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EFFECT OF MODIFIED SUGAR PALM FIBER ADDITION ON MECHANICAL PROPERTIES AND FOURIER TRANSFORM INFRARED SPECTROSCOPY (FT-IR) ANALYSIS OF BIOPLASTIC FROM AVOCADO SEED STARCH WITH PLASTICIZER GLYCEROL

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ABSTRACT

The effect of modified sugar palm fiber addition on mechanical properties and Fourier Transform Infrared Spectroscopy (FT-IR) analysis of bioplastic from avocado seed starch with plasticizer glycerol were studied. Mechanical properties of bioplastic were determined by tensile strengths, elongation at break, and modulus young. Bioplastic manufacturing process is carried out by solution casting technique. Fiber serves as filler in bioplastic, in this research, the filler that was used was modified sugar palm fiber. Modified sugar palm fiber was soaked in 5% (w/v) NaOH to lose the lignin contents. Variations of avocado seed starch and modified sugar palm fiber composition ratio were 6:4, 7:3 and 8:2 (w/w) and variations of glycerol addition were 0.1; 0.2; 0.3; 0.4 (v/w). From the analysis conducted on the mechanical properties, can be found that the best composition ratio between avocado seed starch and modified sugar palm fiber was 6:4 (w/w), the best variation of glycerol addition was 0.1 (v/w), with a tensile strength 3.46 MPa, elongation at break 5.90%, and modulus young 63.45 MPa. From the result of FT-IR analysis indicated O-H group, C-H group, C=O group, and C-O group on bioplastics.

Keywords: avocado seed, bioplastic, glycerol, sugar palm fiber, tensile strength.

INTRODUCTION

The demand for plastics has increased over time, due to the plastic has a number of advantages, lighter, easier, and cheaper price. Most plastics used today are conventional plastic as we know, conventional plastic takes 500-1000 years to decompose in the soil.

The difficulty of unravelling this plastic causes environmental problems. Nowadays, people are more aware about the harmful effects of petrochemical derived plastic materials in the environment. (Muneer, 2014). The solution of this problem is to replace the use of conventional plastics with bioplastic. In terms of usability, bioplastic have in common with conventional plastic, bioplastic can only break down faster than conventional plastic, so as to reduce the negative impact on the environment the materials used in this study on the starch is a bioplastic avocado seeds for cool fiber modified plasticizer and glycerol.

The purpose of this research is to know the influence of the addition of starch modified sugar palm fiber against mechanical properties and analysis of Fourier Transform Infrared Spectroscopy (FT-IR) bioplastic from avocado seed starch by using plasticizer glycerol. As for the mechanical properties include tensile strength, elongation at break, and young's modulus.

LITERATURE REVIEW

Bioplastics are not just one single substance, they comprise of a whole family of materials with differing properties and applications. According to European Bioplastics, a plastic material is defined as a bioplastic if it is either biobased, biodegradable, or features both properties (Maulida *et al*., 2016).

Biodegradation is a chemical process during which micro-organisms that are available in the environment convert materials into natural substances such as water, carbon dioxide, and compost (artificial additives are not needed). The process of biodegradation depends on the surrounding environmental conditions (e.g. location or temperature), on the material and on the application (Maulida *et al*., 2016).

Starch is used for it is easily degradable by nature to be environmentally friendly compounds. In Indonesia founded various plants yield flour (starch) like cassava (Maulida *et al*., 2016). Avocado is plant that owns dark green peel, oily green pulp, and big seed that represents 10-22% from total weight (Lopez, 1998). This avocado grows well in tropical country like Indonesia. Based on Badan Pusat Statistik Republik Indonesia (BPS), production of avocado in Indonesia increases from 2009 to 2013 and in 2013 production of avocado is 276,318 tons (BPS, 2014).

Sugar palm fibers contain cellulose 51.5%. The sugar palm fibers were roofed with sugar palm tree is generated, have physical characteristics include: fiber form is black, with a diameter of less than 0.5 mm, are stiff and resilient. Sugar palm fiber has not been widely used, such as a broom maker and ropes. There are still many untapped sugarpalm so wasted (Maulida *et al*., 2016). On the otherhand sugar palm as an amplifier in less developed bioplastic.

But straw roofs have the fiber content of cellulose which is quite high. The lignin content of the quite large on style, amounting to 41.88% (Sahari *et al*., 2012). Then done soaking in style with 5% NaOH to remove lignin content in style. This is called the modified sugar palm fiber. Biodegradable plastics from starches have lesselastic properties and are hydrophilic so need other additional ingredients added to enhance the characteristics had engineer (Utami, *et al*., 2014). Plasticizer to improve elasticity function by reducing the degree of hydrogen bonds and increase the distance between the molecules of the polymer. The more the use of plasticizer will then increase the solubility. Similarly, the use of plasticizer that is hydrophilic will also increase the solubility in water.

Glycerol provide higher solubility than sorbitol on starch based bioplastic (Sanyang *et al*., 2015). The manufacturing process is carried out using bioplastic engineering solution casting. As for analyzing research testing is done by testing the mechanical properties tensile strength, in the form of elongation at break and modulus young, and analysis of Fourier Transform Infrared Spectroscopy (FT-IR).

METHODOLOGY

Materials

Avocado seed strach, sugar palm fiber, glycerol, aquadest, and sodium hydroxide.

Starch Isolation

Avocado seed at amount of 100 grams were washed by clean water. Avocado seed was cut with thickness ± 2 cm, then added 100 ml water that were used to simplify the crushing process (Lubis et al., 2018). Next, avocado seed was crumbled by using blender. Pulp of avocado seed was taken out from blender and filtered and let at free air for 30 minutes to get the precipitation from the avocado seed pulp. The precipitation was separated with water, then the precipitation was added with water and deposited again for 30 mins. The precipitation now was dried in oven with temperature 70°C for 30 minutes. Earned the dried powder of starch, then sifted with sieve 100 mesh (Ginting a *et al*., 2018).

Modified Sugar Palm Fiber Preparation

Sugar palm fiber were washed with water to remove dirt. Fibers soaked into a solution of 100 ml of 5% NaOH for 2 hours. Dried in the sun for 1 hour. Fibers milled with ball mill for 60 minutes. Fibers that have been milled sieved with sieve mesh number of 200 mesh.

Film Preparation

The procedure of making bioplastics is, mixed glycerol varied mass of 0.2; 0.3 and 0.4 ml/g (weight of the starch) with a ratio of starch: modified sugar palm fiber mass is varied 8:2, 7:3 and 6:4 g and distilled water with a ratio of starch: distilled water is 1:20 (w/v). The heated mixture while stirring using a stirrer to a temperature of 90°C. Then added 15% NaOH, wait up to 20 minutes. The mixture is then cooled and printed on acrylic mold with a size of 25 x 25 x 3 mm. Plastic cooled for 24 hours (Ginting b *et al*., 2018), allowed to stand at room temperature until the plastic can be removed from the mold.

Then the resulting bioplastic tested properties include tensile strength properties, elongation at break and modulus young by using tool autograph-shimadzu based on ASTM D882. Done is also testing the FT-IR (Fourier Transform Infrared Spectroscopy) using tools Shimadzu IR on starch and avocado seeds bioplastic produced which aims to know the functional group which is present on the seed starch avocado and bioplastic and to know the nature of the bioplastic.

RESULTS AND DISCUSSIONS

Bioplastics produced in this research is black bioplastics.

Figure-1. Bioplastics after drying.

To determine the mechanical properties of bioplastics can be determined from the test results of tensile strength, elongation at break and modulus young.

Effect of variations modified sugar palm fiber addition and plasticizer glycerol on tensile strength of bioplastics properties

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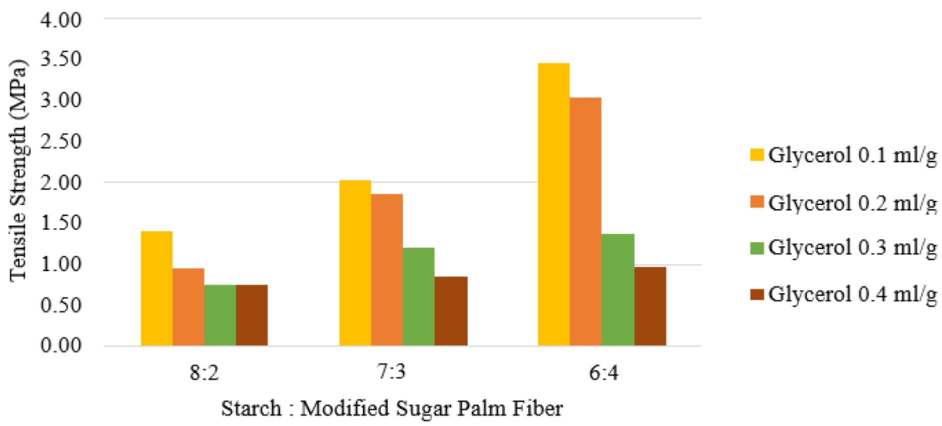

Figure-2. Effect variation of fibers modified filler and plasticizer glycerol properties on tensile strength of bioplastic.

In Figure-2 can be seen the effect of adding modified sugar palm fiber and plasticizers glycerol on tensile strength of bioplastics from avocado seed starch. In Figure-2 shows that the addition of fiber mass-modified sugar palm fiber that tensile strength increased, and the addition of glycerol plasticizer lowers the tensile strength of bioplastics. The highest tensile strength values bioplastics obtained at mass ratio of starch: modified sugar palm fiber which is 6:4 and glycerol 0.1 ml/g with a value of 3.46 MPa with modulus young of 63.45 MPa. While the lowest tensile strength values obtained at mass ratio of starch: modified sugar palm fiber is 8:2 and glycerol 0.4ml/g at 0.75 MPa.

From Figure-2 can be seen the effect of the addition filler of modified sugar palm fiber and plasticizer glycerol on tensile strength of bioplastics. The more mass of modified sugar palm fiber are added, the higher tensile strength values are generated. Modified sugar palm fiber added in the starch solution is to fill and improve the cohesiveness of bioplastics is formed, thus increasing the resilience of bioplastics when testing the tensile strength, as reported by Abdorezza *et al*. (2011) found an increase in tensile strength due to the amount of fiber that is more and more, the reinforcement in the composite will be greater so that it will be able to receive a tensile load which is the greater, which in turn can increase the tensile strength of the composite.

In the study Susanti *et al*. (2015) with the title Composites Synthesis-Based Bioplastic Tapioca Fiber Reinforced Bamboo obtained the highest tensile strength of 0.068 MPa when compared, then the tensile strength test results in this study are higher by 3.46 MPa. It can be caused by the particle size of the powder modified sugar palm fiber which is 200 mesh, while the size of the bamboo fiber is used in the form of fiber pieces. Munandar *et al.* (2013) reported that the diameter of the fiber influence on the strength of its appeal. The smaller the fiber diameter the strength of great appeal. This is because the group has a number of small diameter fiber bonding and a lot of small size so that a strong bond. While the larger diameter then its strength is small. Large diameter fiber groups have little bond amount and a large size so that the bonds between not strong. In Figure-2 it can be seen that the increasing plasticizer, the tensile strength will decrease this because with the addition of glycerol as a plasticizer, the molecules of plasticizers in bioplastics is located between the chain bonding biopolymers and can interact by forming grooves hydrogen bonds in the chain of the bonds between the polymer thus causing interactions between the molecules of biopolymers become increasingly reduced. This leads to reduced tensile strength utilizing bioplastics with the addition of plasticizers (Bertuzzi, 2012). Abdorezza *et al.* (2011) states that the addition of plasticizers can cause a decrease in stiffness bioplastic material. This is because their guardians visco elastic response speed and mobility of the molecular chain of the polymer.

Effect of variations of modified sugar palm fiber addition and plasticizer glycerol on elongation at break of bioplastics

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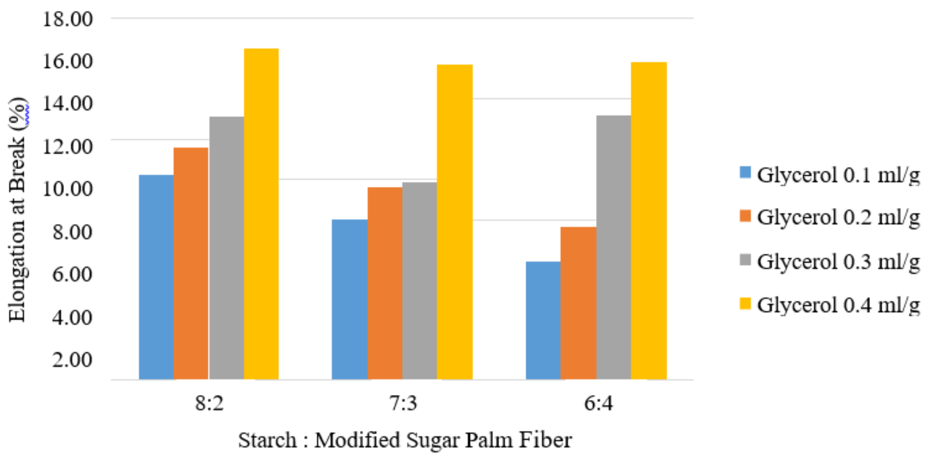

Figure-3. Effect of variation of modified sugar palm fiber addition and plasticizer glycerol on elongation at break of bioplastic

Figure-3 shows the correlation of modified sugar palm fiber and plasticizer glycerol on elongation at break of bioplastics from avocado seed starch. From the above picture can be seen the value of the elongation at break is at the highest in the addition of modified sugar palm fiber 2 grams and glycerol 0.4 ml/g is equal to 16.49%, while the elongation at break the lowest in the addition of modified sugar palm fiber 4 grams and glycerol 0.1 ml/g is equal to 5.90 %.

From Figure-3 it can be seen the effect of the addition of modified sugar palm fiber filler and plasticizer glycerol to the elongation at break of bioplastics. With the increasing number of modified sugar palm fiber can cause the value of the elongation at break of bioplastics into decline. Then, with the increasing amount of glycerol can cause the value of the elongation at break of bioplastics to be increased. Its role in increasing the elongation at break properties of bioplastics are glycerol, it can be seen from the chart above that only by increasing additional volume of glycerol can result in substantial changes to the elongation at break of bioplastics. Without the addition of plasticizer, amylose and amylopectin will form a film and a structure with rich regions of amylose and amylopectin, where the interaction between the molecules of amylose and amylopectin, it makes the film bioplastics brittle and stiff. Plasticizer is an additive that can soften when added in a material. To increase the flexibility of a film, the plasticizer used because it has the ability to reduce internal hydrogen bonds between polymer chains while increasing the molecular space. The percentage elongation is inversely proportional to the addition of fiber filler fibers, thus increasing the filler fibers fiber elongation percentage value will decrease. This is due to the decline in bond intermolecular distance.

If the levels of plasticizer and filler material constantly being upgraded will cause decreased tensile strength bioplastic films. This is because the molecular equilibrium has passed, so that the molecule plasticizers and fillers that excess in a separate phase outside the matrix phase and will decrease the intermolecular forces between the chain that led to the chain movement freer and intermolecular force will also decrease (Sanyang, et.al 2015; Setiani, *et al* 2013).

The addition of plasticizers serves as a conduiton the elastic properties of bioplastics, so the more plasticizers are given will increase the value of the extension of plastic. Plasticizer can reduce internal hydrogen bonding molecules and lead to weakening of the intermolecular attractive force adjacent polymer chains, thereby reducing the tensile breaking. Besides the addition of plasticizer able to reduce brittleness and increase the flexibility of the polymer film (Maulida et al., 2016).

Characteristics analysis of FT-IR bioplastics without /with modified sugar palm fiber addition and plasticizers glycerol

Analysis of the functional groups FT-IR is required to determine the functional groups contained in bioplastics without/with modified sugar palm fiber addition and plasticizer glycerol, analysis of functional groups FT-IR done using. From the analysis of functional groups using FT-IR results obtained spectrum in the form of graphs that can be viewed in Figure-4 as follows:

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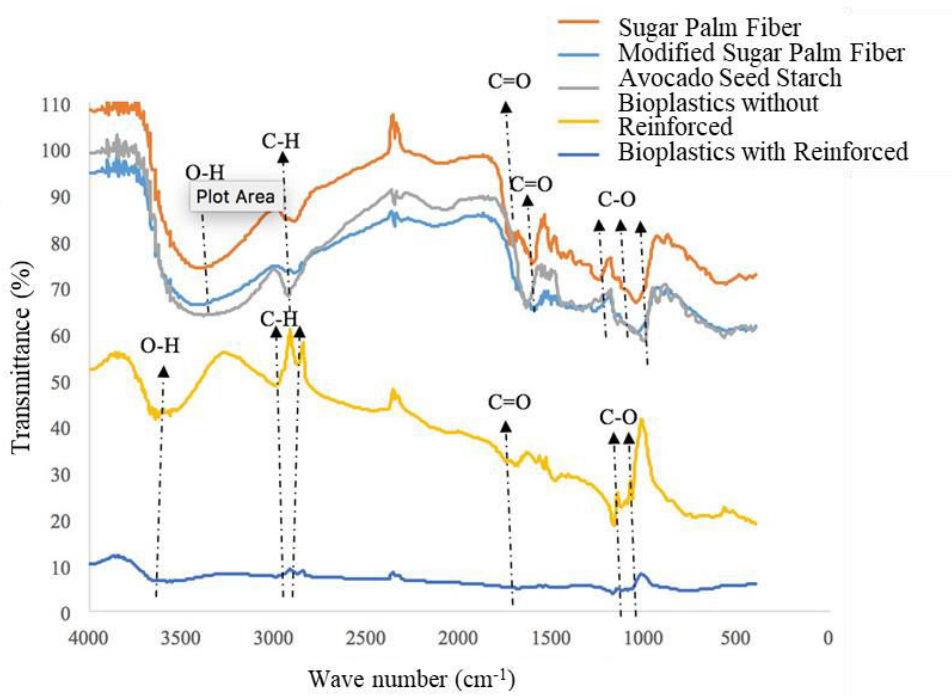

Figure-4. Characteristics of FT-IR bioplastics without and with modified sugar palm fiber and plasticizer glycerol.

On both bioplastics can be seen the appearance of the absorption peak at wave number 3572.17 cm^{-1} which is the presence of O-H group. The emergence of absorption peaks at wave number 2993.52 cm^{-1} and 2877.79 cm^{-1} which is the presence of C-H group. The addition fiber-modified fibers causes the appearance of an increase in the absorption peak at wave number 1747.51 cm^{-1} of 1739.79 cm^{-1} which is the presence of an aldehyde group C=O, as well as the emergence of an increase in the absorption peak at wave number 116.58 cm^{-1} of 1172.72 cm^{-1} which is the C=O group. The emergence of the group C=O aldehyde starch chain termination due to the glycoside form aldehyde groups C=O and OH groups at the ends of amylose or amylopectin contained in the starch. In addition to the OH group, the presence of other functional groups contained within the bioplastics such as carbonyl functional group and ester functional groups. The existence of this cluster characteristics make plastic biodegradable. Their group - the OH group of alcohol, alkane C-H, C-H stretch aldehyde group, spanning the group C=O amide, the span of C-O ester group shows the structure contained on bioplastics (Ginting, c, *et al* 2015).

CONCLUSIONS

Modified sugar palm fiber are sugar palm fiber soaked with 15% NaOH to order missing of lignin content. Bioplastics made from starch can be made with casting solution techniques. Addition of modified sugar palm fiber addition increased the value of tensile strength but decreased the value of elongation at break. Otherwise, adding glycerol content decreased the value of tensile strength and increased the elongation at a break value.

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