JKPL Jurnal Kependudukan dan Pembangunan Lingkungan
ISSN 2775-7471 (P) 2775-748X (E)
Vol 3 No 1 Juni 2022

Production of Edible Film from Durian Seed Starch (Durio zibenthinus) as Biodegradable Plastic

*Zikra Putri Rustian and Indang Dewata
Departemen Kimia, Padang State University, Indonesia

*Email: rustianzikra@gmail.com

Abtract: The edible film is a plastic that is easily degraded by microbes in the soil due to the presence of starch. The purpose of this study was to determine the effect of adding PEG-based carrageenan and determine the physical, mechanical, and biodegradable properties, and to compare it with the Japanese Industrial Standard (JIS) ZI707. The study was conducted using 4% PEG and variations in the addition of carrageenan concentrations of 0%, 0.5%, 1%, 1.5%, and 2%. The results of the physical properties test, the higher the concentration of addition of carrageenan, the higher the thickness value. The results of the tensile strength test showed that for the addition of 0% concentration the results obtained were 0.352 Mpa for 0.5% concentration, namely 0.568 Mpa, for 1% concentration, 0.746 Mpa, for 1.5% concentration, 1.047 Mpa and 2% concentration of 0.896 Mpa. For testing the mechanical properties, the optimum results were obtained with the addition of 1.5% carrageenan concentration with a tensile strength of 1.407 MPa and an elongation of 0.582%, and an elasticity of 403 MPa. The FTIR results show that there are no new functional groups from the test results.

Keywords — edible film, carragenan, PEG4, durian

I. INTRODUCTION

The rapid development of the era has resulted in the higher use of plastic as a life support material. Indonesia is recorded as the second largest country in the world as a contributor to plastic waste. Plastic waste that is thrown into the environment will take a long time to degrade and last a long time in the marine environment. Plastic waste that has been in the water for a long time will be degraded so that it turns into smaller particles called microplastics (plastic particles with a size of <5mm). and can end in death (Warni & Dewata, 2021).

The edible film is a thin layer of organic material that is generally edible and can be used as a new alternative for food coating materials as a layer that can inhibit the transfer of carbon dioxide, oxygen, moisture, aroma, and dissolved substances in food (Murni et al).

The durian plant (Durio zibenthinus) is a fruit that comes from tropical countries, one of which is Indonesia, whose production can be said to be abundant. The result of durian fruit that has not been used optimally is durian seeds. Durian seeds have a fairly high starch content of 43.6%. This high enough content makes starch from durian seeds can be used as one of the basic ingredients for making starch-based edible films. This durian seed starch-based edible film will be added with Polyethylene Glycol (PEG) in order to increase the stability and elasticity of the edible film, but from the results obtained, the edible film produced is still relatively fragile.

The addition of carrageenan in the study is an addition to the elasticity and strength of the edible film. The carrageenan used is the type of kappa carrageenan (K-Carrageenan). K-Carrageenan has a sulfate ester content of about 25% to 30% (Rusli et al., 2017). In K-Carrageenan, it is this sulfate ester group that has a relationship with the strength properties possessed by Kappa Carrageenan type carrageenan. With the addition of K-Carrageenan, it is expected to produce edible films with better characteristics than pure starch (Sulistyo F.T. et al., 2018).

This research will use the gelatinization method. Gelatination in general can be defined as a process of swelling of the granules of starch which has irreversible properties. This method will work optimally if the sample is heated at a temperature range of 55 – 65 °C. The addition of carrageenan variations will be carried out at five different concentrations, namely concentrations of 0%, 0.5%, 1%, 1.5%, and 2%.

Tests of physical and mechanical properties were carried out in order to determine the optimum conditions for the addition of carrageenan in the manufacture of edible films made from durian seed starch. The physical properties tested were the thickness of the edible film and testing the mechanical properties by testing the tensile strength and elasticity of the edible film. The characterization analysis will be carried out using the FTIR tool. The introductory section mainly contains: (1) Situation Analysis; (2) Problems; (3) Solutions offered to solve the problem; (4) summary of theoretical studies related to problem solving; and (5) expectations of the results and benefits of community service.

II. IMPLEMENTATION METHOD

This research was conducted in February – June 2022. The preparation and analysis of edible films were carried out at the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Padang State University, and testing of the mechanical properties of edible films was carried out at the Metallurgical Laboratory, Faculty of Mechanical Engineering, Andalas University, Padang.

The materials used were durian seed starch which was extracted using distilled water, lime water as a soaking medium from durian seeds to reduce the sap present in durian seeds, kappa carrageenan type carrageenan, and polyethylene glycol (PEG).

A. Durian Seed Starch Production

Edible films are made using starch produced from starch made from the extraction of durian seeds. Extraction of starch is done by cutting the durian seeds into small pieces and soaking the seeds in lime water for approximately 1-2 hours to reduce the sap. After soaking the durian seeds, they were washed using distilled water and blended finely. After that, the mashed durian seeds will be deposited for 24 hours to form two phases. Then the precipitate will be separated and dried in an oven at 50°C for 6 hours. Then the starch from durian seeds will be tested for iodine (Cornelia et al., 2013)

B. Edible Film Production

Edible Film is made using the gelatinization method. Starch was weighed as much as 5 grams then added with 100 ml of distilled water then added 2 ml of polyethylene glycol 4% and carrageenan addition concentrations of 0%, 0.5%, 1%, 1.5%, and 2%

and will be heated at a temperature of 70-80°C. until the mixture thickens. The mixture will then be poured into a plastic mold and allowed to stand for a while at room temperature and then heated in an oven at 60°C for approximately 4 hours with periodic control to avoid cracks in the edible film (Sari et al., 2021).

C. Physical Properties of Edible Film (Thickness) Testing

The thickness test of the edible film was carried out with a screw micrometer. Testing will be carried out at 5 different points. Then the value of the 5 test points is calculated so that the average value of the thickness of the edible film is obtained.

D. Edible Film Mechanical Properties Testing

Tensile strength and elasticity tests were carried out with both ends of the edible film clamped using a tensile strength tool, which then operated until the edible film broke. Then the computer monitor will show the tensile strength (Mpa) (%) elongation and elasticity of the sample.

E. Analisa Gugus Fungsi Edible Film

Functional group analysis will be carried out using the FTIR instrument where the edible film sample tested is a sample that has optimum conditions based on the results of testing the mechanical properties of the edible film.Tensile strength and elasticity tests were carried out with both ends of the edible film clamped using a tensile strength tool, which then operated until the edible film broke. Then the computer monitor will show the tensile strength (Mpa) (%) elongation and elasticity of the sample.

III. RESULTS AND DISCUSSION

A. Durian Seed Starch Production

Starch is a polysaccharide composed of amylose and amylopectin. Durian seed starch is obtained by a simple extraction process using distilled water as the solvent, so that durian seed starch deposits are obtained. This starch precipitate will then be washed thoroughly using distilled water and dried using an oven to obtain a white durian seed starch powder.

The durian seed starch powder obtained was then tested quantitatively using the FTIR instrument and qualitatively tested with the iodine test. The test using the FTIR instrument is to analyze the functional groups contained in durian seeds. The results of the analysis of the functional groups of durian seed powder using FTIR can be compared with the functional groups of starch in the laboratory.

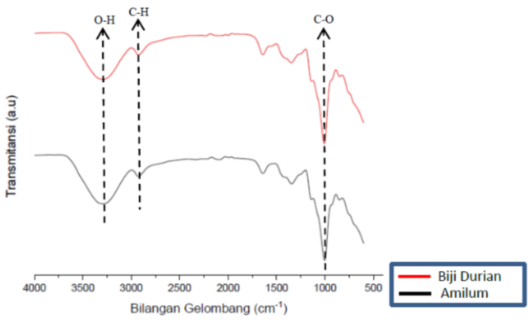

Figure 1. Comparison of FTIR Results of Starch and Starch Standards

Based on the test results, it can be seen that the stingray from durian seeds has O-H bonds at wave numbers 3550 – 3200 cm-1, C-H bonds at wave numbers 3000 – 2840 cm-1, and C-O bonds at wave numbers 1085 – 1050 cm-1. The results of the spectra of durian seed starch when compared with starch in the laboratory have almost the same results.

B. Edible Film Production

Figure 2. *Edible Film from Durian Seed Starch*

Making edible films using starch from durian seeds involves a gelatinization process. The gelatinization process occurs when the starch granules interact with water at high temperatures resulting in the breakdown of hydrogen bonds. This broken hydrogen bond results in the entry of water into the starch granules, resulting in swelling of the starch granules. The size of the starch granules will continue to swell until they finally burst. At this time, the amylose and amylopectin contained in the starch diffuse out and form a gel (Jacob et al., 2014). The gel formed from the above process will then be printed and dried in an oven at 60°C for 4 hours.

Edible films are made by mixing several materials without any change in chemical structure, and only physical changes occur. Where in the process no new substances are formed but only interactions occur between hydrogen bonds with starch used with polyethylene glycol (PEG) and carrageenan. The addition of plasticizers can reduce intramolecular hydrogen bonds between polymers or can reduce intermolecular strength so that the addition of plasticizers can reduce or overcome the brittleness of edible films (Nofiandi et al., 2016). Carrageenan has sulfate groups and non-sulfate groups and has a strong gel structure so that it can produce edible films of better quality (Putri & Fitrianto, 2020).

C. Physical Properties of Edible Film (Thickness) Testing

The thickness of the edible film is a characterization that can affect the mechanical properties of the edible film. The thickness of the edible film will increase along with the increasing concentration used as a constituent of the edible film (Setiani et al., 2013). Film thickness is a physical property of the film that can be affected by the concentration of dissolved solids in the film-making solution and the size of the film printer used (Murni et al., 2013).

No	Carragenan	**Thickness**						Total	Averange
		Point 1	Point 2	Point 3	Point 4	Point 5	Point 6		
1	Without carragenan	0.08	0.065	0.07	0.065	0.07	0.07	0.42	0.07
2	Carragenan 0,5%	0.08	0.085	0.085	0.09	0.08	0.075	0.495	0.0825
3	Carragenan 1%	0.085	0.085	0.085	0.09	0.08	0.08	0.505	0.0842
4	Carragenan 1,5%	0.09	0.085	0.08	0.09	0.08	0.09	0.515	0.0858
5	Carragenan 2%	0.095	0.09	0.09	0.100	0.095	0.08	0.55	0.0917

Table 1. Edible Film Thickness Data

JKPL Jurnal Kependudukan dan Pembangunan Lingkungan
ISSN 2775-7471 (P) 2775-748X (E)
Vol 3 No 1 Juni 2022

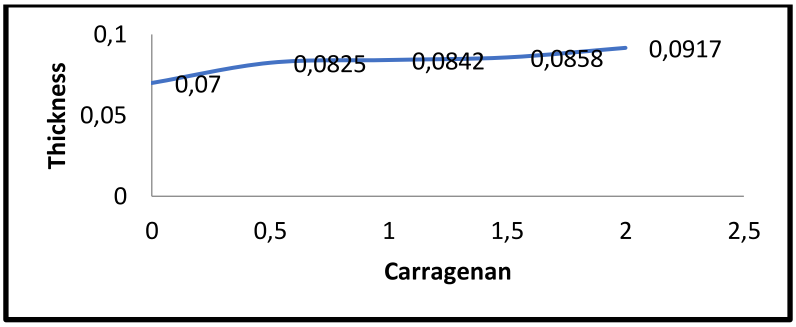

Figure 3. Graph of the Effect of Addition of Carrageenan Concentration to Thickness

Based on the picture, it can be seen that as the concentration of carrageenan increases, the thickness value also increases. The highest thickness value is at the concentration of 2% carrageenan addition, which is 0.0917. The higher the concentration of carrageenan added, the more the thickness of the edible film produced will increase. This is because the addition of carrageenan can increase the viscosity of the solution, resulting in an increasing thickness of the edible film (Handito, 2011).

D. Mechanical Properties of Edible Film

1. Edible Film Tensile Strength

Tensile strength is the maximum strain that the edible film can withstand before it breaks. Where the higher the value of tensile strength, the better the quality of the edible film produced (Jacob et al., 2014). The parameters of the tensile strength are carried out to determine the ability of the structure to be able to withstand the given load without being damaged. The following table data on the thickness of the edible film

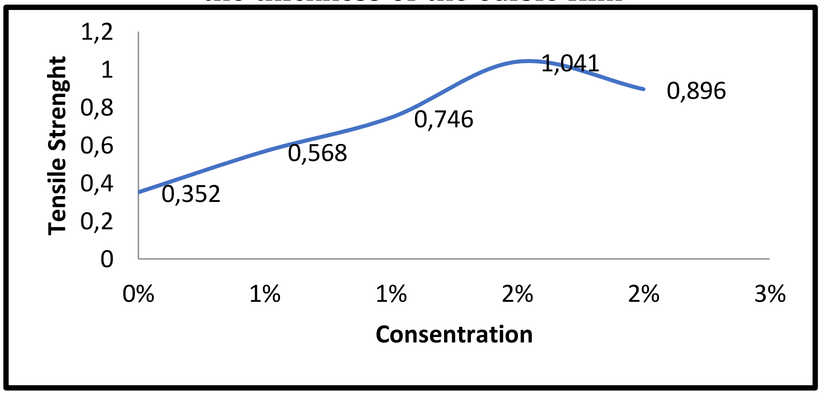

Figure 4. Graph of Effect of Addition of Carrageenan Concentration to Tensile Strength

Based on Figure 13, it can be seen that the tensile strength value of the edible film increased along with the addition of carrageenan concentration and then decreased again. The highest tensile strength value is at a concentration of 1.5%, which is 1.041Mpa. The addition of carrageenan concentration causes an increase in the tensile strength value of the edible film because carrageenan can form a stronger polymer matrix on the edible film (Jacoeb et al., 2014).

The increase in the tensile strength value occurred at a concentration of 1.5% and then decreased again at a concentration of 2%. This is because the addition of carrageenan up to a concentration of 1.5% can still form a strong matrix due to the intermolecular bonds of starch with carrageenan. However, at a concentration of 2% carrageenan addition, the tensile strength value decreased. This is due to the

Jurnal Kependudukan dan Pembangunan Lingkungan
ISSN 2775-7471 (P) 2775-748X (E)
Vol 3 No 1 Juni 2022

saturated condition in the matrix of the edible film so the addition of carrageenan no longer works for the tensile strength value.

2. Modulus Elastisitas *Edible Film*

The elasticity of the edible film is a measure of the strength of the edible film produced

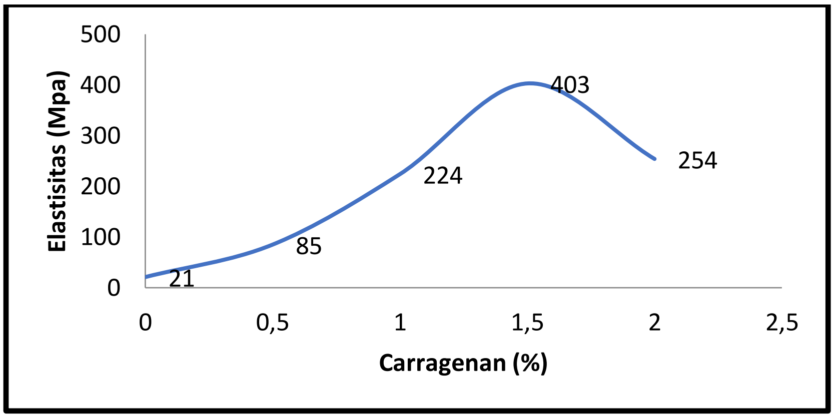

Figure 5. Graph of the Effect of Addition of Carrageenan Concentration to Elasticity

Based on the graph above, it can be seen that the elasticity has increased at the concentration of 1.5% addition of carrageenan, which is 403 Mpa. The elasticity value of the edible film is influenced by the addition of carrageenan concentration, where the greater the carrageenan concentration added, the more the elasticity value will increase. The greater the concentration used, the thicker the polymer composing the matrix, as a result, the force required to break the specimen will be greater and the tensile strength value will be even greater (Ariska & Suyatno, 2015).

E. Edible Film Functional Group Analysis

Characterization of functional groups on edible films was carried out using the FTIR instrument in the range of wave numbers of 4000-400 cm-1. Analysis using FTIR only involves the mechanical properties of the edible film, namely the optimum tensile strength and elasticity of the edible film.

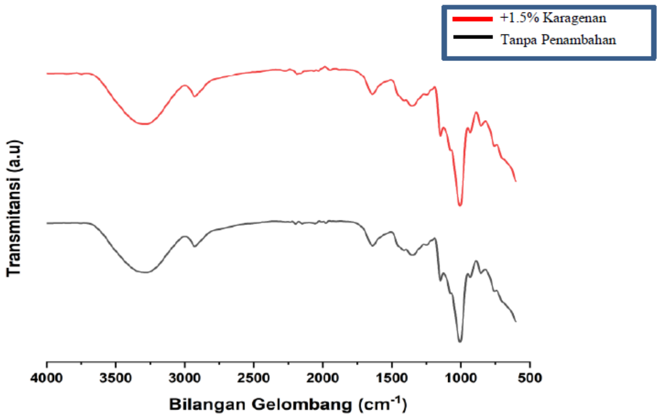

Figure 6. Spectra of FTIR Edible Film Without Addition of Carrageenan and Optimum Conditions of Addition of Carrageenan

Tests were carried out to determine or analyze the functional groups present in edible films made without the addition of carrageenan. The figure shows that there are O-H bonds at wave numbers around 3550 – 3200 cm-1, C-H bonds at wave numbers 3000 – 2840 cm-1, C-O bonds (carbonyl) at wavelengths 1085 – 1050 cm-1, and C=O bonds. in the range of wave numbers 1900 – 1650 cm-1.

The next test is to analyze the functional groups present in the edible film with the addition of carrageenan. In the picture it can be seen that there are O-H bonds at wave numbers 3500 – 3200 cm-1, C-H bonds at wave numbers 3000 – 2840 cm-1, C-O bonds (carbonyl) at wavelengths 1085 – 1050 cm-1 and C=O bonds at wavelengths 1085 – 1050 cm-1. range of wave numbers 1900 – 1650 cm-1.

Based on testing using FTIR spectra, no new functional groups were found which indicated that the edible film only had a physical blending process due to the absence of new functional groups so that the film had the same properties as its constituent components (Herrmann & Bucksch, 2014).

IV. CONCLUSION

The optimum condition for the addition of carrageenan in the manufacture of edible films from durian seed starch is the addition of 1.5% carrageenan because it has the highest tensile strength value of 1,041 MPa and elasticity value of 403 MPa and characterization using FTIR did not show the addition of new functional groups.

Referension

Ariska, R. E., & Suyatno. (2015). Pengaruh konsentrasi karagenan terhadap sifat fisik dan mekanik *Edible Film* dari pati bonggol pisang dan karagenan dengan plasticizer gliserol. *Prosiding Seminar Nasional Kimia*, 34–40.

Cornelia, M., Syarief, R., Effendi, H., & Nurtama, B. (2013). Pemanfaatan Pati Biji Durian (Durio zibethinus Murr.) dan Pati Sagu (Metroxylon sp.) Dalam Pembuatan Bioplastik. *Jurnal Kimia Dan Kemasan*, *35*(1), 20. https://doi.org/10.24817/jkk.v35i1.1869

Handito, D. (2011). Pengaruh Konsentrasi Karagenan Terhadap Sifat Fisik Dan Mekanik Edible Film (the Effect of Carrageenan Concentrations on Mechanical and Physical Properties of Edible Films). *Agroteksos*, *21*(2–3), 151–157.

Herrmann, H., & Bucksch, H. (2014). Dictionary Geotechnical Engineering/Wörterbuch GeoTechnik. In *Dictionary Geotechnical Engineering/Wörterbuch GeoTechnik*. https://doi.org/10.1007/978-3-642-41714-6

Jacoeb, A. M., Nugraha, R.-, & Dia utari, S. P. sri. (2014). Pembuatan Edible Film Dari Pati Buah Lindur Dengan Penambahan Gliserol Dan Karaginan. *Jurnal Pengolahan Hasil Perikanan Indonesia*, *17*(1), 14–21. https://doi.org/10.17844/jphpi.v17i1.8132

Murni, W., Pawignyo, H., Widyawati, D., & Sari, N. (2013). *Prosiding Seminar Nasional Teknik Kimia "Kejuangan" Pembuatan Edible Film dari Tepung Jagung (Zea Mays L.) dan Kitosan*. 1–9.

Nofiandi, D., Ningsih, W., & Putri, A. S. L. (2016). Pembuatan dan Karakterisasi Edible Film dari Poliblend Pati Sukun-Polivinil Alkohol dengan Propilenglikol sebagai Plasticizer. *Jurnal Katalisator*, *1*(2), 1–12. https://doi.org/10.22216/jk.v1i2.1113

Putri, R. D. A., & Fitrianto, R. (2020). Research Innovation and Entrepreneurship Edible Film Innovation from Jackfruit Seed Starch (Artocarpus hetrophyllus) with the Addition of Sorbitol and Carrageenan. *International Journal of Research Innovation and Entrepreneurship*.

Rusli, A., Metusalach, Salengke, & Tahir, M. M. (2017). Karakterisasi Edible Film Karagenan Dengan. *Jphpi*, *20*(2), 219–229.

Setiani, W., Sudiarti, T., & Rahmidar, L. (2013). Preparasi Dan Karakterisasi Edible Film Dari Poliblend Pati Sukun-Kitosan. *Jurnal Kimia VALENSI*. https://doi.org/10.15408/jkv.v3i2.506

Sulistyo F.T., Utomo A.R., & Erni S. (2018). KARAKTERISTIK FISIKOKIMIA EDIBLE FILM BERBASIS GELATIN (Effects of Carrageenan Concentration towards Physicochemical Characteristic of Gelatin Based Edible Film). *Journal of Food Technology and Nutrition*, *17*(2), 75–80.

Warni, K., & Dewata, I. (2021). Penentuan Limbah Mikroplastik Polyethylene Terephthalate Dengan Metode Glikolisis Dalam Air Laut di Kota Padang. *Periodic*, *10*(1), 21–27.