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THE USE OF JACKFRUIT SEEDS AS EDIBLE FILM WITH THE ADDITION OF CARRAGEENAN TENSILE STRENGTH AND BIODEGRADATION

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Abtract : *Edible film* is a thin plastic with a thickness of less than 0,25 mm and serves to protect food products. This study aims to determine the effect of adding carrageenan to edible film made from jackfruit seed starch *(Artocarpus heterophyllus)* on thickness, tensile strength, biodegradation and functional group analysis using the FTIR technique. This research was conducted by varying the concentration of carrageenan used, namely 0%, 0.5%, 1%, 1.5% and 2%. Based on the results of the analysis carried out, the addition of carrageenan affects the thickness, tensile strength and biodegradation of *edible films*. The maximum tensile strength was found in the addition of 1.5% carrageenan, which was 13.315 MPa, while the thickness and biodegradation increased with increasing carrageenan concentration. The tensile strength and thickness values obtained on the edible film have met the JIS ZI 707 standard *edible film*.

keywords : Jackfruit Seed, Carrageenan, Edible Film, Starch, Biodegradation

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I. INTRODUCTION

Indonesia's the increasing use of plastic in daily life is causing serious environmental problems. Plastic waste that is difficult to decompose by microorganisms will accumulate for hundreds of years, affecting environmental pollution (Dewata & Tarmizi, 2015). Based on local statistical data on plastic waste, Indonesia ranks second with 5.4 million tons per year or 14 percent of the total waste production (Handayani & Wijayanti, 2015). In June 2006, the United Nations stated in its Environmental Program that there are 46,000 plastic waste in the ocean every square mile (Nasution, 2015). Plastic waste will degrade in the water into small particles called microplastics. Accidentally ingested marine organisms cause a blockage in the digestive process resulting in death (Warni & Dewata, 2021).

Edible film is a thin plastic less than 0.25 mm thick that serves to protect food products (Paul, 2020). Edible membranes are made from naturally occurring polymers, such as fats, proteins, and sugars, especially starch. Starch is a complex biopolymer widely used in the manufacture of edible films, because starch is easily degraded, difficult to dissolve in water, and easy to obtain. The hydrophilic properties of starch can be used to make edible films (Hidayah et al., 2015). The jackfruit tends to be used only for the flesh of the fruit, so many jackfruit seeds are discarded as waste, as jackfruit seeds are high in starch (Hidayah et al., 2015). 100 grams of jackfruit seeds contain 36.7 grams of carbohydrates with 94.5% starch (Dermawan et al., 2020).

Starch consists of two components, which are amylose and amylopectin. Amylopectin is amylose with branches. The polymeric branch chains are linked via -(1 →6) glycosidic bonds to the remaining linear chains. Branching occurs every 25 residues and the subchain contains about 15 to 25 glucose residues. Amylose is a non-proprietary linear polymer of -D-glucose. Amylose consists of 100 to 1000-D-glucose residues linked together via -(1 →4) glycoside bonds (Moran et al., 2012).

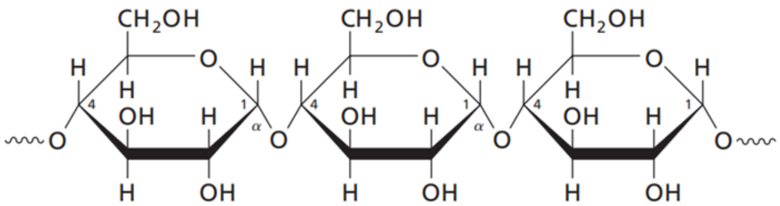

Figure 1 . amylose structure

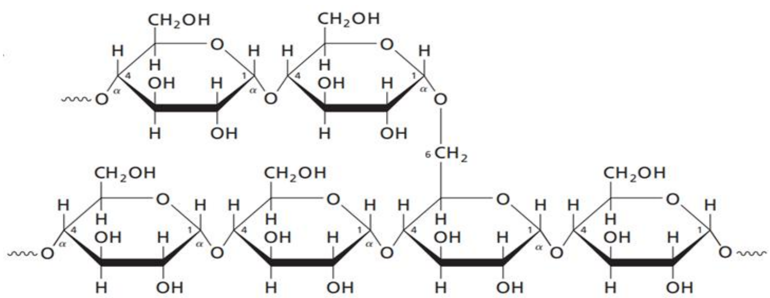

Figure 2 . Amylopectin structure

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The edible film of pure starch has many weaknesses such as rigid, easy to break and less elastic, so it is necessary to add a plasticizer. The manufacture of edible films generally uses plasticizers such as glycerol, sorbitol, and polyethylene glycol (Herrmann & Bucksch, 2014). In addition, the addition of other additives can improve the mechanical properties of edible films, among which is carrageenan. Carrageenan is a high molecular weight polysaccharide extracted from seaweed (Fardhayanti., 2015). In this study, the carrageenan used was kappa-carrageenan which contains many 3,6-anhydro-D-galactose groups, and this group has more hydrophobic properties (Rosley et al., 2017).

II. RESEARCH METHODS

2.1 Tools and materials

The equipment used in the study is divided into two parts preparation and tuk characterization. Sample preparation tools are glassware, heating, magnetic stirrer, thermometer, edible film molds, oven, and desiccator. Edible film characterization equipment is micrometer screw, tensile strength and FTIR.

2.2Starch extract

The percentage of starch extraction from jackfruit seeds by the method implemented by Hedaya (2015) Jackfruit seeds are cleaned from the skin, then cut into small pieces, washed with water until clean, and then soaked in lemon water for an hour. K emudian It is dried and washed with distilled water. Next, the jackfruit seeds are mashed using a blender in a ratio of 1: 1 until the jackfruit seeds are smooth, then the jackfruit seed pulp is obtained and then filtered until the starch comes out from the jackfruit seeds, and then settled for ± 12 hours. After its sedimentation, it is filtered and washed with distilled water. Starch in the form of pasta in the oven at a temperature of 70 ° C for 3 hours. So that produced jackfruit seed starch which is coarse, further starch was obtained by sanding and sieving using a 100 mesh sieve to obtain a fine textured starch.

2.3 Sintesi Edible film

Make edible films by dissolving 5 g of jackfruit seed starch flour in 100 ml of distilled water. The starch solution was added with a plasticizer polyethylene glycol, and variations of carrageenan were added with variations of 0%, 0.5%, 1%, 1.5%, 2% w/v. Using the mixture heated at a temperature of 70-85 ° C for 15 minutes by mixing. Then a solution of an edible film containing a homogenous substance is introduced into a mold and left to cool to room temperature, then dried only by entering the oven at 60 °C for 4 hours (Hidayah et al., 2015)

2.4 Edible Film Characterization

2.4.1 Thickness Edible Film

Edible film thickness test was performed measuring 5 different points at random. Then the obtained thickness values are added and divided so that the average thickness of the edible film is obtained.

$$Thickness = \frac{total\ thickness\ 5points}{5}$$

2.4.2 Test Tensile strength

A robust assay pulls a maximum retention voltage by an edible film that was pulled before the film fell off (Coniwanti et al., 2014). The edible film sample is clamped at

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both ends with a tensile strength tool and then the tool is turned so that the sample breaks.

$$Tensile\ strength = \frac{F}{Ao}$$

Description :

F : Load given (N)

A_0 : cross-sectional area of the sample (M^2)

2.4.3 Edible Film Biodegradation Test

The biodegradation assay was performed by burying the wafer in soil, and the film was cut into small pieces measuring 6 cm × 2 cm, and then weighed with an analytical balance to obtain the initial weight. The weighed film was buried in the soil to a depth of 15 cm for 15 days (3, 6, 9, 12 and 15 day intervals). Then he took the film off the ground and then weighed it so that the weight of the film would be obtained after it was buried. Biodegradation test can be searched by formula:

$$\%weight\ (W) = \frac{W1 - W2}{W1} \times 100\%$$ (Panjaitan *et al.*, 2017)

2.4.4 FTIR Test

Characterization of the edible film structure using the FTIR instrument aimed at identifying the functional groups and types of bonds present in the edible film. The edible membrane samples were marked by the wave number 4000-400 cm^{-1}.

Figure 3 . Jackfruit seed starch edible film

III. RESULT AND DISCUSSION

Edible Film Thickness

Thickness is a characteristic of an edible membrane that can affect the mechanical properties of edible membranes. The thickness of the edible layer will increase with increasing concentration of the constituent solids used so that a thicker edible film is obtained (Setiani et al., 2013). Besides being affected by the components that make up the thickness of the edible film, it is also affected by the area of the printing plate used and the volume of the solution to be printed (Supeni et al., nd.). The effect of adding carrageenan to the thickness of the edible film can be seen in Figure 4.

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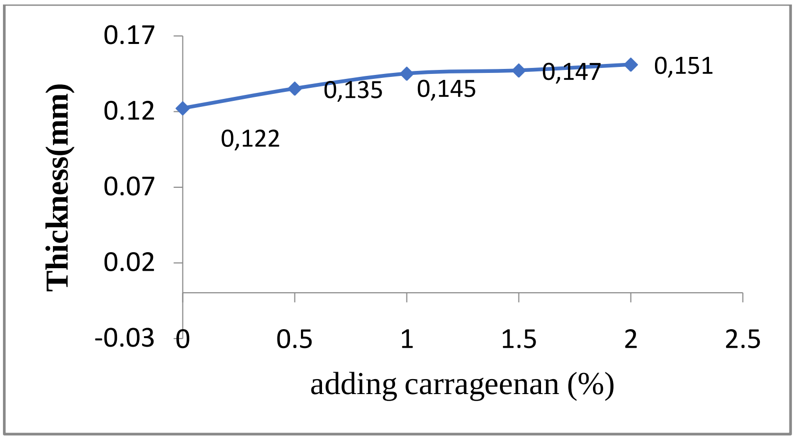

Figure 4 . The effect of adding carrageenan to the thickness of the edible film

Based on Figure 4, the thickness of the edible film increases with the increase in the concentration of carrageenan. The highest thickness can be observed when a 2% concentration of carrageenan is added at 0.151 mM. The increase in thickness value with increasing concentration of carrageenan addition because carrageenan can increase the viscosity of the solution so as to produce an increase in the thickness of the edible film. The thickness value produced according to the Japanese edible industrial standard (JIZ) ZI 707 is good, as it is still less than the maximum edible film standard of 0.25 mm (Setyaji et al., 2018).

Tensile Strenght *Edible Film*

The tensile strength is the maximum pressure the edible film can withstand when pulled before it breaks. A higher value of tensile strength will be obtained for better edible film quality (Coniwanti et al., 2014). The effect of adding carrageenan on the tensile strength of the edible film can be seen in Figure 5.

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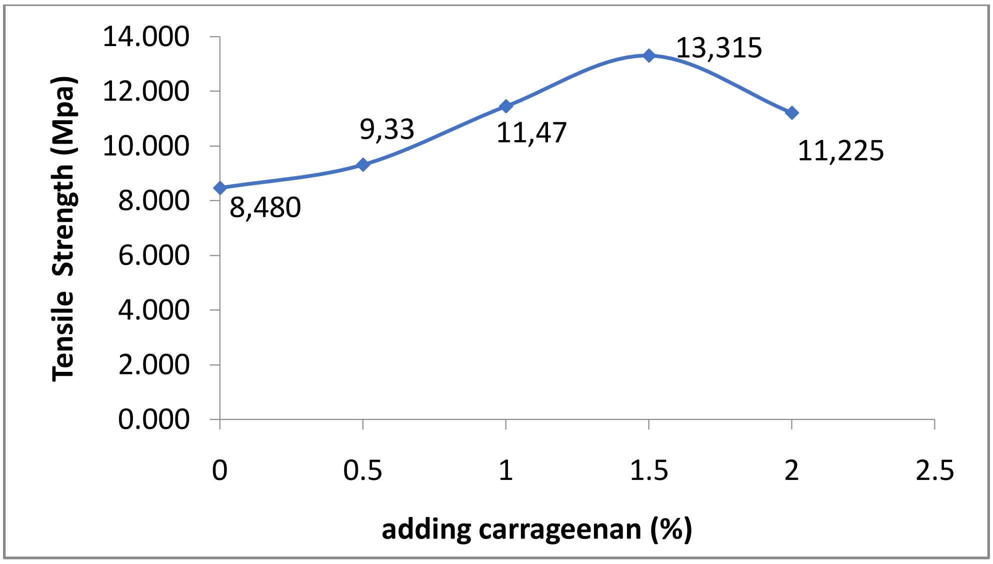

Figure 5 . The effect of adding carrageenan to the tensile strength value of edible film

Based on Figure 5, it can be seen that the tensile strength of the edible film increased with the addition of carrageenan concentration, and then decreased again. The tensile strength value can be seen at the 1.5% carrageenan concentration of 13.315 MPa. Increasing the tensile strength value due to the addition of carrageenan in the edible film which can produce matrix that increase in strength so that the energy required to break is greatest (Wahjuningsih et al., 2019). In addition, a higher concentration of carrageenan will result in a better ability of the edible layer to bind water (Dewi et al., 2020), so that the resulting hydrogen bonds become stronger and more difficult to break (Ikhsan et al., 2021). Based on the Japanese industrial standard, the tensile strength of the obtained edible film is identical to the standard, which is 3.92 MPa.

Edible FilmBiodegradation

The biodegradation test was performed to determine the ability of the film to natural effects in a certain period of time to obtain the percentage of damage. In addition to knowing the time it takes for the film to completely decompose in nature (Pimpan et al., 2001). The biodegradation test is determined by evaluating the effect of burial by weight loss on samples before and after burial. The soil conditions used were controlled at pH 7 and room temperature. Biodegradation is characterized by the breaking of polymer chains characterized by weight loss (Putra et al., 2019). The effect of adding carrageenan to the biodegradation process is shown in Figure 6

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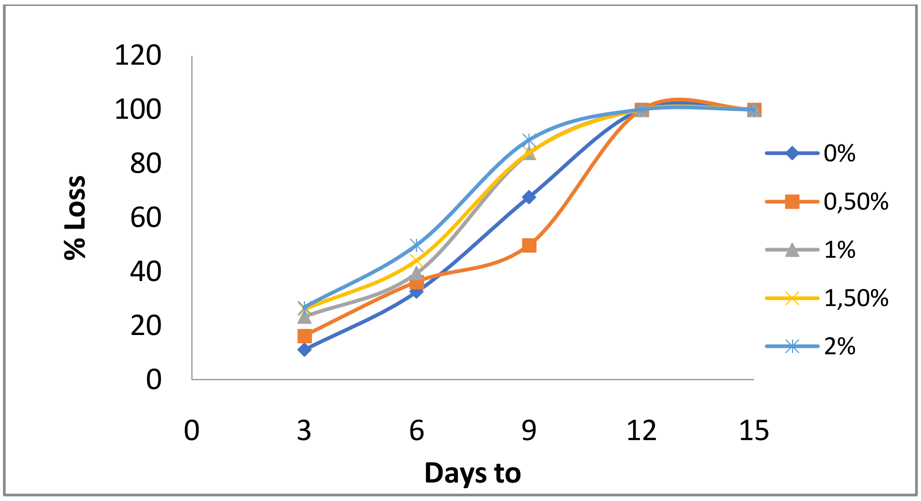

Figure 6 . Effect of carrageenan addition on edible film biodegradation

Based on the image, we can see that the biodegradation of edible membranes increased with increasing concentrations of carrageenan. The higher the concentration of carrageenan added, the % biodegradation of the edible film from day to day continues to increase. The decomposing edible membranes are characterized by damage after burial. Edible film with degradable ability. The edible film has the ability to absorb water, as the number of water levels of the edible film will become an edible film more easily degradable (Herrmann & Bucksch, 2014).

Functional Group Analysis Of Edible Film

The functional group analysis of the edible films was analyzed using the FTIR instrument at wavenumbers 4000-400 cm-1. The edible film test results using FTIR can be seen in Figure 7.

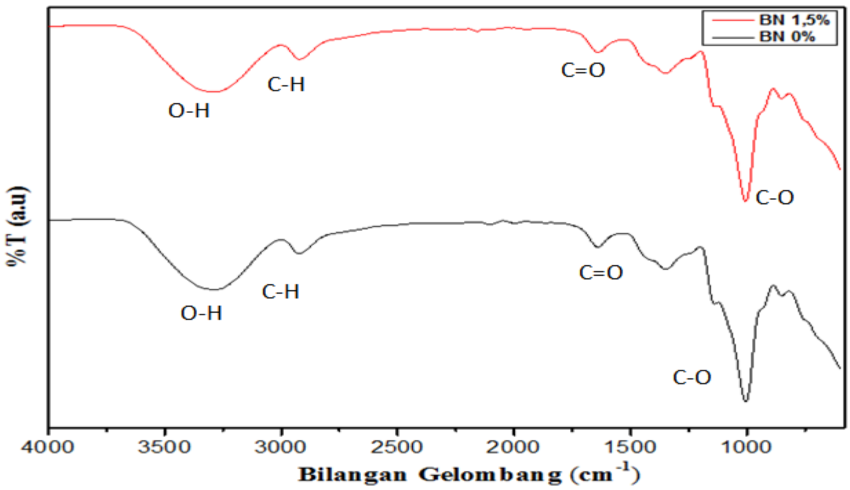

Figure 7 . FTIR spectra of *edible film* without and with the addition of carrageenan

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Based on the FTIR spectra, the functional groups present in the edible film can be analyzed, as in the spectra there is an OH group with an OH wave number of 3600-3010 cm-1, and a CH group with a wave number 3000-2800 cm-1. The presence of a C = O group with a wave number of 1638.65 cm-1, and carbon dioxide at a wave number of 1004.85 cm-1. Based on the results of the FTIR analysis, no new functional groups were found in the edible films with the addition of carrageenan, because at the time of making edible films, only a physical mixing process occurs (Ariska & Suyanto, 2015).

III. CONCLUSION

Edible films with the addition of carrageenan can affect the thickness, tensile strength and biodegradability of edible films. The thickness value increased with the addition of carrageenan, and the maximum tensile strength value was obtained by adding 1.5% carrageenan, while the biodegradation was increased by adding carrageenan.FTIR spectra of edible membranes without addition of chitosan contain OH, CH, C = O and CO bonds where no new functional groups are present.

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