JKPL
JURNAL KEPENDUDUKAN DAN PEMBANGUNAN LINGKUNGAN

p_ISSN = 2775-7541
e_ISSN = 2775-748x
Vol 2 no 2 Tahun 2021

THE EFFECT OF CHITOSAN ON EDIBLE FILMS FROM CASSAVA PEEL ON TENSILE STRENGTH AND BIODEGRADATION OF EDIBLE FILM

***Vira Maryati, Indang Dewata**

Departement Chemistry,FMIPA Universitas Negeri Padang-Indonesia
*Coresponding Author: viramaryati99@gmail.com

Abstract : Edible film is a plastic that has a thickness of less than 0.25 mm and functions as a wrapper for food products. This study aims to determine the effect of adding chitosan to edible films made from cassava peel starch on the tensile strength and biodegradation of edible films. Variations in the concentration of chitosan added were 0%, 0.5%, 1%, 1.5% and 2%. Based on the results of the analysis that has been carried out, it is obtained data that the addition of chitosan affects the tensile strength and biodegradation of the edible film. The maximum tensile strength value was obtained with the addition of 1% chitosan of 14.91 Mpa. Biodegradation of edible film decreases with the addition of chitosan. Edible film without the addition of chitosan has a biodegradation value of 55.64%, while the edible film with the addition of 0.5%, 1%, 1.5%, and 2% chitosan has a biodegradation value of 43.72%, 24.15%, 17.61% and 10.98%. The tensile strength value obtained has met the standard value of JIS Z1707 edible film.

Keywords:Chitosan, Starch, Tensile Strength, Biodegradation, Edible Film

p_ISSN = 2775-7541
e_ISSN = 2775-748x
Vol 2 no 2 Tahun 2021

I. INTRODUCTION

The use of plastic is indispensable in everyday life as packaging for food and other industrial products. Plastic turns out to face various problems in the environment, which cannot be decomposed naturally by microorganisms in the soil, causing a buildup of plastic waste (Imran et al., 2014). Industrial waste in the form of plastic produced has a negative effect on biotic and abiotic components (soil, air and water). Because, this industrial waste causes environmental pollution and decreases the quality of life for humans and other living things (Dewata et al., 2018).

Plastic waste in Indonesia ranks second with 5.4 million tons per year or 14% of the total waste production (Fransiska et al., 2018). In recent years, it can be seen that Indonesia is one of the largest producers of plastic waste into the sea, due to serious environmental problems caused by non-degradable packaging (Zareie et al., 2020).By understanding these problems, a packaging made of renewable and economical materials was developed, namely by presenting bioplastics in the form of edible films, because they are biodegradable. Apart from not being harmful to the environment, edible films as food wrappers can also improve product quality because they are organic, non-toxic and can be eaten directly (Setiani et al., 2013).

Edible movies has raw materials derived from foodstuffs such as proteins, lipids and polysaccharides, especially starch (Nur Hanani et al., 2014).Cassava root skin is usually considered as waste that cannot be utilized (Hartati et al., 2008). Each kilogram of cassava can usually produce 15-20% tuber skin (Suryati et al., 2017). So that there are 44-59% starch chemical components contained in cassava peels, then cassava peels have great potential to be developed into bioplastics in the form of edible films (Alfian et al., 2020).

The weakness of starch biopolymer is its low resistance and resistance to water, because the hydrophilicity of starch affects its stability and mechanical properties (García et al., 2011). To improve the properties and functions of starch, it is necessary to add hydrophobic substances and have antibacterial activity, namely the addition of chitosan (Chillo et al., 2008). Chitosan is a compound that is poorly soluble in water and H2SO4, slightly soluble in HNO3 and easily soluble in CH3COOH (Ikhsan et al., 2021).Chitosan has one of the properties, namely as a binder used to make plastic, increases the transparency of the resulting plastic film, and has antibacterial properties (Epriyanti et al., 2016). Several studies on the plasticization of chitosan films have shown that polyethylene glycol (PEG) can improve the elastic properties of edible films with chitosan (Suyatma et al., 2005).

II. RESEARCH METHODS

2.1. Tools and materials

The equipment in this study was divided into two, namely for sample preparation and characterization. Tools for sample preparation are glassware, heating, Magnetic Stirrer, Thermometer,edible film mold, Oven, desiccator.

p_ISSN = 2775-7541
e_ISSN = 2775-748x
Vol 2 no 2 Tahun 2021

Equipment for characterization of physical properties is a micrometer screw, Tensile strength, and FTIR.

2.2 **Starch Extraction**

The process of extracting starch from cassava peel using the method carried out by Anita, et al (2013). 100 grams of cassava peel cut into small pieces and washed with running water. Then soak in water and change every 15 minutes until the color of the soak in water becomes clear, then soak in water for 24 hours. Next, put 100 ml of distilled water and 100 grams of cassava peel into a blender to facilitate the crushing process into cassava peel pulp. Then the slurry obtained is filtered and deposited for approximately 30 minutes to obtain a precipitate from the cassava peel dregs. After that, the resulting precipitate in the form of wet starch, dried under direct sunlight for 1-2 days. Then dry the starch in the oven at 70℃ for ± 30 minutes until completely dry. After getting dry starch, then grinding and sifting to get a fine powder from starch.

2.3 Edible Film Synthesis

The process of making edible film is done by takingcassava peel starch as much as 5 grams, then dissolved with 2 ml of polyethylene glycol into 100 ml of distilled water. Heat the mixture at a temperature of 70-85℃ while stirring for 15 minutes. After that, add the chitosan concentration which is varied, namely 0%; 0.5%; 1%; 1.5%; or 2% w/v to make edible film from cassava peel. Chitosan was first dissolved with 1% acetic acid. Printing is done by pouring the solution into a square mold and cooling it at room temperature. The solution was then dried in an oven at 60℃ for ± 4 hours until an edible film is formed.

2.4 Edible film characterization

2.4.1 Edible film Thickness Test

Measurements were made randomly from 5 different points. The thickness valuesobtained are then added and divided to obtain the average thickness of the edible film.

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

2.4.2 Tensile Strength Test

Test Tensile strength is the maximum strength (durability) test value of an edible film after being stretched until it breaks. The edible film sample is clamped at both ends using a tensile strength tool, then the tool is operated until the sample breaks.

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

Information :

F : Load given (N)

Ao : Sample cross-sectional area (M2)

2.4.3 Edible film biodegradation test

p_ISSN = 2775-7541
e_ISSN = 2775-748x
Vol 2 no 2 Tahun 2021

The biodegradation test was carried out using the method carried out by Panjaitan (2017). Edible film is cut to a size of 2 cm x 6 cm.Then, the initial mass (W1) was weighed, then the sample was buried in the soil to a depth of 15 cm and allowed to stand for one week. The edible film was dried in a desiccator and weighed to obtain a constant weight (W2).Percentage of mass loss from edible film can be determined by using the equation:

$$\% weight\ (W) = \frac{W1 - W2}{W1} \times 100\%$$

2.4.4 FTIR Test

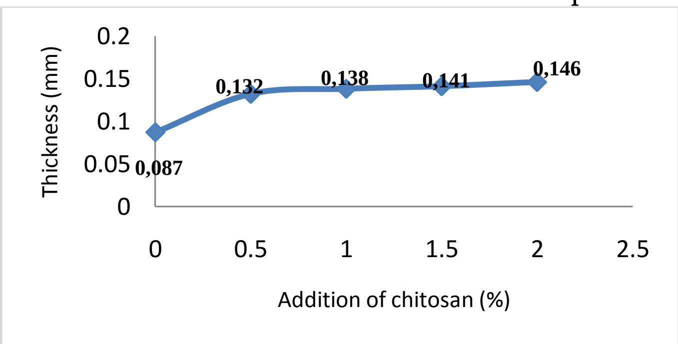
Characterization of the structure of edible films using the FTIR instrument aims to determine the functional groups and types of bonds contained in the edible film. Edible film samples were characterized at a wave number of 4000 - 600 cm-1.

III. RESULTS AND DISCUSSION

Picture 1. *Edible film from cassava peel starch with the addition of chitosan*

Edible film thickness

Thickness *edible film*including important characteristics of edible films, because the thickness of the edible film affects the mechanical properties of the edible film. The results of the thickness test of edible film made from cassava peel with variations in the addition of chitosan can be seen in the picture2.

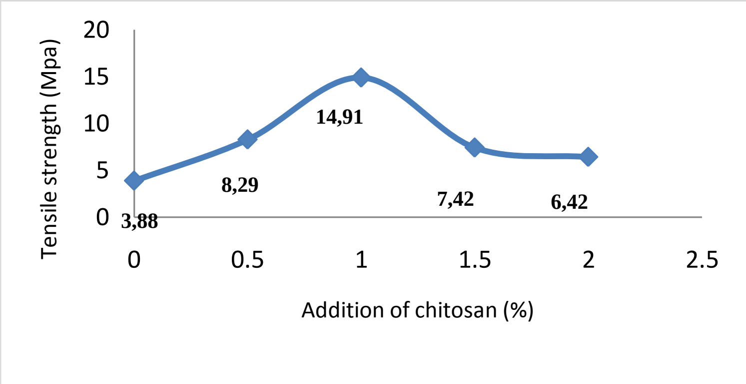


Picture 2. Effect of addition of chitosan on thickness*edible film*

The thickness of the edible film continues to increase along with the addition of chitosan.The more the addition of chitosan, the thicker the edible film, this is due to an increase in the concentration of the material used, thereby increasing the thickness of the edible film (Nofiandi et al., 2016). Overall, the edible film produced has a thickness below the maximum standard of edible film thickness according to the Japanese Industrial Standard (JIS) Z1707, which is 0.25 mm..

Tensile Strength edible film

Score Tensile strength is the maximum stress that the edible film can withstand when stretched or pulled before the edible film breaks. The effect of the addition of chitosan on the tensile strength of edible film can be seen in the picture 3.

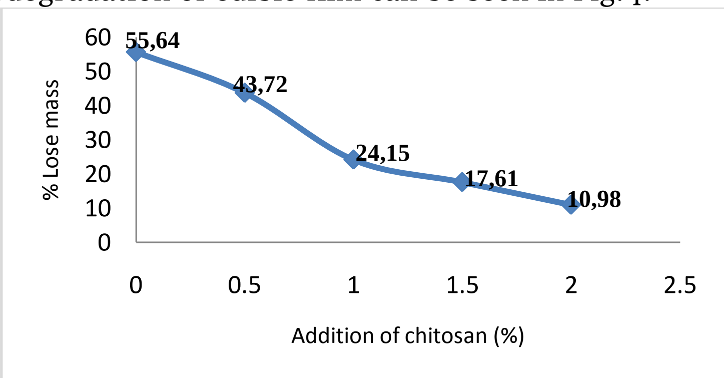


Picture 3. Effect of addition of chitosan on tensile strength *edible film*

The value of the tensile strength of edible films increases with the addition of the concentration of chitosan, then it will decrease again after passing the maximum condition. The higher the concentration of chitosan added, the more hydrogen bonds formed on the edible film, so more energy is needed to break the bonds (Mirah Pradnya Dewi et al., 2015). The tensile strength value of edible film with variations in the addition of chitosan obtained has met the minimum standard for the tensile strength value set by*Japanese Industrial Standard (JIS) Z1707*, which is 3.92 MPa.

Biodegradation of edible film

The purpose of the biodegradation test is to determine the effect of the edible film produced, which can be decomposed by microorganisms in the soil within a certain time limit, in order to obtain the percentage loss of mass until the edible film decomposes completely naturally (Marlina et al., 2021). The soil condition used in this biodegradation test is loose soil with a pH of 7. The effect of adding chitosan to the biodegradation of edible film can be seen in Fig.4.



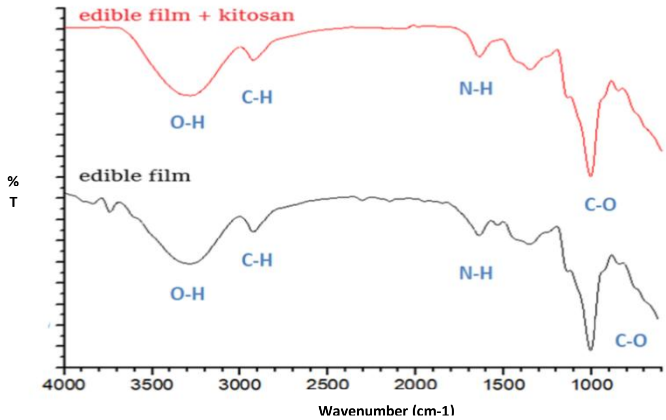
Picture 4. Effect of addition of chitosan on biodegradation *edible film*

JKPL
JURNAL KEPENDUDUKAN DAN PEMBANGUNAN LINGKUNGAN
p_ISSN = 2775-7541
e_ISSN = 2775-748x
Vol 2 no 2 Tahun 2021

Based on the picture, it can be seen that edible films made without the addition of chitosan degrade faster than those made with the addition of chitosan. According to research (Udjiana et al., 2019), indicating that with the increase in the amount of chitosan used, the biodegradable plastic is more difficult to degrade. This is because chitosan is hydrophobic so it protects the edible film from water contained in the soil.

FTIR

The characterization of the functional groups contained in the edible film 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 5.



Picture 5. FTIR Spectra *Edible film and Edible film + chitosan*

Based on the FTIR spectral image, can be analyzed the functional groups contained in the edible film without the addition of chitosan with the addition of 1% chitosan edible film shows the presence of OH bonds at wave numbers 3500 – 3200 cm-1, CH bonds at wave numbers 2800 – 2950 cm-1, NH bonds at wave numbers 1650 – 1580 cm-1 and CO (carbonyl) bonds at wave numbers 1000 – 1150 cm -1. So that there is no new group in the edible film with the addition of chitosan and the shift is not too far away. This is because all the spectrums show the same functional groups at almost the same wave number (Susilawati, Mustafa I., 2011).

IV. CONCLUSION

The addition of chitosan to the edible film affects the tensile strength and biodegradation of the edible film. The maximum tensile strength value was obtained in the edible film with the addition of 1% chitosan, while the biodegradation of the edible film decreased along with the increase in the concentration of chitosan.The FTIR spectra of edible film without the addition of chitosan and with the addition of chitosan have OH, CH, NH and CO bonds, so there is no new functional group.

REFERENCES

Alfian, A., Wahyuningtyas2, D., & Paramita Dwi Sukmawati3. (2020). Making Edible Film from Cassava Peel Starch Using Sorbitol Plasticizer with Citric

p_ISSN = 2775-7541
e_ISSN = 2775-748x
Vol 2 no 2 Tahun 2021

Acid as Crosslinking Agent (Variations of Addition of Carrageenan and Addition of Citric Acid). Journal of Process Innovation, 5, 46–56.

Chilo, S., Flores, S., Mastromatteo, M., Conte, A., Gerschenson, L., & Del Nobile, MA (2008). Influence of glycerol and chitosan on tapioca starch-based edible film properties. Journal of Food Engineering, 88(2), 159–168. https://doi.org/10.1016/j.jfoodeng.2008.02.002

Dewata, I., & Danhas, YH (2018). Environmental pollution.

Epriyanti, NMH, Harsojuwono, BA, & Arnata, IW (2016). Effect of Temperature and Drying Time on the Characteristics of Biodegradable Plastic Composites From Cassava Peel Starch And Chitosan. Journal of Agroindustrial Engineering and Management, 4(1), 21–30.

Fransiska, D., Giyatmi, G., Irianto, HE, Darmawan, M., & Melanie, S. (2018). Characteristics of k-carrageenan film with the addition of Polyethylene Glycol Plasticizer. Journal of Postharvest and Marine and Fishery Biotechnology, 13(1), 13. https://doi.org/10.15578/jpbkp.v13i1.504

García, NL, Ribba, L., Dufresne, A., Aranguren, M., & Goyanes, S. (2011). Effect of glycerol on the morphology of nanocomposites made from thermoplastic starch and starch nanocrystals. Carbohydrate Polymers, 84(1), 203–210. https://doi.org/10.1016/j.carbpol.2010.11.024

Hartati, I., Kurniasari, L., & Yulianto, M. (2008). Enzymatic Inactivation in the Production of linamarin from cassava leaves as an anti-neoplastic compound. UNWAHAS Momentum Journal, 4(2), 113672.

Ikhsan, MH, Dewata, I., Nizar, UK, Padang, UN, Strength, T., Film, E., & Introduction, I. (2021). Effect of addition of chitosan on tensile strength and biodegradation of edible film from banana weevil starch. Journal of Population and Environmental Development, 2(1), 44–50.

Imran, YL, Hutomo, GS, & Rahim, A. (2014). Synthesis and characterization of bioplastic based on sago starch (Metroxylon sp) Synthesis and characterization of bioplastic based on sago starch (Metroxylon sp). EJ. Agrotechnics, 2(1), 38–46.

Lusi, Marlina., DAN (2021). The effect of variations in the addition of chitosan and glycerol on the characteristics of biodegradable plastics from sweet potato starch. 15(2).

Mirah Pradnya Dewi, I., Admadi H, B., & Arnata, I. (2015). Effect of Composite Materials Mixture and Glycerol Concentration on Bioplastic Characteristics of Cassava Peel Starch and Chitosan. Journal of Agroindustrial Engineering and Management, 3(3), 41–50.

Nofiandi, D., Ningsih, W., & Putri, ASL (2016). Production and Characterization of Edible Film from Polyblend Breadfruit Starch-Polyvinyl Alcohol with Propylene glycol as Plasticizer. Journal of Catalysts, 1(2), 1–12. https://doi.org/10.22216/jk.v1i2.1113

Nur Hanani, ZA, Roos, YH, & Kerry, JP (2014). Use and application of gelatin as potential biodegradable packaging materials for food products. International Journal of Biological Macromolecules, 71, 94–102. https://doi.org/10.1016/j.ijbiomac.2014.04.027

Panjaitan, RM, Irdoni, & Bahruddin. (2017). Effect of Content and Size of Cellulose Based on Banana Stems on the Characteristics and Morphology of Bioplastics Made from Taro Bulb Starch. 4(1), 1–7.

Setiani, W., Sudiarti, T., & Rahmidar, L. (2013). Preparation and Characterization of Edible Films from Polunlend Pati Sukun-Kitosan. Valence, 3(2), 100–109.

Suryati, S., Meriatna, M., & Marlina, M. (2017). Optimization of the Process of Making Bioplastics From Cassava Peel Waste Starch. Unimal Journal of Chemical Technology, 5(1), 78. https://doi.org/10.29103/jtku.v5i1.81

Susilawati, Mustafa I., & MD (2011). Plastics From a Mixture of Low De Biodegradable PL Polyethylene (LDPE)) and Cassava Starch with the Addition of Acrilyc Acid Susilawa ti , Irfan Mustafa , Desy Maulina. 11(2).

Suyatma, NE, Tighzert, L., Copinet, A., & Coma, V. (2005). Effects of hydrophilic plasticizers on mechanical, thermal, and surface properties of chitosan films. Journal of Agricultural and Food Chemistry, 53(10), 3950–3957. https://doi.org/10.1021/jf048790+

Udjiana, SS, Hadiantoro, S., Syarwani, M., & Suharti, PH (2019). Production and Characterization of Biodegradable Plastic from Taro Bulbs (Xanthosoma sagittifolium) with the Addition of Chitosan and Calcium Silicate Fillers. Journal of Chemical and Environmental Engineering, 3(1), 10. https://doi.org/10.33795/jtkl.v3i1.80

Zareie, Z., Tabatabaei Yazdi, F., & Mortazavi, SA (2020). Development and characterization of antioxidant and antimicrobial edible films based on chitosan and gamma-aminobutyric acid-rich fermented soy protein. Carbohydrate Polymers, 244(March), 116491. https://doi.org/10.1016/j.carbpol.2020.116491

Zulisma Anita, Fauzi Akbar, & Hamidah Harahap. (2013). Effect of Addition of Glycerol on Mechanical Properties of Biodegradable Plastic Films from Cassava Peel Starch. USU Journal of Chemical Engineering, 2(2), 37–41. https://doi.org/10.32734/jtk.v2i2.1437