Characteristics and Morphology of Biodegradable Plastics from Oil Palm Waste for Agricultural and Forestry Applications

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Abstract. The use of conventional plastics in human life is very diverse, one of which is as a seedling container (polybags) for agriculture and forestry crop. Although the use of polybags is felt to make it easier for humans in the nursery but causes severe hazards to the environment. This research will synthesize biodegradable plastic from oil palm waste, in the form of cellulose and starch from the stem. The parameters that will be measured from this study are mechanical and thermal properties, as well as their morphology.

1. Introduction
Plastic composite products are widely circulating in the community in various uses, such as household furniture, kitchen appliances, automotive components to food packaging. These products are produced using base oil from non-renewable materials. In its use, plastic goods will produce plastic waste that cannot be decomposed by decomposing microorganisms in nature (non-biodegradable). Plastic products have caused environmental problems, namely accumulation in large quantities in nature [1]. One of the contributors of plastic waste in nature is in planting activities, especially in the needs of the agricultural and forestry sector planting media in the form of polybags. When planting seeds in the field, usually the plastic is left just like that so that there is accumulation in nature. Often polybags used can cause damage to the root system, thus affecting subsequent growth in the field (Noraskhin and Ibrahim, 2009; [2].

2. Materials and Methods
The materials used include palm oil plantations of PTPN II Tanjung Morawa plantation, glycerol, vinegar acid, and aquades. Making starch from palm oil is done by splitting the oil palm stem and then separating the hard skin and the spout [3]. The sponge is shaved to become wood powder. Wood powder plus water then squeezed then filtered with filter cloth. The pulp is set aside as cellulose fiber for plastic fillers later, while starchy water precipitated for 3 hours, then wet starch was produced. The wet starch was washed by adding water and deposited for 3 hours then the wet starch was dried in an oven at a temperature of 500 C until the starch moisture content was ± 10%.
Making biodegradable plastic is done by dissolving palm starch in distilled water with a ratio of 1:20. Then glycerol and vinegar acid were added, then rotated with a magnetic stirrer at a temperature of 80°C to form a gel. The plastic formation is done by the film casting method and in the oven at 60°C. As a comparison, a plastic film from tapioca starch was made.

The crystallinity of composite films was measured using X-ray diffraction / XRD (Shimadzu XRD-7000 MaximaX, Japan) at 40 kV and 30 mA, angles 10° - 40° with Ni CuKα radiation filters (λ = 1.5406 Å). Characterization of mechanical properties (tensile strength, tensile modulus, and broken elongation) of composite films was carried out based on ASTM D882-75b (Standard Test Method for Tensile Properties of Thin Plastic Sheeting) at crosshead speeds of 50mm / min.

3. Result and Discussion

Figure 1 shows that it has been successfully synthesized biodegradable plastic films from palm starch as well as plastic films from commercial starch (tapioca) which have elastic properties. This is because oil palm has a very high starch content (above 95%), which is 96%, almost equals tapioca starch content of 96.99%, so it is very good as a raw material for modified starch products [3]. Tapioca starch-based plastic has a clearer and more transparent visual appearance, while plastic from palm starch is more opaque and slightly yellowish in color. This is because palm starch has a lower degree of whiteness and paste clarity than tapioca starch, thus affecting the color and clarity of the plastic film produced.

The surface morphology of biodegradable plastic film in Figure 2 shows that the plastic from palm starch has a surface that is not porous and looks finer than the plastic surface of tapioca starch. Oil palm starch has a higher final viscosity than commercial starch so that the palm starch becomes younger experiencing retrogradation [3]. During the retrogradation process amylose crystallizes so that the structure is compact and resistant to hydrolysis [4].
Figure 2. Plastic morphology Biodegradable plastic from tapioca starch (a) and palm starch (b), 10x magnification.

Figure 3 shows the value of water uptake by plastic based on palm starch is lower than tapioca-based plastic. Amylose content in palm starch was lower than tapioca starch, while amylopectin levels in palm starch were higher than tapioca starch [3]. The main components of edible film compiler are three groups: hydrocolloid, fat, and composites [5]. One of the main ingredients used in the manufacture of edible films is starch which belongs to the hydrocolloid group, which is an easy-to-obtain material, inexpensive, and of various types in Indonesia. Low levels of amylose and high amylopectin can facilitate the starch gelatinization process because it can reduce the solubility of starch in water so that starch can only expand in hot water which is needed in the starch gelatinization process. With high amylopectin levels, much space is available so that this space will be filled by mixing biopolymers.

Figure 3. Water Absorption Percentage Graph by Plastic Made from Tapioca and Palm Starch
The results of testing with XRD showed that the degree of crystallinity in palm starch was higher than the crystallinity of tapioca starch, which was 31.51% and 27.78%, respectively. Higher crystallinity indicates a lower amorphous region so that the structure is more crystalline and stable. This will have an impact on the nature of the plastic that will be produced.

![Figure 4. XRD Graph of Tapioca and Palm Starch-Based Plastics](image)

The mechanical properties of starch-based degradable plastics are shown in Figure 5. Overall, it was shown that plastics made from palm starch had better mechanical properties than those made from tapioca starch. This is caused by the higher crystallinity of palm starch and the effect of amylose and amylopectin levels. Palm starch had lower amylose content than tapioca starch [4]. While the amylopectin content of palm starch is higher than the level of amylopectin in tapioca starch. Low levels of amylose and high amylopectin could facilitate the starch gelatinization process because it can reduce the solubility of starch in water so that starch can only expand in hot water which is needed in the starch gelatinization process [6]. With high amylopectin levels, much empty space is available so that this empty space will be filled by mixing biopolymers.
4. Conclusion

This study shows that there are various types of glycerol from bioplastic sheets which will be affected by water uptake and tensile strength properties. The results obtained showed that the tapioca starch-based bioplastic sheets had the highest percentage in water uptake and the palm oil starch-based bioplastics sheets had the lowest water absorption. In the mechanical properties of some biodegradable plastics from oil palm starch has better properties, this is due to the higher crystallinity of palm starch and the influence of amylose and amylopectin levels.

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**Acknowledgments**

The authors would like to thank the Research Institutions, University of Sumatera Utara for its financial support by the TALENTA Research Implementation Contract of the University of Sumatera Utara, 2018 (Grant No: 2590 / UN.1.R / PPM / 2018 March 16, 2018).