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# EFFECT OF ADDITION OF CARRAGEENAN ON TENSILE STRENGTH AND BIODEGRADATION OF *EDIBLE FILM* FROM CASSAVA PEEL STARCH

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**Abstract:**Edible film is a thin plastic with a thickness of less than 0.25 mm which serves to protect food products. This study aims to determine the effect of adding carrageenan to Edible films made from cassava peel starch (Manihot utilissima) on the mechanical properties and biodegradation of Edible films. This experimental study varied the addition of carrageenan with various concentrations of 0%, 0.5%, 1%, 1.5%, 2%. In this Edible film, data obtained that the addition of carrageenan affects the tensile strength and biodegradation of the Edible film. The maximum tensile strength was obtained by adding 18.54 MPa of carrageenan. Biodegradation of Edible film is increasing along with the addition of carrageenan. The mechanical properties obtained in this study have met the standard of JIS Z1707 Edible film.

Keywords : Cassava Peel (Manihot utilissima), Edible film, Carrageenan, Tensile Strength, Biodegradation

## I. INTRODUCTION

Excessive use of plastic in daily life will have a negative impact on the environment because it is difficult to be degraded by microorganisms, so it will continue to accumulate, impacting environmental pollution (Fathanah et al., 2018) and decrease in the quality of life of humans and other living things (Dewata et al., 2018). Plastic wastein Indonesia is the second largest producer (Inswa, 2013). Plastic waste that is thrown carelessly can last up to hundreds of years in the environment(Dewata & Tarmizi, 2015).

One potential alternative is plastic made from organic (bioplastic) which can be decomposed naturally. Bioplastics are one of the most innovative materials derived from nature and are biodegradable(Sidek et al., 2019). Bioplastics have the same function as synthetic plastics, but are safer and more environmentally friendly. One of the bioplastic products is *Edible film*.

*Edible film* is a thin plastic that has biodegradable properties and a barrier to mass transfer as well as to facilitate food handling (Krochta, 1992). with a thickness

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of less than 0.3 mm which serves to protect food products(Paul, 2020) and can come from food ingredients such as lipids, proteins and polysaccharides, especially starch.

Starch can be used as *Edible film* because it is biodegradable, low production costs and can be renewed (Oluwasina et al., 2019).Materials that have these properties are cassava peel (Manihot utilissima). According to Liu (2005) in Cui (2005) and Iswandi (2012), about 50% of the weight of cassava peel is carbohydrates where the starch content of cassava peel is around 44-59%. Because in Indonesia, cassava peel is very easy to find, so it has the potential to be used as *Edible film*.

*Edible film* has a weakness that is brittle, easily broken and less flexible (Mali et al., 2005; Iswandi & Dewata, 2020). Disadvantages of *Edible films* can be overcome by adding hydrophobic materials such as carrageenan can increase the mechanical strength of the *Edible film* (Suryaningrum et al, 2005).

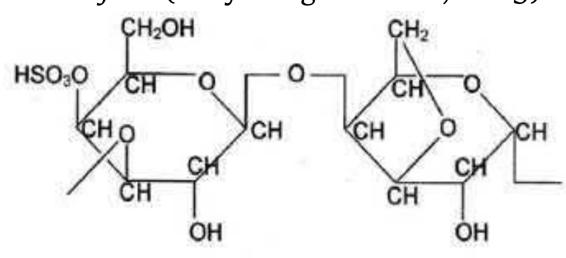


Figure 1.Kappa carrageenan structure(Santoso et al., 2013)

The advantages of carrageenan are that it can increase the structural unity of the product, is resistant to carbon dioxide, oxygen and lipids, has the desired mechanical properties (Murdinah et al., 2007) and can form a gel in water and produce the strongest gel for sample preparation and characterization. The tools for sample preparation are glassware, heating, magnetic Stirrer, thermometer, *Edible film* mold, oven, desiccator. Equipment for characterization of physical properties is a micrometer screw, tensile strength, and FTIR.

## II.RESEARCH METHOD

2.2 Extraction of Starch

Cassava peel washed as much as 100 grams. After that, soaking is done where every 15 minutes the water is replaced until it is slightly clear and then soaked again for 24 hours. Then to facilitate the crushing process, put 100 ml of water and 100 grams of cassava peel into a blender. After that the obtained slurry is filtered and deposited for approximately 30 minutes to obtain a precipitate. After 30 minutes the sediment is separated from the water, then the resulting precipitate is then dried in the sun for about 1-2 days. Then the starch in the oven for 30 minutes at a temperature of 70°C until completely dry.

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2.3 *Edible film* Synthesis

5 grams of cassava peel starch was dissolved in 100 ml of distilled water. Then added 2 ml of polyethylene glycol. After that add carrageenan with variations (0%; 0.5%; 1%; 1.5%; 2%; 2.5% w/v) then at a temperature of 70-80°C stirred and heated for 15 minutes while stirring until homogeneous. After that, the solution was poured into molds and dried in an oven for 4 hours at 60 °C to form a thin layer (*Edible film*). Then the analysis stage is carried out.

2.4 Characterization

2.4.1 Thickness Test

Measurements were made randomly from 5 different points. The thickness values obtained are then added and divided so that the average thickness of the *Edible film* is obtained(Ballesteros-Mártinez et al., 2020).

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

2.4.2 Tensile Strength Test

The tensile test is the maximum tension of the *Edible film* when it is pulled before the *Edible film* breaks(Umar & Dewata, 2017; Hidayati et al., 2019). The *Edible film* sample is clamped at both ends using a tensile strength tool, then the tool is operated until the sample breaks.

$$tensile\ strength = \frac{F}{\text{Ao}}$$

Information :

F : Load given (N)

A0 : Sample cross-sectional area (M2)

2.4.3 *Edible film* biodegradation test

The biodegradation test was carried out using the method carried out by Panjaitan (2017). To get the initial weight (W1), weigh the *Edible film* measuring 2x6 cm using an analytical balance. *Edible film* was buried in the soil to a depth of 15 cm for 7 days. Next, samples were taken from the soil, washed with distilled water and weighed to obtain the weight of the buried film (W2). Percentage of mass loss from *Edible film* can be determined by using the equation:

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

2.4.4 FTIR Test

Characterization of the structure of *Edible films* using the FTIR instrument aims to determine the type of bond and functional groups contained in the *Edible film*. *Edible film* samples were characterized at a wave number of 4000 - 600 cm-1.

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Figure 2.*Edible film* from cassava peel starch with the addition of carrageenan

## III. RESULT AND DISCUSSION

### Thickness

The total amount of solids contained in the solution and the mold used will affect the thickness (Supeni et al. 2015). The results of the thickness test of *Edible films* made from cassava peels with variations in the addition of carrageenan can be seen in Figure 3.

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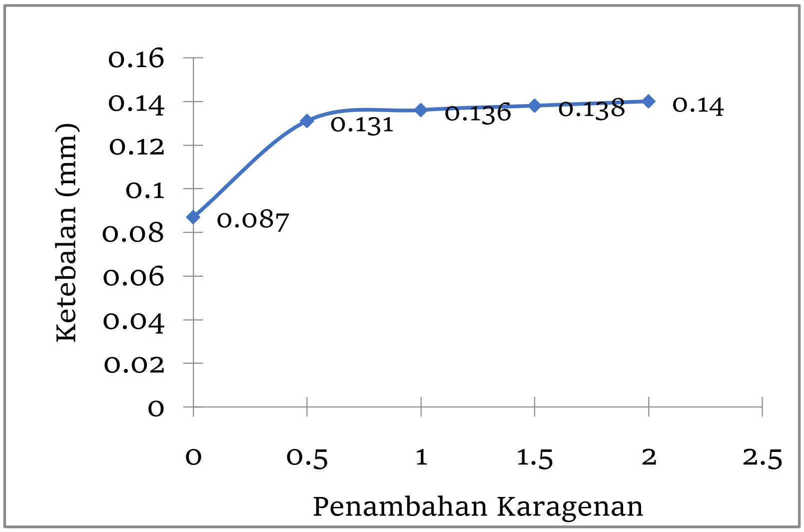


Figure 3.Effect of addition of carrageenan on thickness *Edible film*

The thickness of the *Edible film* continues to increase as the concentration of carrageenan increases where the *Edible film*'s water vapor can be absorbed by the carrageenan to a certain extent. *Edible film* The resulting thickness is in accordance with the Japanese Industrial Standard, which is a maximum of 0.25 mm.

**Tensile Strength *Edible film***

The maximum stress that the *Edible film* can withstand when it is pulled before the film breaks is also known as tensile strength where the higher the tensile strength value of the *Edible film*, the better the quality of the *Edible film* produced(Coniwanti et al., 2014; Dewata & Umar, 2019). The results of the tensile strength test for *Edible films* made from cassava peels with variations in the addition of carrageenan can be seen in Figure 4.

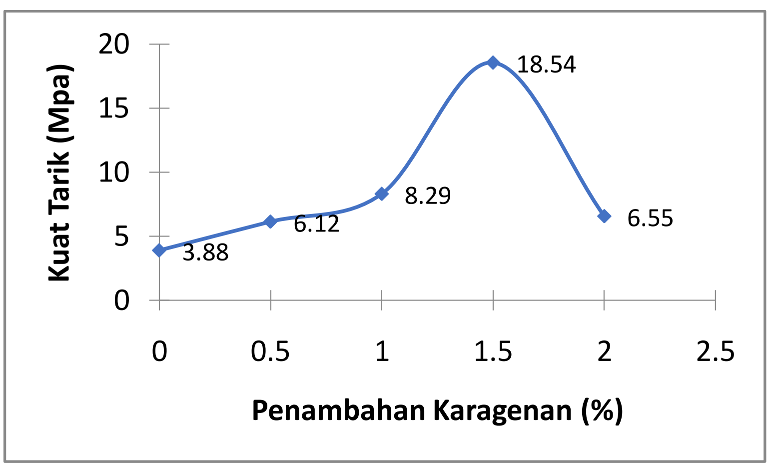


Figure 4.Effect of addition of carrageenan on tensile strength

The tensile strength of *Edible film* increased up to a concentration of 1.5% carrageenan, then decreased at a concentration of 2%. The increase in tensile strength was due to the addition of carrageenan to the *Edible film* which resulted in a stronger film matrix (Wahjuningsih et al., 2019) so that the intermolecular tensile strength on the *Edible film* is getting stronger (Sulistyo et al.,2018; Umar *et al.,* 2018). The decrease in tensile strength at a concentration of 2% was due to the matrix in the *Edible film* having passed the saturation point and too much carrageenan was used which indicated that the carrageenan no longer affected the tensile strength value. Based on the results obtained, the addition of carrageenan to the tensile strength value has met the standards set by*Japanese Industrial Standard*, which is 3.92 MPa.

**Biodegradation of *Edible film***

The biodegradation process is influenced by the type of soil and the number of decomposing microorganisms present in the soil. The biodegradation test was determined by assessing the effect of burial with the percent weight loss on the sample before and after burial. Biodegradation of *Edible film* can be seen in Figure 5.

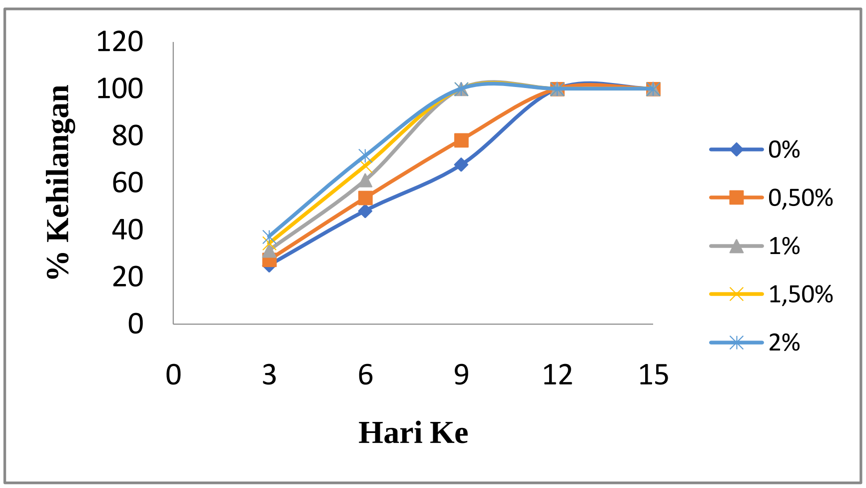


Figure 5.Effect of addition of carrageenan on biodegradation*Edible film*

*Edible film* biodegradation increased with increasing carrageenan concentration. The more carrageenan is added, the % biodegradation of the *Edible film* from day to day continues to increase. Maulana et al.(2021) stated that *Edible film* is easily degraded because it contains hydroxyl (OH) and carboxyl (CO) groups which are easily degraded in nature.

**FTIR**

The characterization of the functional groups contained in edibles using the FTIR instrument was carried out at a wave number of 4000 - 600 cm-1. The results of the FTIR *Edible film* test can be seen in Figure 6.

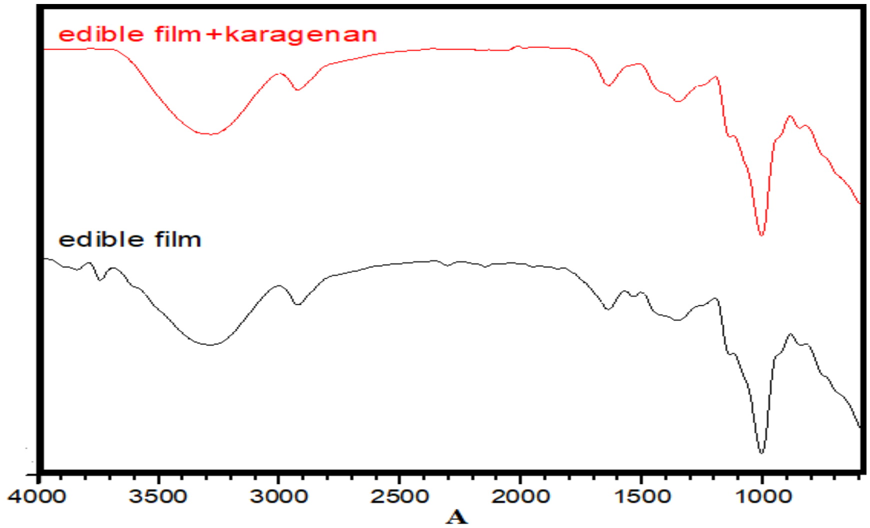


Figure 6. FTIR spectra*Edible film* and *Edible film* + carrageenan

Based on the FTIR spectra. The functional groups of *Edible films* can be analyzed without the addition of carrageenan, showing that the presence of OH bonds at wave numbers 3576-3000 cm-1, CH bonds at wave numbers 2989-2845 cm-1, C=O bonds at wave numbers 1693-1554 cm-1, -CH bonds at wave number 1354.88 cm-1, CO bonds at wave numbers 1122-935 cm-1 and on *Edible film* with carrageenan indicate that there are OH bonds in the wave number area 3696-3004cm-1, CH bonds at wave numbers 3000-2818 cm-1, C=O bonds in the wave number 1694-1523 cm-1, –CH bonds in the wave number 1351.13 cm-1, CO bonds in the wave number 1124-884 cm-1. So that in *Edible films* with the addition of carrageenan only physical changes occur because no new functional groups are formed.

## IV. CONCLUSION

The addition of carrageenan to the *Edible film* affects the tensile strength and biodegradation of the *Edible film*. The tensile strength value increased with the addition of carrageenan, while the biodegradation of *Edible film* decreased with the addition of carrageenan.The FTIR spectra of *Edible film* without and with the addition of carrageenan have OH, CH and CO bonds.

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