Application of edible film from chitosan as biodegradable packaging

E Saputra1,2, W Tjahjaningsih1 and A A Abdillah1

1Department of Marine, Faculty of Fisheries and Marine, Universitas Airlangga, Kampus C Jalan Mulyorejo, Surabaya 60115 Jawa Timur, Indonesia.

2Corresponding Author: ekasaputra@fpk.unair.ac.id

Abstract. The application of film on the African catfish burger stored at room temperature can maintain the quality of the African catfish burger in terms of water content, protein content, fat content, ash content, water activity, and TPC (total plate count) and organoleptic values. Based on these parameters, it can be concluded that the African catfish burger wrapped in the edible film can last up to two days of storage at room temperature.

1. Introduction

The packaging is the final part of a process of production of foodstuffs or other products. The packaging is useful to increase consumer acceptance, but also reduce the degree of damage that occurs during transport. The packaging is also one way to protect or increase the shelf life of food and non-food products. The packaging is not only aimed at preserving, but also a means of supporting the transportation, distribution, and become an important part of the effort to overcome the competition of product marketing. Currently, the packaging industry is dominated by packaging materials made from plastic. This resulted in the increase of plastic waste in the world, including Indonesia. [1] stated that currently about 150 million tons of plastic are produced worldwide each year, most of these plastics cause environmental pollution.

Plastic packaging commonly used are polyethylene, polystyrene, polyvinylchloride (PVC) resin and the many impacts that are not damaging to the environment because both of them cannot be degraded biologically, expensive in recycling and contamination of foodstuffs due to the presence of certain substances migrated into the food. One alternative solution is the use of edible film which has some advantages, such as to protect the product, the original appearance of the product can be maintained, safe for the environment, and can be eaten. [2] stated that one of the benefits of using edible films can reduce microbes are found in foods that can extend the shelf life of the product and safe for consumers. Increased demand for edible film caused by the development of the food industry is also demanding the packaging industry (packaging) to flourish, especially in the food packaging industry. [3] stated edible films are generally made of protein (wheat gluten, collagen, gelatin, keratin, casein, and soy), polysaccharides (hydro soluble cellulose derivatives, starch, alginate, pectin, carrageenan) and lipid (wax, triglycerides, oils, and fatty acids ) all of these materials can be used alone or together.

Chitosan has the potential to be developed as an ingredient for the manufacture of edible films that can be used as a stabilizer, thickener, emulsifier, and forming a clear protective coating for food products. [4] observed that chitosan films are a good barrier against oxygen but the poor barrier to water vapor. Chitosan is a polysaccharide derived from shrimp processing industry wastes. The use of
chitosan as an edible film-making material is expected to reduce shrimp processing waste so that the skin of underutilized shrimp in the shrimp processing industry can be utilized. The existence of the use of chitosan as edible film producers is expected to reduce reliance on the use of plastic as a packaging synthesis. Films with material properties of chitosan have a strong, but less elastic so that the resulting movie looks stiff and less flexible, so it takes an additive or plasticizer to improve the characteristics of the resulting film. One of the materials that can be used as a plasticizer is carboxymethylcellulose (CMC). CMC has the advantage that it can be applied to a wide range of products compared to other water-soluble polymer and CMC is also able to bind with water to minimize shrinkage or increase the water-binding capability.

2. Material and methods
2.1. Time and Place
The present research is performed in the Laboratory of Aquaculture, Faculty of Fisheries and Marine, Airlangga University.

2.2. Materials and Equipment
This research was conducted in two stages, the first stage is the manufacture of edible chitosan films using three different CMC concentrations are 0.1%, 0.3%, and 0.5%.

2.3. Research Methods
The analysis conducted in this study consisted of a 2 analysis is an analysis of the characterization in the manufacture of edible film covering thickness, water vapor transmission rate, tensile strength, and percent elongation [5].

2.4. Observations and Measurements
2.4.1. Proximate test.
Proximate testing includes testing of water content, protein content, fat content, and ash content using AOAC standards.

2.4.2. Water activity (aw).
The tool used to measure water activity is the aw sprint. Swiss Made-Novasiana TH 500. Before using this tool is calibrated using a saturated salt solution whose aw value is known. The sample is cut into small pieces and put into a sensor plate. The sensor cup cover is closed and the start button is pressed to initiate the measurement. A few moments later the monitor screen shows the level of the sample aw.

2.4.3. Total Plate Count Value (TPC).
The microbiological test is done by calculating the number of microbes in the sample by dilution as necessary and done in duplicate. A mixture of 1 ml was taken and put into a tube containing 9 ml of sterile 0.85% saline solution to obtain dilution 10-2. Then performed a similar procedure for dilution of 10-3 and so on up to 10-5 dilution. For sterile incorporated into a sterile petri dish and allowed to clot. 0.1 ml of the diluted sample is pipetted on the agar surface. Example leveled on the surface of agar using a sterile glass rod and incubated at 10 °C for 5 days.

3. Results and discussions
3.1. Proximate test
Based on the results of the proximate analysis conducted, consisting of water content, protein content, fat content, and ash content; the results obtained are listed in Table 1. Based on the table, the edible film is worthwhile to serve as biodegradable packaging materials. Edible film applications were tested for fishery products, namely fish burger.
Table 1. Results of analysis of proximate levels

|                        | Concentration 0,1% | Concentration 0,3% | Concentration 0,5% |
|------------------------|--------------------|--------------------|--------------------|
| Water Content          | 69.79              | 70.11              | 71.43              |
| Protein Content        | 15.11              | 15.15              | 15.34              |
| Fat Content            | 0.30               | 0.31               | 0.31               |
| Ash Content            | 2.45               | 2.48               | 2.55               |

The characterization results in the making of the edible film in the present research, generate thickness values, and tensile strength which meets the standard value criteria for the edible film characterization. Whereas, the water vapor transmission rate and the elongation percentage have not yet met the standard value criteria for the characterization of the edible film. Based on the research conducted, the researchers suggest that in further study, additional material such as plasticizer or the combination with other materials be used in the production of the edible carrageenan film. Hopefully, by the addition of plasticizers, the quality of the film will become much better.

3.2. Water activity (aw)
Based on the research results, the value of the water activity of burger products during storage ranged from 0.916–0.910%. The Aw value of a food ingredient will reach a balance with the relative air humidity (RH) of the space around the food ingredient. If the RH around the room is lower than its Aw, the food will experience water evaporation. On the other hand, if the RH of the room is higher than Aw of the foodstuff, there will be water absorption by the foodstuff until a time when a balanced condition is reached.

3.3. Total Plate Count (TPC) Value
The number of bacteria that grow on edible film sample results of the study ranged from $1.07 \times 10^4$ to $7.35 \times 10^6$ colonies/g sample. The average results of the analysis of microbes on chitosan coating during storage at room temperature are presented in Table 2.

Table 2. The average value of TPC with chitosan coating solution for room temperature storage.

| Storage Time (Hours) | Edible Film   |
|----------------------|---------------|
| 0                    | $1.07 \times 10^4$ |
| 6                    | $2.01 \times 10^4$ |
| 12                   | $3.15 \times 10^5$ |
| 18                   | $7.35 \times 10^6$ |

The oxygen concentration in foodstuffs and the environment affects the types of microorganisms that can grow in foodstuffs. These bacteria need nutrients for life and growth, while the protein content in the African catfish burger is high enough so that it is a good substrate for microbial growth.

4. Conclusions
The application of film on the African catfish burger stored at room temperature can maintain the quality of the African catfish burger in terms of water content, protein content, fat content, ash content, and water activity as well as organoleptic values. Based on the TPC value, the African catfish burger can last up to two days of storage at room temperature.

5. References
[1] Parra D F, Tadini C C, Ponce P, and Lugao A B 2004 Carb Poly 58 475-481.
[2] Perez L M, Balague C E, Rubiolo A C, and Verdini R A 2011 Food Sci 1 287-293.
[3] Gallo Q A J, Debeaufort F, Callegarin F, and Voilley A 2000 Mem Sci 180 37-46.
[4] Butler B L, Vergant P J, Testin R F, Bunn J M, and Wiles J L 1996 Food Sci 5 953-961.
[5] Karbowiak T, Debeaufort F, Champion D, and Voilley A 2006 Inte Sci 2 400-10.
6. Acknowledgement
This paper and research would not have been possible and completed without the extraordinary support from the Faculty of Fisheries and Marine of Universitas Airlangga.

[6] Fernando A, Osorio P, Molina S, Matiacevich J E, and Olivier S 2011 Food Sci 1 287-293.
[7] Bonilla J 2012 Food Eng 2 208-213.
[8] Parris N 1995 Agri and Food Chem 6 1432-1435.