

Oil Palm Empty Bunches as an Alternative Raw Material for Making Bioplastics

Husaini A^{1,*} Zaman M¹ Chodijah S¹ Hilwatullisan¹ Ibrahim²

¹ *Chemical engineering Department, Politeknik Negeri Sriwijaya, Jalan Srijaya Negara, Palembang, 30139 Indonesia*

² *Chemical engineering Study Program, Politeknik Negeri Sriwijaya, Jalan Srijaya Negara, Palembang, 30139 Indonesia*

* *Corresponding author E-mail : husaini@polsri.ac.id*

ABSTRACT

The purpose of this research is to obtain bioplastics that are biodegradable and safe if disposed of in the environment. This bioplastic is made using Empty Bunches and white rice and plasticizer. White rice flour as a source of starch with variations in the addition of chitosan additives and glycerol plasticizer. The analysis of the biodegradable plastic products produced was tested for physical and mechanical characteristics such as thickness, water resistance test (%), biodegradation rate (%), and tensile strength (MPa). The method used is by mixing the starch from the mixture of empty bunches and white rice and adding glycerol and chitosan plasticizers. The mixture is heated at a temperature of 70 - 80 °C for 60 minutes. Data from the analysis of Biodegradable plastics products showed that the more glycerol and starch added, the greater the tensile strength and the percentage of elongation. Bioplastics produced From the data, it can be seen that 1.2 grams of chitosan has the best water resistance compared to the others, which is valued at 78.02%. This is due to the hydrophobic nature of chitosan and insoluble in water. So, the greater the chitosan concentration, the greater the % water resistance and the better the plastic resistance to water.

Keyword : *bioplastics, biodegradable, plasticizer, palm bunch, biodegradable plastics*

1. INTRODUCTION

Recent research based on a survey of 2518 members of the general public has identified that the Australian public are highly concerned about the environmental impact of plastics, particularly in relation to ocean plastics[1]. The development of bioplastic technology has been carried out by several researchers at the time, namely by utilizing cellulose of empty bunch raw materials [2], rapeseed oil industry [3], waste of cassava peel (*manihot utilisima*) and shrimp shell[4], from wheat Janeng starch [5]. The resulting Bioplastic characteristics are influenced by the type of plasticizer, by using the plasticizer sorbitol can improve the characteristics of bioplastic [6].

The waste byproduct of the palm oil extraction process is very large, reaching 70–80 million tonnes per year. In palm oil mills, palm oil comprises only 10% of the total biomass, while the remaining (90%) biomass is disposed of as waste. This problem tends to burden operators with disposal difficulties and increase operating costs. To solve this problem, palm oil waste is recycled with various applications. Among

others; Fronds and stems are used as raw material for livestock, mesocarp is used as boiler fuel, core shells are reused as road paving, Empty bunches are converted into soil conditioners and fiberboard. However, the reuse of empty bunches as a soil conditioner is still not popular and there is still a lot of excess waste to be handled. The steam from the sterilization process produces a high moisture content in the empty bunch; as high as 60%, making it unfit for use as boiler fuel. Finally, burning it for nothing was the only option the farmers chose. To make matters worse, empty bunch production showed an increasing trend with 7 million tonnes of waste generated in 2007[7].

Bioplastic production using raw materials for empty bunches has been successfully carried out using modified cellulose, composites with plasticizers and compatibilizer[2]. The results of studies conducted by bioplastics were produced using starch and cellulose of seaweed *eucheuma spinosum* and the addition of sorghum stem fillers, which are thought to affect the mechanical and physical properties of bioplastics[8].

Bioplastics from starch are generally brittle and stiff so it is necessary to add glycerol to increase the

flexibility of polymeric materials which are plasticizers. Glycerol is a plasticizer that is hydrophilic, making it suitable for hydrophilic bioplastics such as starch.[8]

In this study, bioplastics are made using the extrusion method, which is a method of mixing two or more materials into one by utilizing starch which expands due to heat and friction during the extrusion process. After using the bioplastic extrusion method, it is continued with the microwave assisted molding method or the Baking Process where the dough is molded and heated in an oven at 60°C and for ± 4 hours.

2. RESEARCH METHOD

Empty Bunches was collected from an oil palm mill in Banyu asin, Indonesia. Fresh empty bunches were chopped and sun dried until the moisture content was less than 10%. Dried EB chopped into small pieces about 5 cm long and stored in a container at room temperature prior to the experiment.

Composite bioplastics from empty bunches and glutinous rice that has been crushed into flour added to chitosan, then add distilled water. After that, mix glycerol and acetic acid. Then heated at a temperature of 70 - 80 °C and stirring for 60 minutes at a speed of 300 rpm. The amount of glycerol added is 5 ml, 8 ml, 10 ml, 12 ml and 14 ml, and mixed with chitosan 0.4 gr, 0.6 gr, 0.8 gr, 1 gr and 1.2 gr. The results were printed and dried in an oven at 50 OC and tested for the parameters of the bioplastic characteristics, including % moisture content, % biodegradability, tensile strength and % elongation.

3. RESULT AND DISCUSSION

The manufacture of Biodegradable Plastics begins with the preparation of materials such as cleaning empty bunches. Furthermore, the oil palm are refined by removing one from the boulders and then cleaned until clean and dried under the sun for ± 2 days after they are dry then cut into small pieces, then put into a flour machine until they become smoother. After the refining process is complete, the oil palm empty bunch flour is sieved so that empty bunch flour is finer and of a uniform size and can be used for making bioplastics.

After obtaining the empty bunch flour, it is followed by mixing 10 grams of starch raw material (white rice flour) according to the variation determined in the experimental treatment. Adding 5 grams of empty bunch flour, so that the total weight of the raw material is 15 grams. Then add other additives, namely chitosan solution in accordance with the specified variables (dissolved first in 1ml of glacial acetic acid with a concentration of 1%), glycerol as a plasticizer, glycerol (5; 8; 10; 12; 14 ml), then heated in hotplate at a temperature of 70-80°C because at this temperature the

starch paste is formed which is the initial form of plastic.

Then the solution will thicken like glue and then pour it into a glass mold with a size of 20 x 20 cm with a 3M double tape on each side to facilitate removal, then the baking process or in the oven with a temperature of 60°C for ± 4 hours. After dry, then pulled from the mold and become Biodegradable Plastic and proceed to the analysis process of tensile strength, moisture content and biodegativity test.

3.1 Characteristics of Biodegradable Plastics

a. Water Resistance (%)

In plastic, it is expected that the water absorbed by the material is a little bit, the greater the percentage of the water resistance value, the less water will be absorbed by the plastic. Water resistance is carried out by weighing the sample before and after immersing it in water. The concentration of chitosan added to biodegradable plastic is directly proportional to the water resistance test, namely the more the concentration of chitosan added to the biodegradable plastic, the greater the water resistance value. The average value of water absorption can be seen in Figure 1.

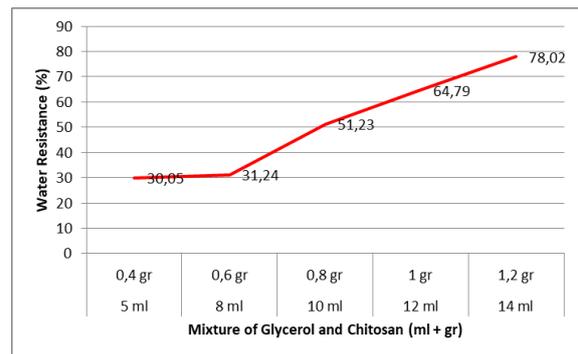


Figure 1. The relationship between water resistance and mix glycerol + chitosan

From the data, it can be seen that 1.2 grams of chitosan has the best water resistance compared to the others, which is valued at 78.02%. This is due to the hydrophobic nature of chitosan and insoluble in water. So, the greater the chitosan concentration, the greater the % water resistance and the better the plastic resistance to water. This is because the more hydrogen bonds there are in the bioplastic so that the chemical bonds will be stronger and harder to break because it requires a large amount of energy to break these bonds. As a comparison, the supermarket plastic biodegradable with a tensile strength value of 92.46%. Based on the Indonesian national standard (SNI). In this study, the value of water resistance in the research sample is still far away from the comparison sample so that the sample of this study does not meet the Indonesian national standard.

b. Biodegradation Rate (%)

The biodegradation rate test aims to determine the size of the sample broken down by microorganisms in the soil. The value of the biodegradation rate of bioplastics can be seen in Figure 2.

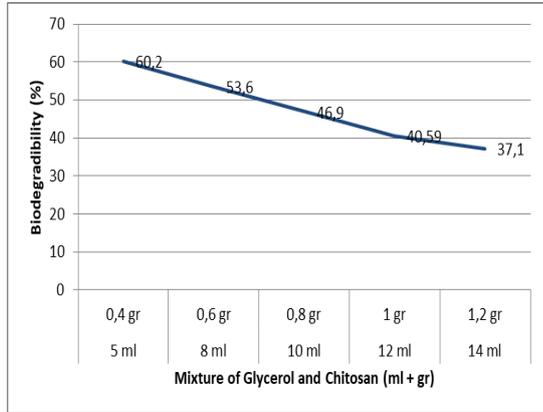


Figure 2. The relationship between biodegradability and mix glycerol + chitosan

In this study, the biodegradable plastic degradation test was carried out for 14 days or 2 weeks, so we can calculate that within 14 days the bioplastic should be able to decompose as much as 16%. Therefore, the sample that can be said to be included in the Indonesian National Standard (SNI) is the sample with the addition of variations of chitosan 0.4, 0.6, 0.8, 1, 1.2 grams. However, the best level of degradation is the addition of 0.4 g of chitosan with the percentage degradation of 60.02%. This is because chitosan has strong and hydrophobic properties so that the less chitosan is added to the plastic, the faster the decomposition process.

c. Tensile Strength (MPa)

The tensile strength of bioplastics in this research is the maximum strength or tensile strength of the bioplastics that can be achieved before breaking or tearing. The measurement of tensile strength aims to determine the magnitude of a force required to achieve maximum tension in each area of the bioplastic area.

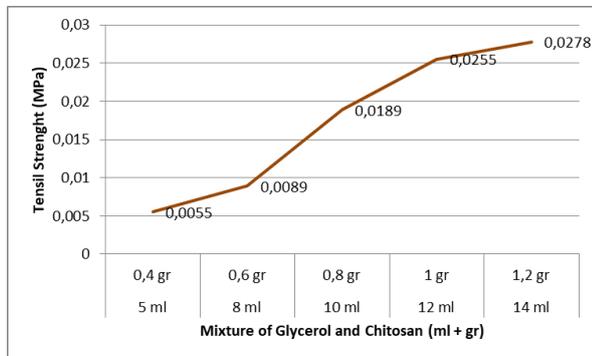


Figure 3. The relationship between Tensile Strength and mix glycerol + chitosan

The number of chitosan concentrations in biodegradable plastic is directly proportional to the tensile strength value of biodegradable plastic, namely the more the concentration of chitosan in biodegradable plastic, the greater the tensile strength value. The tensile strength value of biodegradable plastic can be seen in Figure 3.

This plastic is able to with stand loads of up to 1 kg. The amount of the optimum tensile strength produced in this study is 0.0278 MPa, where the magnitude of the tensile strength still does not meet the SNI.

d. Percent Elongation

Measurement of the percent elongation or elongation is carried out to determine the percentage change in the length of the film when it is pulled until it breaks. You can see the % elongation value in Figure 4.

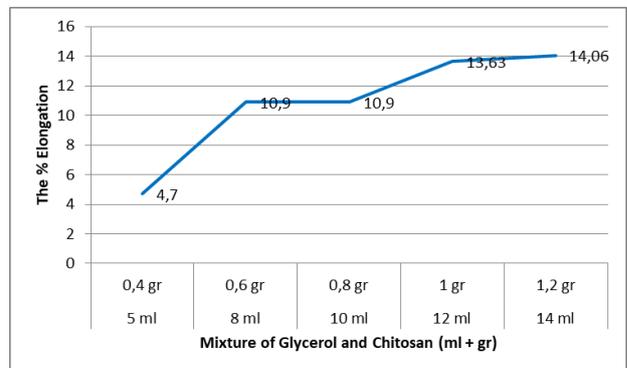


Figure 4. The Relation between Elongation Percentage Analysis (%) and mix glycerol + chitosan

The highest percentage elongation yield was 14.06% at 14 ml glycerol concentration while the lowest elongation percent value was 4.70 % at 5 ml glycerol concentration.

The increase in the percent value of elongation or elongation is influenced by the addition of glycerol. Glycerol functions as a plasticizer located between the biopolymer chains so that the distance between chitosan and starch will increase. The hydrogen bonds between chitosan-starch are reduced and replaced by hydrogen interactions between chitosan-glycerol. Bioplastic will be more elastic so that the elongation tends to increase even though it is pulled with a small pressure. Based on this theory, it shows that the suitability of adding glycerol can increase the elasticity of bioplastics

4. CONCLUSION

The physical and mechanical characteristics of Biodegradable foam made from a mixture of starch and empty bunches produced are as follows, water resistance: 51.23%, tensile strength: 0.0189 MPa and biodegradation rate: 46.9% and % E: 10.9%

The best composition of the ratio of glycerol and chitosan used for making plastic (biodegradable) is in the 12ml + 1gr variation, in the addition of 5gr empty bunches with the following characteristics, water resistance: 64.79%, tensile strength: 0.0255 MPa biodegradation rate of 40.59% and % E: 13.63%.

Comparison between the tensile strength and water resistance value of bioplastic (biodegradable plastic) and bioplastic (biodegradable plastic) Indomaret is as follows. The value of plastic tensile strength (biodegradable): 0.0255 Mpa and water resistance: 64.79%, while bioplastic (biodegradable plastic) Indomaret had a tensile strength value: 0.00490 Mpa and water resistance: 92.46%.

ACKNOWLEDGMENT

The authors would like to thank to Chemical engineering department, state sriwijaya polytechnic and also SIMLITABMAS-DIKTI for had been financing and given the opportunity to conduct this reaseach under The Competitive Research Grant Program 2019-2020 sriwijaya state of Polytechnic.

REFERENCES

- [1] L. Dilkes-Hoffman, P. Ashworth, B. Laycock, S. Pratt, and P. Lant, "Public attitudes towards bioplastics – knowledge, perception and end-of-life management," *Resour. Conserv. Recycl.*, 2019, doi: 10.1016/j.resconrec.2019.104479.
- [2] Isroi, A. Cifriadi, T. Panji, N. A. Wibowo, and K. Syamsu, "Bioplastic production from cellulose of oil palm empty fruit bunch," 2017, doi: 10.1088/1755-1315/65/1/012011.
- [3] M. Delgado, M. Felix, and C. Bengoechea, "Development of bioplastic materials: From rapeseed oil industry by products to added-value biodegradable biocomposite materials," *Ind. Crops Prod.*, 2018, doi: 10.1016/j.indcrop.2018.09.013.
- [4] Dasumiati, N. Saridewi, and M. Malik, "Food packaging development of bioplastic from basic waste of cassava peel (*manihot utilisima*) and shrimp shell," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 602, no. 1, 2019, doi: 10.1088/1757-899X/602/1/012053.
- [5] Saiful, H. Helwati, S. Saleha, and T. M. Iqbalsyah, "Development of bioplastic from wheat Janeng starch for food packaging," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 523, no. 1, 2019, doi: 10.1088/1757-899X/523/1/012015.
- [6] M. H. S. Ginting, R. Hasibuan, M. Lubis, D. S. Tanjung, and N. Iqbal, "Effect of hydrochloric acid concentration as chitosan solvent on mechanical properties of bioplastics from durian seed starch (*durio zibethinus*) with filler chitosan and plasticizer sorbitol," 2017, doi: 10.1088/1757-899X/180/1/012126.
- [7] M. K. Faizi *et al.*, "An overview of the Oil Palm Empty Fruit Bunch (OPEFB) potential as reinforcing fibre in polymer composite for energy absorption applications," 2016, doi: 10.1051/mateconf/20179001064.
- [8] Y. Darni, F. Y. Dewi, and L. Lismeri, "Modification of Sorghum Starch-Cellulose Bioplastic with Sorghum Stalks Filler," *J. Rekayasa Kim. Lingkung.*, 2017, doi: 10.23955/rkl.v12i1.5410.