The characterization of edible coating from tilapia surimi as a biodegradable packaging

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Abstract. One of the problems that often arise in the fisheries sector is maintaining the quality. In the room temperature, the fish more quickly enter the phase of rigor mortis and lasted shorter. The retention of fresh fish can be extended by adding antibacterial compounds in the form of synthetic chemicals or natural ingredients. One of the safe natural ingredients used to extend the freshness of the fish is the edible coating. Edible coatings may be composed of hydrocolloid, lipids and composites. In the food industry surimi can be used as an ingredient to make edible packaging or better known in the form of edible film and protein-based edible coating. Edible film and potential coatings are used as packaging materials as they may affect food quality, food safety, and shelf life. Protein-based edible film have superior inhibitory and mechanical properties compared to polysaccharide-based ones. This is because protein contains 20 different amino acids and has most special characteristics that produce functional characteristics when compared with polysaccharides used as an ingredient in edible film and coating making most homopolymers.

1. Introduction

One of the problems that often arises in the fisheries sector is maintaining quality. The quality of fish can be maintained if the fish is handled carefully, clean, stored in a room with refrigeration, and quick. At room temperature, the fish enters the phase of rigor mortis more rapidly and does not last for long. If the rigor phase can no longer be maintained, then decay by enzyme and bacterial activity will take place more quickly. The activity of enzyme and bacteria causes change very rapidly so that the fish enters the phase of post rigor. This phase indicates that the quality of fish is low and unfit for consumption in terms of maintaining the quality of fish and its relation to shelf life. The longer the shelf life of a fish, the quality of the fish will be better maintained.

The retention of fish freshness can be extended by adding antibacterial compounds in the form of synthetic chemicals or natural ingredients. These compounds can diffuse into the surrounding environment and inhibit or stop bacterial growth. Antibiotic substances are grouped into antibiotics that are effective against several types of bacteria (narrow spectrum) and antibiotics that are effective against many types of bacteria (broad spectrum). Synthetic antibiotics such as tetracyclines have been banned for health reasons, hence no more effective antibiotic agents are used in handling fish catches. The use of natural ingredients can be a solution that is not harmful to health.

One of the safe natural ingredients used to extend the freshness of fish is the edible coating. Edible coatings may be composed of hydrocolloid based (proteins, polysaccharides), lipids (fatty acids, acyl glycerol, waxes or waxes) and composites (mixed hydrocolloids and lipids) [1]. Surimi in the food industry can be used as an ingredient to make edible packaging or is better known in the
form of edible film and protein-based edible coating. Edible film and other potential coatings are used as packaging materials as they may improve food quality, food safety, and product shelf life.

In addition to acting as inhibitors of mass diffusion (moisture, gas, volatile), edible films and coatings also serve as food and additive carriers including flavors, antioxidants, vitamins and dyes, as well as to improve food handling [2]. Edible films and protein-based coatings have superior inhibitory and mechanical properties compared to polysaccharide-based ones. This advantage is due to the fact that proteins contain 20 different types of amino acids and have special characteristics that produce functional characteristics, which is more varied when compared with polysaccharides used in the preparation of edible films and coatings, which are mostly homopolymers.

2. Methodology

2.1. Time and place of research

This research was held on August 2016 in the Laboratory of Aquaculture, Faculty of Fisheries and Marine, Airlangga University.

2.2. Tools and ingredients

The tools used in this research were tilapia fish fillets obtained from several markets in Surabaya city, water, salt, ice, cryoprotectant (sugar), filter paper, packing materials such as cling film, styrofoam and chemicals used for physical and chemical analysis. Other tools used include tools for manufacturing surimi such as knives, scales, plastic trays, grinders, gauze, cutting boards, cool boxes, refrigerators for storage, containers for coating, and equipment for proximate analysis, amino acids, TVB, pH meter, aw meter, TPC, and viscometer.

2.3. Working procedures

This research was conducted in two stages: preliminary research and the main research. The preliminary research included the testing of raw materials used as the basic material for edible coating. Main studies include the manufacture of surimi from fish waste filet and various surimi washing (1, 2, 3) of the edible coating. The frozen surimi is thawed for 20 minutes. The resulting edible coating of surimi was then analyzed for its viscosity.

2.4. Test procedures

a. Potential hydrogen value

pH measurement was done using a digital pH meter. Prior to use, the pH meter was rinsed with distilled water and dried with a tissue. It was further calibrated by the use of the buffer solutions pH 4 and pH 7. The tool was dipped in the buffer and was allowed a moment to steady.

b. Total volatile base value (TVB)

The Total Volatile Base Test is one of the methods of measurement to determine the freshness of fish based on the evaporation of the basic compounds. TVBN analysis is conducted by weighing a sample of 100 grams and adding 300 mL of 7% TCA and then mashed. The solution was filtered with filter paper to obtain a clear filtrate. To make the distillation, the distillate was accommodated with 15 mL of HCl 0.01 M. A few drops of phenol red indicator was added in the distillate and then titrated with NaOH 0.01 M until it turned pink.

c. Total plate count value (TPC)

The microbiological test was done by calculating the number of microbes in the sample by diluting as necessary and was done in duplicate. A mixture of 1 mL was taken and placed into a tube containing 9 mL of sterile 0.85% saline solution in order to obtain dilution 10-2. A similar procedure was then performed for the dilution of 10-3 and so on up to the 10-5 dilution. To sterile, the sample was placed into a sterile petri dish and allowed to clot. 0.1 mL of the diluted sample is pipetted on the agar
surface. The sample was leveled on the surface of agar using a sterile glass rod and incubated at 10 °C for 5 days.

d. Water content
The cleansed porcelain cup is then dried in the oven for 1 hour at 105°C, then cooled in a desiccator for 30 minutes and weighed (A gram). The 2 grams of smoothed sample were weighed in a cup (B gram) and then dried in an oven at 105°C for 6 hours. Next, the sample was chilled with the desiccator for 20 minutes then weighed several times until the fixed weight was obtained (C gram) [3].

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\text{Water content} = \frac{(B - C)}{(B - A)} \times 100\% \tag{1}
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2.5. Data analysis
This research used Complete Randomized Design (CRD) that consists of four treatments and three replications. The treatment in this research is the edible coating on various surimi concentrations (2, 4, 6, and 8 %). Data analysis in this research utilized Analysis of Variance (ANOVA) and continued with the Duncan’s Multiple Range Test to determine which treatment gives a different effect compared to the other treatments [4].

3. Results and Discussions
The pH values of the washing effect at one, two and three washings are 7.01, 6.54 and 6.45 respectively. The value is still considered in a good gel-producing category, although the pH value decreases with the amount of washing. The degree of acidity (pH) of the surimi at one-time washing was still close to the normal pH state. According to Babji and Kee [5], the high pH value at one-time washing is caused by the loss of acid residues (lactic acid as an anaerobic glycolysis process) in muscle protein due to the washing effect [5]. It is also asserted that pH value is very important in relation to gel formation, where the gel formation process will be difficult if the pH value is below 6 [6]. The average pH value of tilapia surimi can be seen in Table 1.

| Washing | pH value |
|---------|----------|
| 1       | 7.01     |
| 2       | 6.54     |
| 3       | 6.45     |

The pH value affects the strength of the gel (ashi). The gel strength will be high if the pH of the meat ranges from 6.0 to 7.0 because the myosin protein is easily soluble in the pH range. The gel strength will be lower outside the pH range, either in a more alkaline state (pH > 7) or in more acidic state (pH < 6) [7].

The Total Volatile Base Test is one of the methods of measurement to determine the freshness of fish based on the evaporation of the basic compounds. The higher the value of TVB shows the decline in meat quality. The TVB value of the surimi-coated tilapia fillet during storage ranged from 9.03 up to 24.44 mg N/100 g sample. The TVB value of the tilapia fillet increased with the length of storage time. The increased TVB value of fish during storage occurred due to the degradation of protein or derivatives, which produces a number of volatile bases such as ammonia, histamine,
hydrogen sulfide, and the foul-smelling trimethylamine. The average value of TVB for the fillet of tilapia can be seen in table 2.

Table 2. The average value of TVB fillet of tilapia with surimi coating solution for room temperature storage.

| Storage time (hours) | Coating surimi |
|----------------------|----------------|
| 0                    | 9.03           |
| 6                    | 12.56          |
| 12                   | 20.54          |
| 18                   | 24.44          |

The TVB value for the fillet of tilapia obtained during these observations was still categorized as fit for consumption as it is below the standard value of TVB, which is 30 mg N/100 g sample. This refers to the standard freshness of the fish based on the value of TVB. An increase in the value of TVB during storage was due to the degradation of the protein, resulting in a number of volatile bases such as ammonia, histamine, and trimethylamine. Surimi has a positively charged polikation able to bind to proteins, one of which is an enzyme. Surimi which binds to the enzyme is able to minimize the action of the enzyme. The binding of the enzyme by surimi only takes place on the surface of the fillet coated with surimi.

The number of bacteria that grew on the tilapia fillet sample ranged from $1.34 \times 10^4$ to $7.55 \times 10^6$ colonies/g sample. The average results of the analysis of microbes on the tilapia fillet with chitosan coating during storage at room temperature are presented in table 3.

Table 3. The average value of TPC fillet of tilapia with chitosan coating solution for room temperature storage.

| Storage time (hours) | Coating surimi |
|----------------------|----------------|
| 0                    | $1.34 \times 10^4$ |
| 6                    | $2.54 \times 10^4$ |
| 12                   | $3.76 \times 10^5$ |
| 18                   | $7.55 \times 10^6$ |

Surimi has an antibacterial ability in inhibiting the growth of microbes. A thin layer (edible coating) of surimi covering the entire surface of the fish will inhibit the entry of O2 and water through the surface of the fish's body and can hinder the evolvement of microbes [8].

The water content of surimi after the washing effect is presented in table 4. Based on the surimi test, the water content ranged from 82.42% to 89.42%. The average value of the water content of tilapia surimi can be seen in table 4.

Table 4. The average value of water content of tilapia surimi.

| Washing | pH value |
|---------|----------|
| 1       | 89.42    |
| 2       | 88.45    |
| 3       | 84.37    |
4. Conclusion
From the research conducted, results show that washing and storage influenced the surimi and kamaboko produced, where there was a decrease of pH value at each increased washing. More research needs to be done on the storage of whole fish at chilling temperatures according to the K-value method to determine more specific levels of fish freshness. Moreover, additional analysis need to be carried out for further research including proximate analysis, amino acid content, free fatty acids, and the activity of katepsin enzymes. It is also advised to undertake research to test the activity of surimi against the whole fish at chilling temperature storage with the K-value method to see more specific levels of the freshness fish. Other additional analyses are needed for future studies including studies on free fatty acids, and enzyme activity katepsin.

5. References
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