Characterization of edible coating based on surimi fillet catfish as biodegradable packaging

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Abstract. One of the problems that often arise in the fisheries sector is maintaining quality. At room temperature, the fish more quickly enter the phase of rigor mortis and last shorter. If the rigor phase can not be maintained for longer, then decay by enzymes and bacterial activity will take place more quickly. 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 fish is an edible coating. Edible coatings may be hydrocolloid-based (proteins, polysaccharides), lipid-based (fatty acids, acyl glycerol, waxes or waxes) or composite (a mixture of hydrocolloids and lipids). Surimi in the food industry 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 can affect food quality, food safety, and product shelf life positively. Edible protein-based films (protein-based film and coating) have superior inhibitory and mechanical properties compared to polysaccharide-based ones.

1. Introduction

One of the problems that often arises in the fisheries sector is maintaining the quality. The quality of the fish can be maintained if the fish is handled carefully, cleanly, if it is stored in a room with cold and if it is done so quickly. At room temperature, the fish more quickly enter the phase of rigor mortis and last for a shorter period of time. If the rigor phase cannot be maintained for longer, then decay by enzymes and bacterial activity will take place more quickly. The activity of enzymes and bacteria causes changes very rapidly, so fish enter phase of post-rigor. This phase indicates that the quality of fish is now 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 the fish, the more the maintained quality will be.

The retention of fresh fish 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 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 that can be used to extend the freshness of the fish is edible coating. Edible coating can be hydrocolloid-based (proteins, polysaccharides), lipid-based (fatty acids, acyl glycerol, waxes or waxes) and a composite (mixed hydrocolloids and lipids). Surimi in the food industry can be used as an ingredient to make edible packaging, 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 can affect food quality, food safety, and product shelf life positively.

Edible films and coatings, in addition to acting as inhibitors of mass diffusion (moisture, gas, volatile), also serve as food and additive carriers including flavors, antioxidants, vitamins and dyes, as well as improving food handling [1]. 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 acid and have special characteristics that produce functional characteristics that are more varied when compared with the polysaccharides used in the preparation of edible films and coatings, which are mostly homopolymers.

Edible film constitutes a specific category from food packaging defined as a type of packaging that resembles a film, a sheet or thin layer as an integral part of the food product that can be eaten together with the product [2]. Edible film is used in food products to prevent mass transfer between the food products and the surrounding environment or between different phases of the mixed food products. Hence, the film is used to avoid damage to the quality of the food because of the physico-chemical changes, texture or chemical reactions that are ongong (fat oxidation, Maillard reactions and enzymatic reactions).

A protective bulkhead can be formulated to prevent the transfer of water vapor, air, flavor or fat and furthermore to improve the quality of food and to increase shelf life. Osorio *et al.* [3] stated that edible film serves as a barrier to water vapor so then the shelf life of the product can be extended. Bonilla *et al.*[4] declared that oxygen is one of the factors that can degrade the quality of food products. Therefore the use of edible film is one of the ways to reduce oxygen.

Edible film can act as a coating that can be degraded by bacteria that is made from renewable resources. This film can replace petroleum-based films as an effort to enhance environmental awareness. At present, the film that can be degraded derives from proteins and polysaccharides [5]. The difference between edible film and edible coating is that edible film is a packaging material established beforehand as a thin layer (film) before being used to package food products. Edible coating is a packaging material that is formed directly on the product and foodstuffs [6]. Edible films and edible coatings are used in medicinal products, confectioneries, fresh fruits and vegetables as well as some meat products (Navam *et al*., 2005).

According to Gennadios *et al*. [7], the advantages obtained from edible film compared to non-edible traditional packagings are as follows:

1. It can be directly consumed with the packaged product so then there is no packaging waste. If the film cannot be consumed, then it can still be degraded by bacteria, thereby reducing environmental pollution.
2. It can improve the organoleptic properties of the food because the flavors, colorants, and sweeteners can be added to therein.
3. It can be used as a nutritional supplement.
4. It can be applied to small products.
5. It can be applied in a heterogeneous product as an insulator between the components of different foods.
6. It can serve as carriers of antimicrobial and antioxidant compounds.
7. It is suitable for the micro-encapsulation of the food's flavor and leaving agents. It can be used together with a non-edible as the inner layer to prevent the migration of components made from chemicals into the food.

Edible coatings and edible films have been used to control gas exchange (O2, CO2, and ethylene) among food products within the surrounding environment or between food components. Both edible coating and edible film can also control the physiological changes within microbiological and physico-chemical food products [8]. The formation of air bubbles and the possibility of holes are influenced by the preparation techniques and chemical composition, including the concentration of the plasticizer.

The presence of air bubbles and holes affects the permeability characteristics of the film [9]. The potential usage of edible films and edible coatings are to slow down the transportaton of oxygen and

carbon dioxide gas from fruit and vegetables, to sustan or prolong medium moisture transfer, and to lessen the transfer of solutes in the frozen food. The greatest shortcoming of most edible films is their lesser ability when it comes to blocking water, which relates to the hydrophilic properties of edible films.

Surimi can be defined as a minced form of fish meat that has undergone a process of bone loss (deboning), washing and the partial removal of the water content (dewatering), becoming a wet concentrated protein from fish meat [10]. Surimi, as a broken fish meat, is washed many times and mixed with cryoprotectant to prevent the occurrence of protein denaturation during frozen storage. Two main elements that must be considered for good quality surimi are the raw materials derived from white fish meat and the low fat content. Biological factors such as laying phases, seasons and sizes may also affect the quality of the resulting surimi [11].

2. Research method

2.1. Time and place

The present research was performed in the Laboratory of Aquaculture in the Faculty of Fisheries and Marine at Airlangga University.

2.2. Materials and equipment

The materials used in this research were trash 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 physics, and chemical analysis. The tools used included the tools for manufacturing surimi such as knives, scales, plastic trays, grinders, gauze, cutting boards, cool boxes, refrigerators for storage, containers for coating, and the equipment for proximate analysis includng amino acids, TVB, a pH meter, aw meter, TPC, and a viscometer.

2.3. Research methods

This research was conducted in two stages; the preliminary research and the main research. The preliminary research included the testing of the raw materials used as the basic material for the edible coating. The main studies included the manufacture of surimi from trash fish waste fillets into edible coating with various surimi concentrations (2, 4, 6, and 8%). The frozen surimi was thawed for 20 minutes before use. The resulting edible coating of surimi was then analyzed for its viscosity.

2.4. Observations and measurements

2.4.1. Potential Hydrogen Value. The pH measurement was done using a digital pHmeter. Prior to use, the pH meter was rinsed with distilled water and dried with a tissue. Furthermore, it was calibrated using buffer solutions of pH 4 and pH 7.

2.4.2. Total Volatile Base Value (TVB).

The test for the Total Volatile Base was one of the methods of measurement used to determine the freshness of the fish is based on the evaporation of the basic compounds. TVBN analysis was conducted by weighing a sample of 100 grams and adding 300 ml of 7% TCA to it, before mashing. The solution was filtered with filter paper in order to obtain a clear filtrate. The distillation was accommodated with 15 ml of HCl 0.01 M. After addng a few drops of phenol red indicator into the distillate, it was is then titrated with NaOH 0.01 M until pink.

2.4.3. Total Plate Count Value (TPC).

The microbiological test was done by calculating the number of microbes in the sample by dilution as necessary, done in duplicate. A mixture of 1 ml was taken and put into a tube containing 9 ml of sterile 0.85% saline solution in order to obtain a dilution 10-2. The researcher then performed a similar procedure for the dilution of 10-3 and so on up to 10-5 dilution. For sterility, this was then incorporated into a sterile petri dish and allowed to clot. 0.1 ml of the diluted sample was pipetted on

the agar surface. The sample was leveled on the surface of the agar using a sterile glass rod and incubated at 10 °C for 5 days.

2.4.4. Water Content [12].
The cleansed porcelain cup was then dried in the oven for 1 hour at 105 ^{0}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 ^{0}C for 6 hours. They were then chilled with the desiccator for 20 minutes and then weighed several times until the weight was fixed (C gram).

3. Results and discussion

3.1. Potential Hydrogen Value (pH)
The pH value of the washing effect was done 1, 2 and 3 times in a row; resulting in 7.10, 7.12 and 6.59 respectively. The value was still in the range of a good gel-producing category, although the pH value decreased with the amount of washing. The degree of acidity (pH) of the surimi after washing once was still close to the normal pH state. According to Babji and Kee [13], the high pH value at washing time 1 is caused by the loss of acid residues (lactic acid as an anaerobic glycolysis process) in the muscle protein due to the washing effect. It is also asserted that the pH value is very important in relation to gel formation, where gel formation process will become difficult if the pH value is below 6 [14]. The average value of the pH of the surimi of tilapia can be seen in Table 1.

Table 1. The average value of the pH of the surimi of tilapia

Washing	pH value
1	7.10
2	7.12
3	6.59

3.2. Total Volatile Base Value (TVB)
The test for the Total Volatile Base is one of the methods of measurement used to determine the freshness of fish based on the evaporation of the basic compounds. The higher the value of TVB, the more that the meat quality has declined. The TVB value of the coating of tilapia with surimi during storage ranged from 10.12 up to 25.54 mg N / 100 g. The value of the TVB in the fillet of tilapia increased with the length of storage. The increasing value of the TVB of the fish during storage occured due to the degradation of the protein or derivatives, which produced a number of volatile bases such as ammonia, histamine, hydrogen sulfide and foul-smelling trimethylamine. The average value of the TVB fillet of tilapia can be seen in Table 2.

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

Storage Time (Hours)	Coating Surimi
0	10,12
6	13,36
12	21,34
18	25,54

3.3. Total Plate Count Value (TPC)

The number of bacteria that grew on tilapia fillet sample results in the study ranged from 1.14 x 10^4 to 7.35 x 10^6 colonies / g sample. The average results of the analysis of the microbes on the fillet of tilapia with a chitosan coating during storage at room temperature have been presented in Table 3.

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

Storage Time (Hours)	Coating Surimi
0	$1,14.10^4$
6	$2,34.10^4$
12	$3,56.10^5$
18	$7,35.10^6$

3.4. Water Content

The water content of the surimi after the complete washing effect has been presented in Table 4. Based on the surimi test, the water content ranged from 85.37% to 88.52%. The average value of the water content of the surimi on the tilapia can be seen in Table 4.

Table 4. The average value of the water content of the surimi coating on the tilapia.

Washing	pH value
1	88.52
2	87.75
3	85.37

3.5 Discussion

The pH value affected the strength of the gel (ashi). The gel strength was high if the pH of the meat ranged from 6.0 to 7.0; because the myosin protein is easily soluble in the given pH range. Outside of the standard pH range, either in a more alkaline state (pH> 7) or in more acidic state (pH <6), the gel strength will be lower [15, 16]. The value for TVB in the fillet of tilapia obtained during these observations revealed that the product category was still fit for consumption. This is as it was still 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 is due to degradation of the protein resultng in a number of volatile bases such as ammonia, histamine, and trimethylamine. Surimi has a positively charged polikation that is able to bind to proteins, one of which is an enzyme. Surimi is thus 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.

Surimi has an antibacterial ability when it comes to inhibiting the growth of microbes. A thin layer (edible coating) of surimi to cover the entire surface of the fish will inhibit the entry of O2 and water through the surface of the fish's body. This is able make it difficult ofr the microbes to evolve [17].

4. Conclusions

From the research, the results showed that washing and storage in a particular manner had an influence on the surimi and kamaboko produced, where in the washing treatment, the pH value decreased. There is a need to do research into the storage of whole fish at chilling temperatures using the K-value method in order to see more specific levels of freshness in the fish. Additional analyzes that need to be looked into in further research includes the proximate analysis, amino acid content, free fatty acids and the activity of the katepsin enzymes.

5. References

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