Addition of Serbitol in Biodegradable Plastic Cateristics from Janeng

Chairul Amni*, Ismet², Sri Aprilia³ and Mariana⁴

Department of Industrial Engineering, Faculty of Engineering, Serambi University of Mekkah JlnTgk. Imum Lueng Bata (0651) 26160 22471 Fax 22471 Banda Aceh

*chairul.amni@serambimekkah.ac.id

Abstract. The manufacture of biodegradable plastic film has been carried out using starch janeng which functions as the main raw material, water that functions as a solvent, and serbitol which functions as a plasticizer. Janeng is chosen as a raw material for making plastic because in addition to being easy to obtain and low in price, its use is still very minimal when compared to other plants which are the staple food of the community, such as rice, corn, potatoes, wheat, and so on. This study aims to make plastic that can reduce the environmental impact by looking at the influence of the plasticizer used on the mechanical properties of the film, the absorption capacity of water, and the decomposition rate of the plastic. The plasticizer used is sorbitol with a weight concentration of 1 ml, 3 ml, and 6 ml of the total weight, and the weight ratio of sago starch and water is 1 g, 3 g, and 6 g. Testing of mechanical properties (tensile strength and elongation) using Universal Testing Machines Electronic System, testing water absorption is done by immersing the film in water for 24 hours, and decomposition rate testing is done by burying the film into the ground. The results showed that the highest tensile strength values were obtained at a concentration of 3 ml of serbitol with a weight ratio of 3 g of starch with a yield of 3.2 kgf/ cm², whereas the highest percentage of elongation was obtained at a concentration of 6 ml of sorbitol with a ratio of weight of 1 g of starch to yield 3.9%. The lowest water absorption was obtained in the composition of 1 ml of serbitol with a weight ratio of 1 gram of starch, which was 2.7%, and the decomposition process occurred for 27 to 33 days.

1. Introduction
For hundreds of years conventional plastics made from petroleum, natural gas and coal have been accused of being the source of environmental pollutants because they are difficult to decompose in nature. The latest breakthrough needs to be made, namely biodegradable plastic by utilizing plant resources. The advantage of using natural raw materials in the manufacture of plastics is that they are biodegradable in nature so they can reduce environmental pollution, and are made from renewable natural resources, so their existence is not limited because it can continue to be preserved. So far a number of agricultural products have been known that have the potential to utilize plastic biopolymers, namely potatoes, corn, soybeans, sago, and cassava.
Generally the main compounds used are carbohydrates (cellulose and starch) and protein. The choice of the main raw material will depend heavily on the use of plastic because each raw material provides different characteristics of plastic products [1].

Janeng starch is starch obtained from fruit Janeng already in ektrasi. During this time, jeneng starch as a source of carbohydrate is less desirable by the public as a food product because of its sticky texture, containing toxins and so far its use is only for traditional ingredients or a mixture of flour in making cakes which are generally produced on a small industrial scale. Because of the lack of various processed from starch janeng, it is necessary to diversify by utilizing the jeneng starch as a raw material for making biodegradable plastic which is expected to replace the use of conventional plastics today. However, to make biodegradable plastic more effective and obtain its mechanical properties (especially its elasticity), it must mix starch with plasticize. in this study using serbitol as plasticize.

2. Methodology

The materials needed in this study were janeng starch, acetic acid, aquadest, and sebitor as plasticize. The tools used in this research are Casting Glass, Chemical Glass, Magnetic stirrer, Measuring Cup, Thermometer, Stop watch, Scissors, Digital Scales, Hot Plate, Computer Type Universal Testing Machines, ovens, petri dishes

Fixed variable, fixed variables for making biodegradable plastics from starch janeng:
1. The stirrer speed is 75 rpm
2. 80 °C gelatinization temperature
3. 1 ml acetic acid
4. 100 ml distilled water

Variable Changes, Variables change in the manufacture of biodegradable plastics from starch janeng:
1. starch janeng with a concentration of 1 g, 3 g, and 6 g
2. Plasticizer serbitol of 1 ml, 3 ml and 6 ml

Research Procedure

Manufacture of Biodegradable Plastics from starchJaneng

The production of biodegradable plastics from starch janeng is carried out as follows:

1. Janeng starch with different concentrations of dissolved in 100 ml of distilled water in the beaker is stirred for 25 minutes.
2. Once the mixture is homogeneous, janeng starch solution is added with a certain ratio in a beaker placed in on a hot plate. Objective use of the hot plate is to accelerate the reaction rate by increasing the temperature right. Then put the magnetic stirrer into a beaker. The purpose of using magnetic stirrer is to avoid lumps of starch shape upon heating and helpful. Starch is heated to a temperature of approximately 80 °C for 15-20 minutes.
3. The added plasticizer (Serbitol) 1 ml, 3 ml, 6 ml starch janeng. The purpose of adding Serbitol to provide elastic properties. At the time of addition of the Serbitol, the starch must be stirred continuously for 15 minutes to avoid lumps and accelerate the homogenization of mixing between starch and serbitol. Then the beaker is removed from the hot plate.
4. After moved starch solution, the starch solution must keep stirring until the normal temperature of about 25-30 °C for 30 minutes so that the viscosity remains keep.
5. After the starch solution is formed and the temperature of the starch solution is normal, then the solution is poured up glass with a thickness of about 1 mm who has been given duct tape on the edges. The purpose of using duct tape is to keep the starch solution from spilling over the edges glass. The pouring of starch solution must be done slowly. The thin layer formed above the glass is put into an oven at 70 °C for 4 hours to allow it to harden and dry.
6. A thin layer that has dried out is released from glass with how to open it with the help of a sharp razor blade slowly in order to escape from the glass casting. The plastic is transferred to the desiccators and stored for 1 day in a place that is not in direct sunlight
Testing

1. Strong Pull Test (Tensile Strength) and Percent Elongation, This test aims to find out how much plastic resistance is due to the tensile force applied to the plastic and to find out the percent of the elongation.

2. Ability Test Water Absorption against water, This test is done so that it can be known how much water can be absorbed by the plastic that has been made.

Analysis biodegradability

Plastic biodegradability analysis is carried out in two ways, namely quantitatively and qualitatively. Quantitatively by determining the mass loss of polymer material. Mass loss is determined by weighing the polymer mass before and after the biodegradation process for a certain time. This test is carried out to determine how long it takes for the plastic that has been made to decompose in the soil with the help of microorganisme [2].

3. Results and Discussion

1. Bioplastics Tensile Strength

The tensile strength and elongation of break test results can be seen in full below in Figure below The graph of the effect of the addition of janeng starch the ratio ofSerbitolconcentrationtobioplastics tensile strength values can be seen in Figure 1.1

![Graph of the effect of the ratio of the addition of sweet starch on tensile strength values bioplastic with a percentage of 1 mL, 3 mL, and 6 mL of serbitol](image)

Figure 1. Graph of the effect of the ratio of the addition of sweet starch on tensile strength values bioplastic with a percentage of 1 mL, 3 mL, and 6 mL of serbitol

Figure 1 shows the change in tensile strength of plastic films with the addition of 1 mL, 3 mL, and 6 mL plasticizer with a ratio of 1 g of starch, 3 g, and 6 g of starch. The value of the highest tensile strength resulting in the addition of 3 g of starchserborjaneng with the addition of 3 mL of 2.5 kgf / cm² The tensile strength of plasticfilm is strongly influenced by the content of the addedplasticizer. The higher the concentration of the plasticizer added to the mixture, the lower the tensile strength of the plastic film. This is because, because the increase in the concentration of the plasticizer will reduce the hydrogen bond in the film so as to increase flexibility, with increasing flexibility the tensile strength of the film will be smaller, because the resulting film becomes more flexible, soft, and flexible so that the tensile strength tends to decrease [3].

2. Elongation of break (%) Bioplastics

Elongation is a change in the maximum length of film before it is disconnected [4]. The higher the concentration ofplasticizer, then the value of elongation will be higher. Elongation test is done to find out the amount of length increase of a polymer before finally
breaking up of elongation of break carried out simultaneously with the measurement of tensile strength. The test results of extension break can be seen in Picture.2

![Graph of the addition of serbitol to starch concentration](image1)

**Figure 2.** Graph of the addition of serbitol to starch concentration

Figure 2 shows that the higher the concentration of plasticizer, the higher the elongation value, the highest percentage of elongation is obtained at a concentration of 1 gram of starch with a ratio of 6 ml of glycerol which is 3.9%. This happens because the increase in the concentration of the plasticizer will increase the speed of the viscoelastic response and molecular mobility of the plastic polymer chain. Increased molecular mobility of polymer chains is indicated by increasingly elastic materials so that the value of elongation tends to increase. This increase will apply as long as the molecular interactions of polymer chains with plasticizers are still formed [5].

3. Absorb power of water

One of the properties of conventional plastic is that it is impervious to liquids. Water absorption is the amount of water absorbed by plastic film in percent after the sample is immersed in water at room temperature for 24 hours. The water fills the empty spaces in the plastic film. The lower the percentage of water absorption obtained the more balanced quality of the plastic. The water absorption value of the research results ranged from 2.7% to 4.3%

![Graph of water absorption](image2)

**Figure 3.** Graph of water absorption

From figure 3 above shows the lowest water absorption value of plastic film is at a concentration of 1 gram of starch with the addition of 1 ml of Serbitol and 2.7% and the highest absorption of water at a
concentration of 6 grams of starch with the addition of 6 ml of Serbitol is 4.3 %, this is because the higher use of plasticizers will increase the adhesive properties between molecules so that the amount of water bound to polysaccharide compounds will experience an increase which causes the water content to be higher.

4. Decomposition Test (Degradability)

Plastic biodegradable is defined as a packaging film that can be recycled and can be destroyed naturally. The process of biodegradation of this plastic in the environment begins with the chemical degradation stage, namely by the molecular oxidation process to produce polymers with low molecular weight. The next process is an attack of microorganisms (bacteria and algae) and enzyme activity (intracellular, extracellular). Can be seen in the graph below.

![Figure 4. Graph of time of degradation of biodegradable plastics in soil](image)

From the graph above shows that the plastic film has been decomposed / degraded naturally in the soil. Plastic which is the fastest decomposed by microorganisms is at a concentration of 1 ml of Serbitol with a degradation time of 27 days and the long degraded period is 33 days with a concentration of 6 ml of Serbitol. This is due to the high concentration of Serbitol so that bacteria are difficult to decipher bioplastics [6]. The soil conditions used for the burial process are moist soil and contain water and it is possible that there are many decomposing microbes that play a role. The character of biodegradability has been practically tested that the plastic film produced can be easily decomposed in soil biologically and chemically and is certainly safe for the environment. Chemically, the plastic film produced is clearly biodegradable, this is caused by the raw materials used are organic and natural raw materials that are easy to interact with water and other microorganisms.

4. Conclusion

From the research that has been done can be taken some conclusions

a. Tensile strength decreased with increasing concentration of plasticizer, the highest tensile strength value was obtained at a concentration of 6 grams of starch with the addition of 3 ml% of serbitol which was 3.2 kgf/ cm².

b. The percentage of elongation increased with increasing concentration of plasticizers, at a concentration of 1 gram of starch with the addition of 6 ml of serbitol, which was 3.9%.

c. The lowest water absorption was obtained in the composition of 1 gram of starch with the addition of 6 ml of serbitol of 2.7

D. The process of plastic film degradation occurs for 27 to 33 days.
References

[1] A. Steinbutchel, “Production of Biodegradable and Edible Packaging Material for Foods.” 2004.
[2] A. Chairul, “Bioplastics from Sweet Potato Starch Wood with Nano-strength Straw and ZnO fiber.” 2015.
[3] U. Muhajirin, “Manufacture of Biodegradable Plastic Made from Sago Starch Using Solvents Acetone.” Ujung Pandang State Pliteknik, Makassar, 2009.
[4] R. Latief, “Plastic Packaging Technology Biodegradable.” 2001.
[5] V. Theresia, “Application and Characteristics of Physical Properties of Biodegradable Plastics from LLDPE and Tapioca Mixtures.” Institut Pertanian Bogor, Bogor, 2003.
[6] D. Yuli and U. Herti, “Study of making and characteristics mechanical properties and hydrophobicity of bioplastics from starch sorghum.” 2010.