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An Edible Film Characteristic of Chitosan Made from Shrimp Waste as a Plasticizer

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Abstract
The edible film is expected to replace the plastic packaging, so it can reduce plastic waste used. Information about edible film as food packaging that is stored at room temperature is still very few found. The aims of research is to assess the characteristics of an edible film from chitosan for biodegradable packaging to substitute plastic in general that it could not be processed further. The results of characterization making edible film chitosan with the addition of a plasticizer from carrageenan produce the value of the thickness, and tensile strength film meet the criteria of standard value for characterization of edible film, while the transmission of water vapor and the percentage of lengthening is not yet meet the criteria of standard value for characterization of edible film. Packaging is the final part of a process for the production of foodstuffs or other products. Today, the packaging industry is dominated by packaging materials made from plastic. This resulted in the increase of plastic waste in the world. Plastic packaging commonly used type of polyethylene, polystyrene, polyvinylchloride (PVC) and resins that many impacts are not as good as the environmental damage can not be decomposed by microorganisms, expensive in recycling and contamination of foodstuffs was due to the presence of certain substances migrated into the food material. One alternative solution is the use of edible film which has several advantages, which are able to protect the product, the original appearance of the product can be maintained, safe for the environment and can be eaten.
Keywords: edible film, chitosan, carrageenan, plasticizer

1. Introduction

Packaging is part the end of a production process food or other products. Packaging useful to increase the consumer revenue, also reduce degrees damage during the transport of products. Packaging is also one of a way to protect or adding power savings food products and non food. Packaging not only aimed to preserve, but also be a means of supporting in transportation, distribution, and forms an important part of an effort to overcome competition product marketing (tekpan.unimus.ac.id, 2007). Packaging industry dominated by plastic materials. It has resulted in an increase of plastic waste in the world. Parra *et al*. (2004) indicated that it is about 150 million tons plastic produced in the world every year whereas majority of plastic will cause pollution of the environment. Packaging of plastic used by public is polyethylene, polystirene, with polyvinylchloride (PVC) and the resin that it is not good effect because they are destroying the environment, cannot be degradation to the biology and expensive for the recycling and contamination of foodstuffs.

One alternative is the use of solving an edible film which has had several profit of them are able to protect the product, performance of native products can be maintained, safe for the environment and can directly eaten. Perez *et al*. (2011) stated that one of the benefits of the use of the edible film can reduce microbes contained in the food so that it can extend the savings products and safe for consumers. The increase in demand for edible film caused by industrial development which it is also demanded food packaging and packaging industry developed especially for food packaging industry. Gallo *et al*. (2000) said that an edible film can be produced by protein (gluten, collagen, gelatin, keratine, casein, and soybean), polysaccharide (cellulose derived from hydrosoluble, starch, alginat, pectin, carrageenan), and lipids (wax, triglyceride, oil, and fatty acids) whereas all these materials can be used alone or mixture. Information about chitosan for edible film is still very little. Recently, chitosan can be used for antibacterial and it's used on pharmaceuticals and the health care industry.

Chitosan has the potential to be developed as a material of edible film because it can be used as stablizer, thickener, emulsifier and the framer of a protective layer on food product. Butler *et al*. (1996) observed that the chitosan film is a good barrier against oxygen but a less barrier against water vapor. Chitosan is a derivative of polysaccharides from waste of a shrimp processing industry. The production of shrimp waste are 65-85% of the shrimp weight, most of the shrimp waste produced by the shrimp processing derived from the head, the skin, and the tails. Utilization of chitosan as a making edible film is expected to reduce waste processing shrimp so that the head/skin/tail shrimp which it less to absorb in shrimp processing industry could be more usefull. Furthermore, the utilization of chitosan as an edible film is expected to reduce the dependency of producers against the use of plastic synthesis as packaging. The edible film is expected to replace the plastic packaging, so it can reduce plastic waste used. Information about edible film as food packaging that is stored at room temperature is still very few found. The aims of research is to assess the characteristics of an edible film from chitosan for biodegradable packaging to substitute plastic in general that it could not be processed further. The hope with this research can reduce plastic waste that comes from food packaging materials. Biodegradable food packaging materials are also useful to protect products while reducing plastic waste results from the packaging of foodstuffs.

2. Materials and Methods

2.1 *Preparation of Research Equipment*

This study was conducted in fish processing laboratory at Faculty of Fisheries and Marine, Universitas Airlangga. Edible film of chitosan is referred of Butler *et al*. (1996) method. These research are designed by Random Design Complete with three treatment levels, that is A_1 (0.5% of chitosan concentration), A_2 (1% of chitosan concentration), A_3 (1.5% of chitosan concentration), and A_4 (2% of chitosan concentration).
Mathematic model based on Gasperz (1991) is as follows:

$Yij = \mu + \tau i + \sum ij$

Where:

Yij = the value of observation from repetition-j who received treatment-i
μ = the middle value common
τi = influence treatment-i
∑ij = influence of error-j who received treatment-i

The data collected and analysed statistically with analysis of the variation (ANOVA). If hypothesis rejected then it will be continued to advanced test by smallest real different test to get the best treatment.

2.2 *The Thickness Test*

Measured the thickness of a film with Microcal Meshmer which it has done on the averaged value from measurement of five of different place of edible film.

2.3 *The Strong Pull and Lengthening Percent (ASTM, 1983)*

Strong pull and lengthening percent is measured using a Tensile Strength and Percen Elongation Tester Strograph-MI Toyoseiki. Before measurement, edible film conditioned advance in room temperature for 24 hours. The tool is arranged on an initial grip separation of 10 cm, cross-head speed of 50 mm per minute and load cell of 5 kg. Strong pull determined based on the burden of maximum and lengthening percent when calculated on a film broken or torn.

2.4 *The Rate of Transmission of Water Vapor Using a Method of the Cup (ASTM, 1983)*

The rate of transmission of water vapor is measured using water vapor transmission rate a tester using r a method of the cup. Formerly, edible film to be measured conditioned at rooms with temperature of 25 + 2 ^{0}C and RH 45 + 5 % for 24 hours. Absorbent material water vapor laid into the cup in such a way so that its surface is three mm from film footage that will be tested.

2.5 *Analyses of Microscopic Structure using Scanning Electron Microscope (SEM)*

Analyses of microscopic structure using Scanning Electron Microscope (SEM) are performed by Toya *et al*. (1986). Scanning electron microscopy (SEM) was a microscope that works with the principle of the emission of electrons on the specimen is irradiated .Sample which is tested using SEM to be in a dry substance. Specimen holder cleaned with hand blower to deprive dust on the sample. A specimen is given a thin layer (coating) from gold-paladium (Au: 80% and Pd: 20%) by using percent to use ion sputter machine (JFC-1100). The thickness of coatings is 400 Å. Next, the specimen has coated then it put into the specimen chamber on SEM to take a picture.

3. Results and Discussion

An important parameter is the thickness of the edible film depends on the formation of the product to be packaged. Thickness of the edible film results ranged from 0.18-0.23 mm. Based on research, it can be seen that the average thickness of the edible film showed a decline result with the increased of chitosan concentration. Analysis results of the value of the thickness of the edible film showed that a different of chitosan concentration is not different significantly ($p>0.05$) against the value of the thickness. Based on Japanesse Industrial Standard (JIS), plastic film for packaging of foods categorized movies is having a maximum thickness of 0.25 mm. The thickness of the edible film on this research were range between 0.18-0.23 mm, it means that the thickness of the edible film on this research still meets the standards for food packaging films. The high thickness of the edible film is caused due chitosan which has a high molecular weight and monomer. Suptijah *et al*. (2008) stated that the cationic polymer chitosan have the number of about 2,000-3,000 monomer and molecular weights of around 800 kD.

The rate of transmission of water vapor is the amount of water vapor through a film surface per unit area (McHugh and Krochta, 1994). The transmission is consisting of the process of dissolving and diffusion of active where the vapor of water soluble on one side of the film diffuses and then through the other side. Speed endurance to the transmission of water vapor determined in the condition of the thickness, temperature and pressure gradient partial water vapor. The value of the rate of transmission of water vapor film of the results ranged from 49.93-52.24mL/m^2/day.

The average value of the rate of transmission of water vapor is nearly equal between each treatment relatively. Based on the results of a variety of analysis was conducted on the value of the rate of transmission of water vapor showed that the treatment did not different significantly ($p>0.05$). Based on JIS, the value of the rate of transmission of water vapor of film for packing maximum is 7 mL/ m^2/day whereas the rate of transmission of water vapor from the research is not yet meets the standard of packaging film. It is caused because the chitosan of edible film is produced by polysacharida. McHugh and Krochta (1994) said that generally film made of material of polysaccharides and proteins have the high value of the transmission of water vapor because the material is polar polymers and have the high number of hydrogen bonds so that it can produce the absorption of water in the high humidity.

Tensile strength film show a maximum of force score that produced if it take to perform a pull test. The higher of the force power that produced is causing the lure will be bigger. Edible films with high tensile strength will be able to protect products from disturbance mechanical. The value of tensile strength film from this research ranged from 18.90-26.70 kgf/cm^2. The average of tensile strength film is not different significantly ($p>0.05$). JIS state that the value of tensile strength film for minimal packaging is 4 kgf/cm^2. The edible film was resulted on this research is range between 18.90-26.70 kgf/cm^2.

The decline in value produced is contrary to the increase of chitosan, the tensile strength film is pertaining to the value of the thickness of the edible film, the higher of the thickness of edible film is causing the powerful of lure from edible film will increase. To produce a good edible film can be used a combination with chitosan and glutaral-dehida or locust bean gum because it capable to form a cross bond with chitosan which the cross bond can increase in elasticity of gel. Purwatiningsih (2007) stated that the higher concentration of glutaral-dehida will make the point of the rupture of a matrix gel. The high concentration of glutaral-dehida will make a cross bond of a matrix is closer so that the depth of penetration in the gel become a small fraction.

The percentage of lengthening is percent of elongation from the addition of material film which measured that it starts of the initial length until broken off. The value of the percentage of lengthening of this research result ranged from 15.95-19.45%.The results of the analysis indicate that the treatment of chitosan does not different significantly ($p>0.05$) against the value of percent enlargement. This is because the properties of chitosan are very awkward and dry.

JIS showed that the minimal value of lengthening percent for packaging is 70%. However, the lengthening percent from this research which ranges between 15.95-19.45% is still not yet meet the standards for food packaging. Based on JIS, the edible film produced on this research meet the criteria of thickness and tensile strength film while at the rate of transmission of water vapor and the percentage of lengthening are still have not fulfilled the criteria of JIS so that it need to find an effort to improve the characteristics of a edible film in the rate of the transmission of water vapor and percentage of lengthening. One way that can be done is with material of a plasticizer added.

Microscopic structures of edible film observed by the scanning electron microscope (SEM) to know the internal structure of the edible film from the differentiation of CMC concentration. In general, edible film which are resulting having a closed pore, compact and small so that it is causing the low permeability, this can be proved by the lower of the rate of transmission water vapor. The fracture is induced by chitosan which are very rigid and less elastic. The addition of plasticizer can produce a good of edible film.

4. Conclusion

The results of characterization making edible film chitosan with the addition of a plasticizer from carrageenan produce the value of the thickness, and tensile strength film meet the criteria of standard value for characterization of edible film, while the transmission of water vapor and the percentage of lengthening is not yet meet the criteria of standard value for characterization of edible film.

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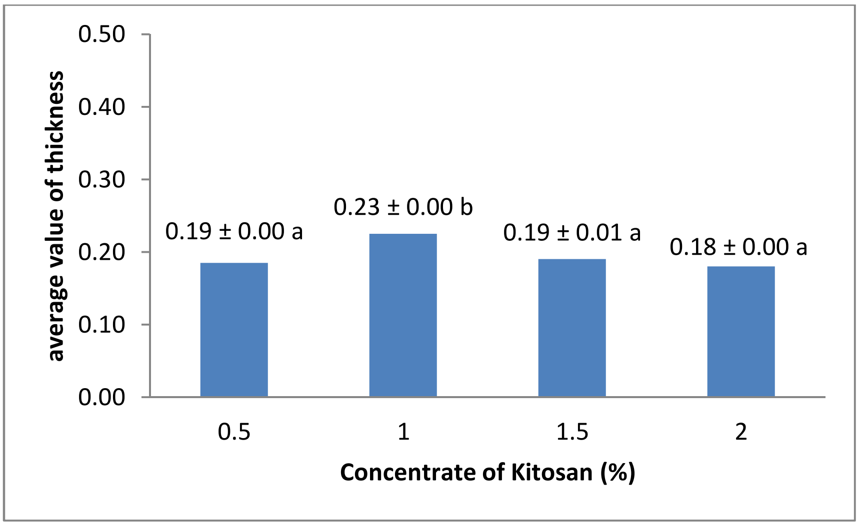

Figure 1. Histogram of the average value of thickness

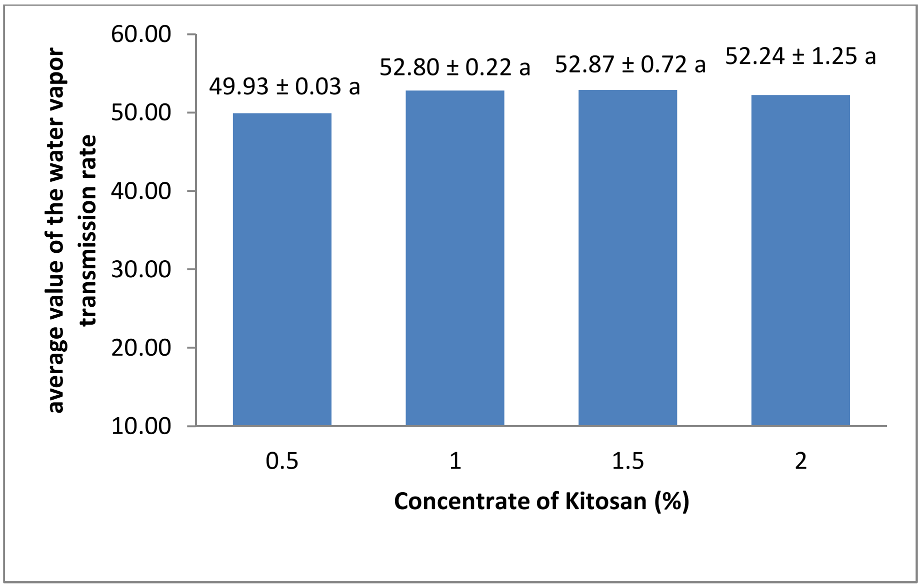

Figure 2. Histogram of the average value of the water vapor transmission rate

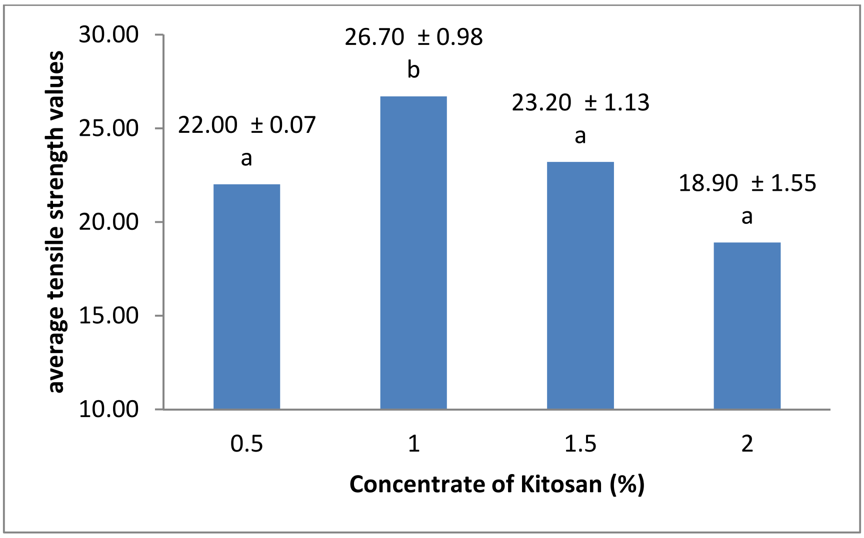

Figure 3. Histogram of average tensile strength values

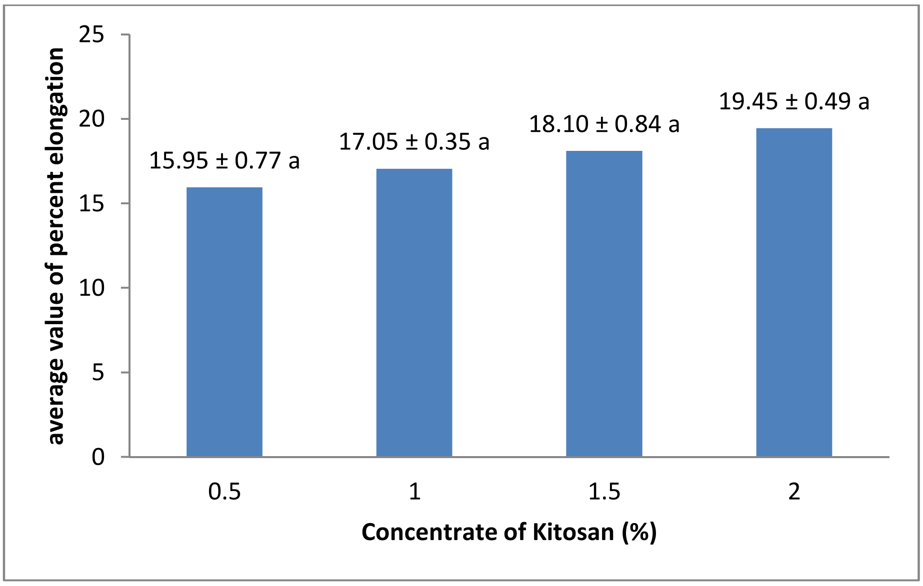

Figure 4. Histogram of the average value of percent elongation

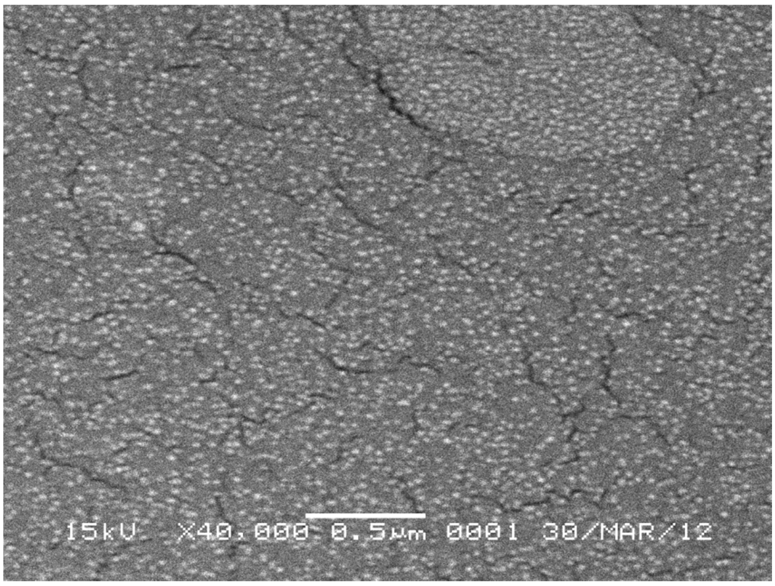

Figure 5. Microscopis structure of edible film