike. This is presumably because the shrimp analogs made from surimi trigger fish, sardines and snakehead has more specific flavor similar to the taste of fish when those compared to the taste of shrimp analog made from surimi tilapia whose fish taste is slightly disguised. According to [14], tapioca flour significantly affected the taste of a product. The research was conducted to study the influence of tapioca flour addition to fish nugget made of black marlin fish flakes. The result from this research showed that the addition of 9% concentration of tapioca flour had influenced the panelists’ preference of product taste.

4. Conclusion
The high protein content and low water content of shrimp analog made of tilapia surimi caused texture and taste of the shrimp analog was favorable. In addition, the high tapioca concentration bound more water, making shrimp analog less brittle and preferable. Therefore, the best nutritional and sensory properties was found in shrimp analog made of tilapia surimi (I) and addition of 8% tapioca flour (T). The texture and taste of the shrimp analog hedonic sensory values were 3-4 (neutral – like). TheI1T3 shrimp analog had a water content of 51.97%, protein content of 15.17%, color hedonic sensory value of 3.69 (neutral-like), taste of 3.37 (neutral), texture 3.31 (neutral) and aroma 2.77 (dislike-neutral).

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