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Making and Characterizing Bioplastic from Cassava (*Manihot utilissima*) Peel Starch with Sorbitol As Plasticizer

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Abstract

Cassava peel is agriculture product waste that is very potential to be one of raw materials of environmentally friendly bioplastic. Bioplastic or biodegradable plastic is plastic material that could be degraded in environment, and made of renewable material such as starch, cellulose, lignin, lipid, and protein. In this research, study on making bioplastic from cassava peel starch and chitosan is carried out with sorbitol as plasticizer, by varying sorbitol concentration addition of 30 and 50%, and starch to chitosan ratio of 10:0, 9:1, 8:2, 7:3, 6:4 (% w) at gelatinization temperature of 80°C. Research result indicates that the best mechanical property of bioplastic for tensile strength value as large of 1.37 Mpa is obtained at sorbitol addition of 30% with starch:chitosan ratio of 7:3. Modulus Young value as large of 3.7 Mpa is obtained at sorbitol addition of 30% and pati:chitosan ratio of 8:2, and elongation % value as large of 26.55% is obtained at sorbitol addition of 50%, and starch:chitosan ratio of 9:1.

Key words: bioplastic, cassava peel starch, chitosan, sorbitol

Introduction

Plastic is one of supporting material that is usually used in human's daily activity. Plastic is used broadly because of light, flexible, transparent, and infrangible plastic properties. Such several plastic properties are the reason why plastic is broadly used particularly as food packaging material. Plastic consumption as package could achieve two third of total amount of plastic consumption in general [7].

Instead of strengthens owned by plastic, of course plastic also has weakness on basic property of plastic material. Plastic usage as packaging material faces various environmental problems, i. e. it could not be recycled, and it could not degraded naturally by microbe in land, so that plastic waste stacking that causes contamination and degradation on environment occurs. Besides that, plastic used currently is synthetic polymer from crude oil material whose amount is limited, and it could not be renewable. Based on the fact, it is necessary the plastic material alternative that is obtained from material that is easily gained, available in nature in large amount, and cheap, but it could produce product with the same strength [5].

The advantage of plastic material from material available in nature could reduce or replace basic material of conventional plastic so that it is easily degraded by decomposing microorganism that is called by biodegradable plastic (bioplastic). The advantage of this bioplastic could surely reduce plastic waste that the longer, the more. This bioplastic is designed to facilitate degradation process toward microorganism enzymatic such as bacteria and fungi [1]. One of materials available and easily degraded in nature is starch. Starch is promisingly basic material for bioplastic making material because of its universal property, renewable, and achievable [8].

Biodegradable plastic or bioplastic is plastic that could be used as conventional plastic should be, but it will be decomposed by microorganism activity to be water and carbon dioxide after

it is used and thrown into environment. Because of its property that could be back to nature, it is categorized as environmentally friendly plastic. In Japan, it has been approved plastic's name *guriinpura* for degradable [4].

Materials and Methods

Extraction of cassava peel starch

Making bioplastic that has basic material of cassava peel is formerly carried out by extraction process of cassava peel starch. At first, cassava peel is cleaned by separating brown peel part, whereas white cassava peel is taken and cut in order to reduce its size, and soaked in sodium metabisulphite for 1 hour. Furthermore, filtration is carried out in order to separate metabisulphite solution. Cassava peel is added with water with comparison of 1:1 and it is crushed by using blender. Cassava peel slurry is filtered, and Filtrate I and Waste I are produced.

Waste I of cassava peel from the first filtration is added water with ratio of 1:1, and then agitation is carried out and continued by filtration. Thus filtrate II is obtained. Filtrate I and filtrate II are mixed and precipitation is carried out for 3 hours in order to obtain starch deposit. Starch deposit obtained is dried in oven at temperature of 40°C for 48 hours. Then, grinding and screening in order to obtain uniformity of cassava peel starch with size of 100 mesh.

Procedure

Making Bioplastic

After extract of cassava peel obtained, the next process is making bioplastic. The initial step is carried out by making solution of cassava peel starch of 10% (w/v) solved in aquadest. Whereas chitosan is solved in glacial acetate acid with concentration of 20% (w/v). Furthermore, cassava peel starch and chitosan are mixed with ratio variation of 10:0; 9:1; 8:2; 7:3, and 6:4 (%). This mixture is agitated for 25 minutes at gelatinization temperature of 80°C. Next, sorbitol plasticized addition is carried out with concentration variation of 30 and 50%, and it is agitated until homogeneous. Then, the homogeneous solution is casted above plate with 2.5 mm thickness. Furthermore, drying is carried out in oven at temperature of 60°C for 5 hours. Sample is released from glass plat, and kept in desiccator for 24 hours. Bioplastic obtained is analysed and characterized.

Results and Discussion

In order to know bioplastic quality resulted, several parameters that are usually used to analyse resulted bioplastic are measured such as tensile strength, elongation at break, and modulus young [3].

Tensile strength of bioplastic

Tensile strength is the amount of maximum strength needed in order to break bioplastic or edible film. Bioplastic that has high tensile strength will be able to give well protection from mechanical disturbance from outside [11].

Figure 1 indicates that addition of sorbitol plasticizer at concentrations of 30 and 50% does not give significant increasing of tensile strength value. Tensile strength value obtained is in the range of 0.196 to 1.37 MPa. The best tensile strength value is obtained at sorbitol concentration addition of 30% at ratio of starch-chitosan of 7:3 is as large of 1.37 MPa. This is caused by composition of starch-chitosan of 7:3, and sorbitol concentration of 30% is

optimum condition of bioplastic formation in order to achieve the highest tensile strength value.

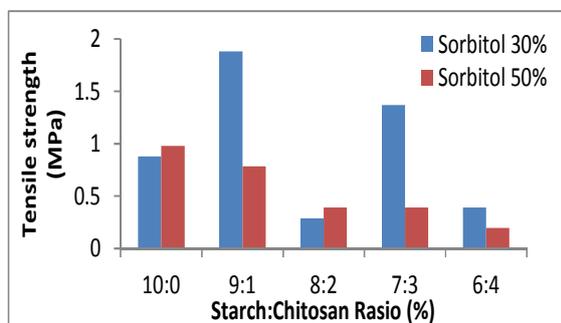


Figure 1. The effect of sorbitol concentration addition and ratio of starch:chitosan toward tensile strength of bioplastic.

The result of research conducted by Butler *et al.* [2] using chitosan and acetate acid solvent of 1% (w/v) indicates that tensile strength will reduce with the more glycerol plasticizer concentration that is added in chitosan solution. Purwanti [10] states that in general by sorbitol addition as plasticizer in solution, the position of constituent molecules of plasticizer lying between binding chain of biopolymer and the plasticizer could interact to form hydrogen binding in binding chain inter-polymer, so that it causes inter-molecule biopolymer interaction more reduced. This fact makes tensile strength of bioplastic to be more reduced with the existence of plasticizer added.

Elongation at break

Elongation at Break indicates the quantity of the change of maximum film length while obtaining tensile strength until the film breaks, compared to the initial length [9]. In general Figure 2 indicates that the concentration addition tendency of sorbitol as plasticizer could increase elongation percentage. Whereas the increase of chitosan composition quantity indicates the tendency to reduce elongation percentage value.

This fact is in compliance with research conducted by Purwanti [10] that states the sorbitol addition in the chain of chitosan polymer binding could make polymer binding reduced so that bioplastic of polymer chain binding becomes flexible, and could increase elongation percentage.

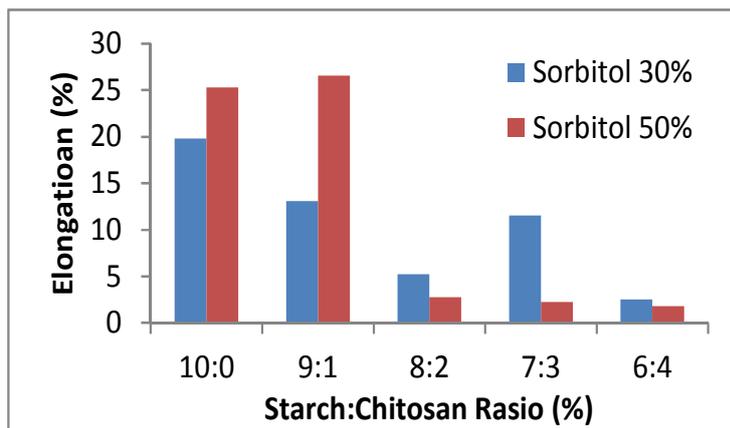


Figure 2. The effect of sorbitol concentration addition and starch: chitosan ratio toward Elongation at Break of bioplastic.

In this research, the highest value of elongation percentage is obtained at sorbitol concentration of 50% with composition of starch-chitosan ratio of 9:1 that is as large of 26.55%.

Modulus young

Modulus Young is obtained from the comparison between tensile strength toward elongation at break. This Modulus Young is also called as the rigidity measure of a material [9]). The effect of sorbitol concentration addition, and starch-chitosan ratio toward Modulus Young could be seen in Figure 3.

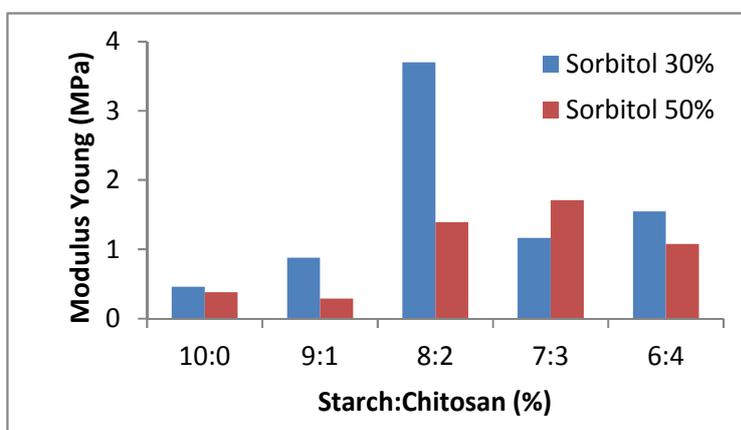


Figure 3. The effect of sorbitol concentration addition, and starch-chitosan ratio toward Modulus Young of bioplastic.

Based on Figure 3, it could be seen that the highest Modulus Young of bioplastic resulted is obtained at sorbitol concentration addition of 30% with starch-chitosan ratio of 8:2, that is as large of 3.7 MPa.

Morphology structure of bioplastic

Morphology structure of bioplastic could be analysed by using SEM (Scanning Electron Microscopic) with the purpose to determine bioplastic homogeneity, cracking, and fineness

resulted. Figure 4 indicates SEM result of bioplastic surface with 5000 times of magnification.

SEM result appeared in Figure 4 indicates that combination of bioplastic from cassava peel starch-chitosan and bioplastic sorbitol at starch-chitosan ratio of 7:3 with sorbitol concentration of 30%, seems less homogeneous, where starch agglomerate does not change completely into gelatine. This is probably caused by agitation process of biopolymer dope that is not spread evenly. Bioplastic homogeneity resulted could be said perfect if distribution or spreading occurs evenly on starch, chitosan, and plasticizer.

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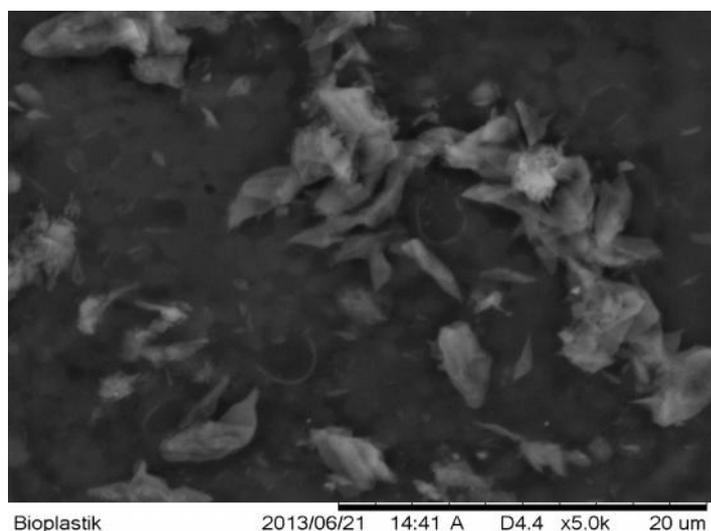


Figure 4. Top surface of bioplastic film at starch-chitosan ratio of 7:3 with sorbitol concentration of 30% (5000 times of magnification).

If cross section structure of bioplastic film resulted is observed (Figure 5), it seems that there are starch granule structure inside, even though it has not been intact, the large granule size that could still be observed, and the small pores location that is almost spread evenly. This fact is probably influenced by incomplete gelatinization so that it causes starch granule still appears on cross section structure of bioplastic resulted.

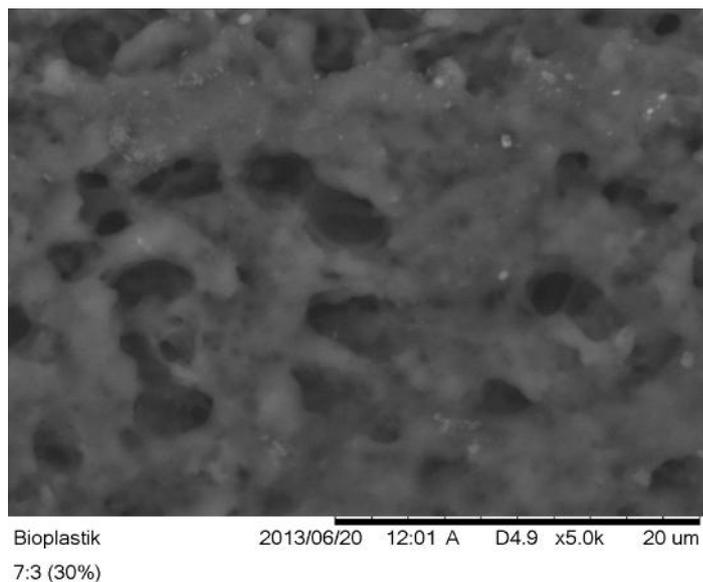


Figure 5. Cross section of bioplastic film at starch-chitosan ratio of 7:3 with sorbitol concentration of 30% (5000 times of magnification)

Conclusions

Based on research result, it could be concluded that bioplastic from cassava peel starch with the best formulation composition has tensile strength value of 1.37 MPa at starch-chitosan ratio of 7:3 and sorbitol concentration of 30%. The best value of Elongation at Break is as large of 26.55% that is obtained at starch-chitosan formulation of 9:1 and sorbitol addition of 50%. The best value of Modulus Young is as large of 3.7 MPa that is obtained at starch-chitosan ratio 8:2 and sorbitol concentration of 30%. Whereas morphology structure of bioplastic, both top and cross section, has not given homogeneous morphology structure.

Acknowledgements

The authors thanks to SIMLITABMAS-DIKTI that has financed this research in research program of competitive grant. The authors also thanks to Badratul Nafis and Ade Irma Junita who assisted in conducting this research.

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