Characteristics of edible film from chitosan as biodegradable packaging

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Abstract. This research aimed to study the capability of CMC in improving the characteristics of an edible film made from chitosan, as well as to see the ability of edible film in maintaining the shelf life of fish burger product at room temperature. Three various concentration of CMC was used, namely 0.1%, 0.3% and 0.5%. The results of chitosan edible film characterization from the three concentrations of CMC showed that the concentration of 0.1% was the best as a plasticizer, with thickness 0.19 mm, water vapor transmission rate 50.8 ml/m²/day, the tensile strength 24.2 kgf/cm², and percentage elongation 18.1%.

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 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 (cellulose, 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 a poor barrier to water vapor. Chitosan is a polysaccharide derived from shrimp processing industry wastes. The use of chitosan as edible film-making materials 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 so as 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. The Film Thickness. The film thickness is measured by Microcal Meshmer. This instrument has an accuracy of up to 0.001 mm. The measurements are taken in five different places, then the results are evenly divided in order to obtain the value of the average film thickness in mm.

2.4.2. Water Vapor Transmission Rate of The Film.
The water vapor transmission pace is measured by using the water vapor transmission rate tester and Bergerlahr cup method. The film that will be measured is conditioned previously at a room temperature of 25 ± 2 °C and RH 45+5% for 24 hours. The moisture-absorbent material (desiccant) is placed in such a way in the cup so that the surface is 3 mm away from the film to be tested.

2.4.3. Tensile strength of the film.
Tensile strength and Elongation percent are measured by using the Tensile Strength and Percent Elongation Tester Strograph-MI Toyoseiki. Prior to the measurement, the film has been conditioned in advance at room temperature for 24 hours. The tool is set on the initial grip separation of 10 cm, crosshead speed 50 mm/minute, and load cell 5 kg.

3. Results and discussion
3.1. Film thickness
The thickness is an important parameter that affects the use of the film in the formation of the product to be packaged. The film thickness ranged from 0.10 to 0.22 the results of studies mm. Histogram
average thickness values can be seen in Figure 1. Based on Figure 1 can be seen that the average value of the film thickness has decreased in line with the addition of CMC concentration.

![Figure 1. Histogram of the average value of thickness.](image)

LSD test results further showed a marked difference between the films of chitosan films without the addition of CMC with the addition of CMC. Films produced from chitosan without giving the CMC has a higher value than the thickness of the films that are subjected to the addition of CMC. This is because the CMC can bind water. Water loss causes the film to have empty cavities in the film so that when the oven-dried the resulting film is getting thin. CMC can bind with water to minimize shrinkage or increase water-binding capability [6].

3.2. Total volatile base value (TVB)
The water vapor transmission rate is the amount of water vapor through a film surface per unit area [7]. Value of the water vapor transmission rate of the film this study ranged from 48.43 to 52.24 ml/m²/day. Histograms of the average value of the water vapor transmission rate can be seen in Figure 2.

![Figure 2. Histogram of the average value of the water vapor transmission rate.](image)

Based on Figure 2 it can be seen that the average value of water vapor transmission rates is relatively similar between each treatment. Based on the results of the analysis of variance were conducted on the value of the water vapor transmission rate, indicating that the treatment did not affect the CMC administration significantly (p> 0.05) to the value of the water vapor transmission rate.

3.3. Tensile strength of the film
Tensile strength indicates the maximum value of the force produced when the tensile test. The higher the force that produced the greater its strength. Edible films with high tensile strength will be able to protect the product from mechanical disturbances well. The tensile strength values of the results of this study ranged from 12.90 to 25.50 kgf/cm². Histogram average tensile strength values can be seen in Figure 3.

![Figure 3](image)

**Figure 3.** Histogram average tensile strength values.

Figure 3 shows the results of the average tensile strength between different treatments, but the results of the analysis of variance showed that treatment CMC administration does not give a real effect on the tensile strength values (P> 0.05).

3.4. Percentage of lengthening

The percentage is the percent elongation of the length of the film material measured starting from the initial length when experiencing withdrawal to drop. The value percent elongation of the results of this study ranged from 16.95 to 20.45%. Histogram average percent elongation values can be seen in Figure 4.

Figure 4 shows the average value of percent elongation. Results of the analysis of variance showed that the administration of the CMC treatment effect (p <0.05) to the value of percent elongation. This is because the nature of chitosan is very stiff/tight in a dry state while the CMC is very elastic/flexible in the dry state. The use of CMC in a larger amount of water caused the ability to bind better to give a gel matrix which can increase the percent elongation of the edible film because CMC has a high gel strength.

![Figure 4](image)

**Figure 4.** Histogram of the average value of percent elongation.
4. Conclusion
The addition of CMC concentration of 0.1% as a plasticizer in the manufacture of edible chitosan films, is the best concentration of the three concentrations used with the characteristic thickness of 0.19 mm, the water vapor transmission rate of 50.8 ml/m²/day tensile strength of 24.2 kgf/cm², and percent elongation of 18.1%.

5. References
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