EFFECT OF TEMPERATURE AND TIME FOR BIOPLASTIC FROM TAPIOCA STARCH

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Abstract

The use of conventional plastic affects the environment because it is difficult to decompose thus causing environmental pollution. Therefore, it is necessary to find alternative that origins from degradable materials. Bioplastics are environmentally friendly plastics that can be somposed by the activity of microorganisms. The development of bioplastics from organic materials has been largely done from starchy materials. In this research, bioplastic was made using tapioca starch with sorbitol and glycerol as plasticizers. This research aimed to determine how the influence of temperature and time at heating bioplastic solutions to the quality of bioplastics. Temperature variations used were 63, 65, and 70^{o}C, while the time variations were 20, 25, 30 minutes. The results showed that the best tensile strength at 65^{o}C and 20 minutes treatment was 0.8231 Mpa, the best elongation at 63^{o}C and 25 minutes treatment was 68.75%, the best water absorption at 63^{o}C and 20 minutes treatment was 46.34%, and all samples were degraded 100 % in 18 days. Bioplastics from tapioca starch is very much faster than conventional plastic to be degrade.

Keywords : bioplastic, starch, temperature, time.

Abstrak

Penggunaan plastik konvensional mempengaruhi lingkungan karena sulit terurai sehingga menyebabkan pencemaran lingkungan. Oleh karena itu, perlu dicari alternatif yang berasal dari bahan yang dapat terdegradasi. Bioplastik adalah plastik ramah lingkungan yang dapat tersusun oleh aktivitas mikroorganisme. Pengembangan bioplastik dari bahan organik sebagian besar telah dilakukan dari bahan tepung. Dalam penelitian ini, bioplastik dibuat menggunakan tepung tapioka dengan sorbitol dan gliserol sebagai *plasticizers*. Penelitian ini bertujuan untuk mengetahui bagaimana pengaruh suhu dan waktu pada pemanasan larutan bioplastik terhadap kualitas bioplastik. Variasi suhu yang digunakan adalah 63, 65, dan 70^{o}C, sedangkan variasi waktunya adalah 20, 25, 30 menit. Hasil penelitian menunjukkan bahwa kekuatan tarik terbaik pada perlakuan 65^{o}C dan 20 menit yaitu 0,8231 Mpa, perpanjangan terbaik pada perlakuan 63^{o}C dan 25 menit yaitu 68,75%, penyerapan air terbaik pada perlakuan 63^{o}C dan 20 menit yaitu 46,34%, dan semua sampel terdegradasi 100% dalam 18 hari. Bioplastik dari tepung tapioka jauh lebih cepat daripada plastik konvensional untuk didegradasi.

Kata Kunci : bioplastik, tepung, suhu, waktu.

1. INTRODUCTION

Unconsciously humans are dependent on the use of plastic. Plastic is one of the goods that can not be separated for the life of humans. Thousands of plastic factories are producing tons of plastic goods which are popularly used by the people because of their ease, cheapness and convenience. Due to non-biodegradable nature they cause hazardous negative impact on the environment. Disposal of plastic waste which are major cause of environment pollution becomes carcinogenic to human, birth defects, impaired immunity,endocrine disruption, development and reproductive effect (Pavani & Rajeswari, 2014). To reduce the use of plastics that cause environmental pollution, then bioplastic research was conducted. Researchers have conducted many researches for managing plastic waste on earth by finding eco-friendly alternative to plastics. This ecofriendly alternative is bioplastics, which are disposed in environment and can easily degrade through the enzymatic actions of microorganisms (Gill, 2014).

The use of tapioca starch as the main ingredient in the manufacture of bioplastics shows great potential , since Indonesia has a diverse range of starch-producing plants (Wahyuningtiyas & Suryanto, 2017). Tapioca starch is one of the most commonly used biopolymers as food packaging material because it is nontoxic, biodegradable, low cost, renewable and abundantly available in nature, its major component is starch, but it may content small amount of lipid, protein, fiber and ash. The starch plays important role in bioplastic forming. Today starch based bioplastic dominates 66% of the global bioplastics market (Mulyono, et al, 2015).

The development and production of biodegradable plastic starch is important. The water contained in starch and other plasticizers play an indispensable role, because the hydrogen plasticizers can form bonds with starch, take the place of the strong action between the hydroxy groups of star molecules, and make starch displays the plasticization. When used alone in packaging applications, starch exhibits a poor performance because of its brittleness and hydrophilic nature (Latina,2013). Very important to find the perfect plasticizer that imparts flexibility (Ma, 2004).

2. METHODOLOGY

The problems of this research are how is the effect of temperature at heating bioplastic solution on bioplastic quality and how is the effect of time at heating bioplastic solution on bioplastic quality.

In this research, the main equipment used was hot plate, beaker glass, and mold and the ingredients were tapioca starch, glycerol, sorbitol, and aquadest. Independent variable in

this research are temperature (63, 65, 70^{o}C) and time (20, 25, 30 minutes). Controlling variable in this research are Glycerol 3.5 ml, tapioca Starch 7 gram, sorbitol 3.5 ml, aquadest 100 ml and the speed of mixture was 300 rpm. Dependent variables in this research are elongation, tensile strength, biodegradable and maximum water absorption.

Process of making bioplastic involves prepare the research material such as tapioca starch, sorbitol, glycerol, and aquadest. Tapioca dissolve with 100 ml aquadest. Sorbitol 3.5 ml and glycerol 3.5 ml were mixed. Each mixed plasticizers were blended at 300 rpm for 10 minutes in order to be homogeneous solution. After that tapioca starch solution and plasticizer solution put into the 500 ml of beaker glass. Mixed both solution in certain temperature with the speed of mixture is 300 rpm in a hot plate for certain time. After mixturing process, then the mixture put into the mold that has been prepare from a ceramic. Then wait until it's dry. A week later then do the testing of mechanical properties (tensile strength and elongation), biodegradability, and water absorption.

Various of tests conducted from this research were Elongation test : Plastic elongation testing is done by comparing the addition of the length that occurs to the length of the material before the tensile strength test is performed. From this elongation test will be able to know the level of elongation of material with the change of composition done at the time of treatment. Tensile test : The optimal composition of plastics is determined by the mechanical properties of the material on tensile strength and material extension. Mechanical properties are now obtained through tensile strength test experiments. The mechanical properties of a material are influenced by the nature of each component and the bonding ability in the constituent compound. Biodegradation test : Biodegradation test was done by soil burial test method.Plastic film at the size of 3x3 cm. The plastic was kept in the desiccator for 24 hours and weighed until it reached the constant weight. After being buried in the ground for 2 weeks. The sample is then dried in the desiccator and weighed until a constant weight is obtained. Maximum water absorption : Samples were cut into 3x3 cm, and the pieces were kept in desiccator for 48 hours. The dried pieces were weighed immediately and then the specimens were soaked in distilled water at room temperature. After 24 hours, the specimens were removed from distilled water, blotted dry with filter paper, and then weighed again. Data were recorded as averages of three specimens. Water absorption of the starch plastic was calculated asfollows (Zuo, Gu, Tan, & Zhang, 2015):

$$\text{Water absorption} = \frac{w_1 - w_0}{w_0} \times 100\%$$

where, w_1 is the mass of the sample after water absorption and w_0 is the mass of the dry sample.

3. RESULT AND DISCUSSION

Below shows the results of biodegradable plastics.

Figure. 1 A sample biodegradable plastic from tapioca

3.1Tensile strength test

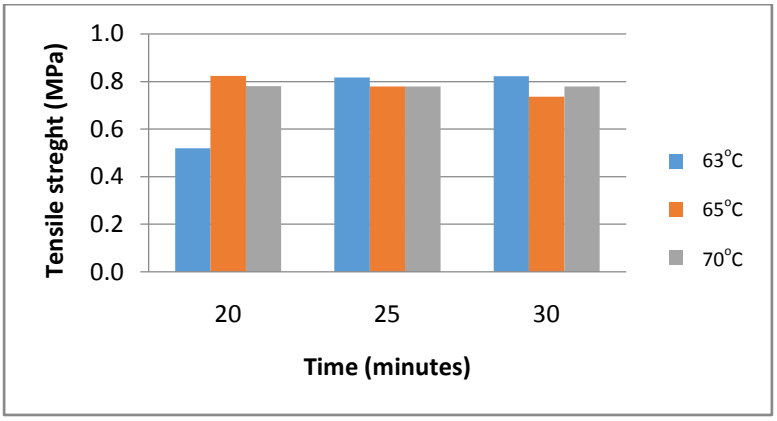

Figure 2 Tensile Strenght versus Time

From Figure 2, it can be seen the results of the highest tensile test at 65^{o}C with a heating time of 20 minutes and 63^{o}C with a time of 25 and 30 minutes with a value of 0.8 MPa and the lowest result at 63^{o}C which is heated for 20 minutes at 0.5 MPa. At each temperature variation has an optimum time so that if the heating time is too short or too long it will affect the viscosity of the solution so that it affects the results of the tensile test. In this study for 63^{o}C temperature the longer the heating time the higher the tensile strength results, for a temperature of 65^{o}C the longer heating time the more tensile strength decreases, and for 70^{o}C when heated at 3 time variations have constant results. However, it appears that there is no significant difference in the results of the tensile test with variations in time and temperature in this study.

3.2 Elongation Test

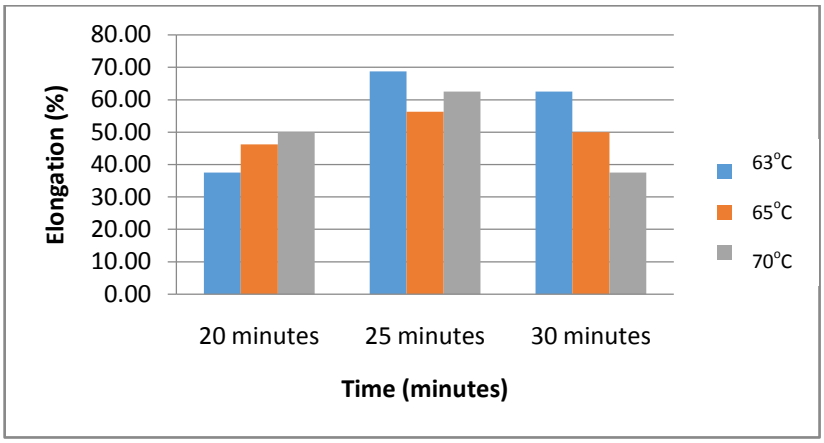

Figure 3 Elongation versus Time

From the figure 3, it can be seen that the highest bioplastic elongation was for 25 minutes at 63°C, and for each temperature the optimum heating time was 25 minutes, as evidenced from the above graph at 25 minutes heating time the elongation results are higher than other heating times. This is because if it is heated too long or too much then the bond between the molecules will not be perfect.

3.3 Maximum Water Absorption Test

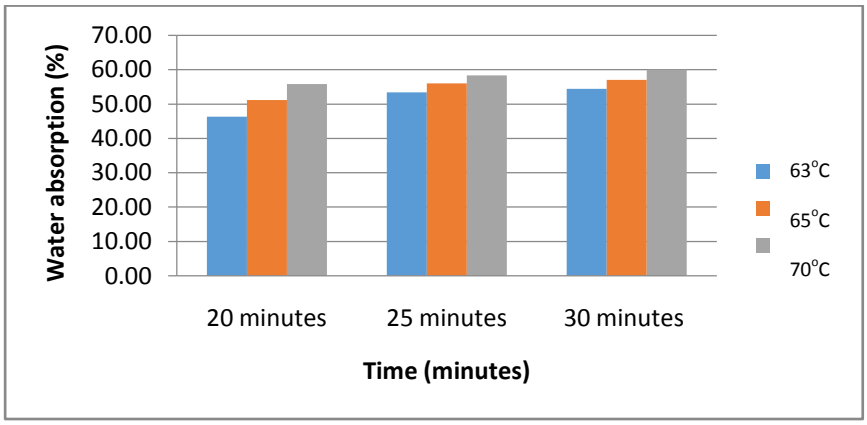

Figure 4 Water Absorption

From the picture above, it shows that the greater the temperature and the longer the heating time,so the greater the water absoption, and according to the above data the highest water absorption is bioplastic at 70°C for 30 minutes. So the higher the temperature and the longer the heating time, the greater the absorption of plastic where the quality of the plastic decreases.

3.4 Biodegradable Test

In the bioplastics sample, biodegradation testing of 100% was lost within 18 days. Based on data on the quality requirements of easily biodegradable plastic bags that refer to SNI 7188.7: 2016, the results of bioplastics in this study meet the biodegradable specifications, because they have been degraded 100% in less than 28 days. The National Standardization Agency (BSN) issued a national standardization of biodegradable bioplastics (in 2016 with the reference code of SNI 7188.7: 2016. In SNI 7188.7: 2016 explained the quality requirements of biodegradable plastic bags.

Tabel 1 Bioplastic requirements are easily biodegradable

Aspect	Requirements	Test Method
Degradability	a. Thermoplastics contain prodegradants	ASTM 5208 ASTM 3826
	b. Tensile elongation (Elongation at break) of less than 5% is achieved after experiencing a maximum UV light treatment for 250 hours	
	c. Bioplastics and / or mixtures with thermoplastics Microbial growth on the surface of the product is more than 60% for 28 days	ASTM G21

(Source: BSN, 2016)

Based on SNI 7188.7: 2016 concerning biodegradable plastic bags, in this study three quality standards were taken (tensile strength, elongation, water absorption, and degrability) as normative references. From the research conducted, the quality standard that is in accordance with the SNI standard has not been obtained due to the method of testing which is not yet in accordance with national standards.

And if compared with other journals as controls. According to Hidayati Sri et al., (2015) on the production of biodegradable films from nata de cassava, the value of tensile strength with the addition of sorbitol 0% was equal to 62.22 MPa close to the tensile strength of PC type Polycarbonate (Hardcoat xx Safeguard and Safeguard) that is equal to 65 MPa. And for this bioplastics from tapioca starch the value of tensile strength also is still too far away.

4. CONCLUSION

From the results of this research it can be concluded that the best tensile strength test was at 65^{o}C and 20 minutes with the result 0.8231 MPa. The best elongation test was at 63^{o}C and 25 minutes with the result of 68.75%. The best water absorption test was at 63^{o}C and 20 minutes with the result of 46.34%. The biodegradable test showed the sample could be 100% decomposed for 18 days.

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