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Characterization and Production of Biodegradable Plastics from Cassava Rubber Starch and Old Newsprint Using Glycerol Plasticizer

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ABSTRACT

Plastic waste is the biggest problem faced by almost all countries. The long process of degradation and the large production of conventional plastics are the main causes of the accumulation of plastic waste, especially in Indonesia. The use of rubber cassava and old newsprint along with fillers in the form of chitosan and glycerol plasticizer are alternatives in avoiding the use of food-grade materials that are still used by the public. The hot mixing method was used in the production of bioplastics, by first extracting the cassava starch, with variations in the use of old newsprint of 1, 2, and 3 grams. This study obtained a good bioplastic in the composition of 3 grams of old newsprint, which produced a tensile strength value of 6.6 MPa, 7.2% elongation, with 44.18% degradation ability for 5 days of burial.

Keywords: Bioplastics, Water Absorption, Degradability, Tensile Strength

1. INTRODUCTION

The accumulation of plastic waste that is based on petroleum becomes a problem that is often faced by Indonesia [10]. The amount of plastic that degrades rapidly in nature is known to be small. Therefore, research on biodegradable plastics technology or also known as bioplastics has been intensified as an effort to save nature from the potential of plastic waste accumulation [1]. Most organic materials such as cellulose, biopolymer and others are the main materials of bioplastic composites [2]. Old newsprint can be used as a source of cellulose in bioplastic production. Biopolymers such as rubber cassava starch and chitosan can also be used as additional materials in the production of bioplastics. Rubber cassava is very easy to find in Indonesia because of its abundant quantity. The condition of the rubber cassava which contains poison makes rubber cassava not widely sold in the market. On the other hand, it is quite cheap when it is bought from farmers directly [3]. Research on the production of bioplastics from rubber cassava has been done by several researchers including Marudin [4], utilizing rubber cassava, glycerol and sorbitol in the manufacture of bioplastics. Another reason to use rubber cassava as a raw material is to avoid using food-grade materials or materials suitable for consumption. Another important material in the form of biopolymers which is commonly used as a reinforcing component in the manufacture of bioplastics, as previously mentioned, is chitosan. Chitosan is a component obtained from the deacetylation of chitin base which is a glucose-based unbranched polysaccharide that is widely distributed as a major component of the exoskeleton of crustaceans and insects as well as bacterial and fungal cells [5]. Another component of bioplastics besides old newsprint mixed with chitosan and rubber cassava starch is plasticizers. The plasticizer most commonly used in bioplastic research is glycerol. Glycerol plasticizer is a compound with a liquid form that is colorless, odorless and has a sweet taste [6]. Glycerol is thick at room temperature (25 ^{0}C) and non-toxic in low concentrations. Some people refer to glycerol as glycol alcohol, glycerin and so on [7].

This research on making bioplastics with the main raw materials of cassava rubber and old newsprint specifically aims to examine which bioplastic products have the best performance by varying the composition of the old newsprint used. There is great hope in the future, if newsprint is considered good as a bioplastic component, it is not impossible to be commercialized on a pilot or factory scale. In addition, this research can also be said to be a form of a simple contribution to research on bioplastics. It is also a caring attitude towards the problem of the accumulation of plastic waste made from petroleum as well as the problem of accumulation of paper waste, for example old newsprint.

Table 1 Characteristics of Biodegradable Plastic Bags According to SNI 7818: 2014

No	Description	Regulation
1	Tensile Strength	Min 13,7 MPa
2	Elongation	400-1120 %

The SNI standard above (Table 1) can be used as a reference that the research on making bioplastics has been said to be successful or not.

2. METHODOLOGY

2.1. Research Materials

The materials used in this study were: rubber cassava starch, old newsprint, chitosan, acetic acid, glycerol, and distilled water.

2.2. Research Tools

The tools used in this study are: stainless steel glass, turbine impeller stirrer, oven, analytical balance, beaker, measuring cup, saucer, spatula, thermometer, 20 x 20 cm mica mold, hot plate, blender, mortar and pestle.

2.3. Research Procedure

2.2.1 Leaching of Rubber Cassava Starch

The preparation of raw materials starts from taking the rubber cassava starch using a leaching process. Preparing rubber cassava starch is by peeling the rubber cassava and then washing it. Next, refine the rubber cassava. Once smooth, add water to the smooth cassava with a ratio of 1: 2 (cassava: water). The next step, filtering using a filter cloth until the pulp and liquid (starch suspension) are obtained. After that, carry out the leaching process again on the dregs obtained from the filtering process, by adding water with a ratio of pulp to water, 1: 2. Conduct filtering again to get starch. Mix the starch liquid obtained from the first and second filtration then let it settle for one hour. The water from the precipitation is discarded to obtain wet starch. The last step is drying the starch under the sun for 2 days under control.

2.2.2 Production of Bioplastics

The production of bioplastics was carried out based on the melt intercalation method, as conducted by Aripin. et al [9]. The variables that were varied are the mass of old newsprint (1 gram, 2 grams, and 3 grams). The fixed variables were the weight of rubber cassava (5 grams), chitosan (1 gram), water volume (100 mL), and glycerol plasticizer volume (5 mL). At first, it was carried out by mixing the rubber cassava starch, chitosan, water and old newsprint and 1% acetic acid into the mixture with the aim to dissolve the chitosan so that the chitosan could dissolve completely with the mixture. Then, the mixture was heated at 90^0C, and stirred with a stirrer for 40 minutes. Before the mixture was put into the mold, it was allowed to stand for 5 minutes so that there were no bubbles in the bioplastic solution. Pour the mixture into a mica mold then dry the mixture in an oven at 55^0C for 7-8 hours. The final step was removing the mixture from the oven, then leaving it at room temperature until the mixture can be removed from the mold [8].

2.2.3 Characterization of Bioplastics Product

The characterization of bioplastic products is obtained from product testing obtained from the research. The tests carried out include tensile strength testing, degradability level testing, and water absorption testing.

3. RESULT AND DISCUSSION

3.1. Mechanical Test

From the obtained tensile strength of the three bioplastics that have been made, the values are quite different from one sample to others (Figure 1). From Figure 1, the best tensile strength value is in the bioplastic sample with a mass of old newsprint of 3 grams. The tensile strength of this sample is 6.6 Mpa and the elongation value or length gain is 7.2%. When it is viewed from the magnitude of the highest elongation value, it was achieved by the bioplastic sample with an old newsprint mass of 1 gram of 12.2%. However, the tensile strength value of the bioplastic sample with a mass of 1 gram was the smallest tensile strength value of 1.3 Mpa. Basically, the value of tensile strength and elongation will always be the opposite. If the tensile strength value is high, the elongation value is low. If the elongation value is high, the tensile strength value is low. It is difficult to find a meeting point between the tensile strength and elongation values of bioplastics. Bioplastics are said to be good in terms of mechanics when they are able to comply with the SNI 7818: 2014 standard with a minimum tensile strength value of 13.7 Mpa and an elongation of 400-1120%. Basically, besides old newsprint, additional fillers can also be used as variations to increase the tensile strength of the bioplastics made [2].

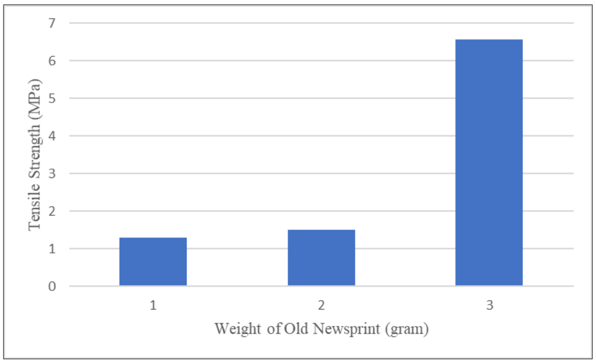

Figure 1 Bioplastic Tensile Strength

3.2. Degradability Test

From the results of the degradability or biodegradability test (Figure 2), the percentage value of weight reduction from the three plastic samples made was obtained. In this case, it can be seen how much influence of the raw material of cassava rubber and old newsprint added with chitosan and glycerol in showing the performance of the bioplastic. The performance is shown from the degradability in the soil. Bioplastic burial was carried out for 5 days from 13 November 2019 to 18 November 2019. Burial for 5 days is considered sufficient in testing the biodegradability of bioplastics. The results of the percentage reduction in weight of each bioplastic sample from the weight of old newsprint of 1 gram, 2 grams and 3 grams, are 17.63%; 31.03%; and 44.18%, respectively. The largest percentage of weight reduction was in the bioplastic sample with a mass of old newsprint of 3 grams. The physical appearance of the bioplastic after burial for 5 days is that it has a moist texture and is easily torn. The biodegradability can also be influenced by how much the role of the plasticizer in the bioplastic. Plasticizer can be used as a factor in the rapid degradation of bioplastics buried in soil or open land [9].

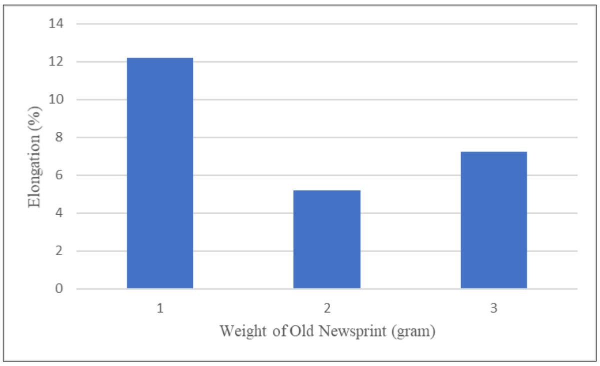

Figure 2. Percentage of Bioplastic Weight Reduction

3.3. Water Absorption Test

The water absorption test shows the ability of bioplastics to attract water (hydrophilic). The more resistant the bioplastic to water, the better the bioplastic is and not less competitive with conventional plastics or synthetic plastics that have long been in the market [3]. From the results of the water absorption test (Figure 3), it was found that the three bioplastic samples showed a constant weight at 70, 80 and 90 minutes they were put into a beaker filled with water. This means that the three samples are no longer able to absorb water.

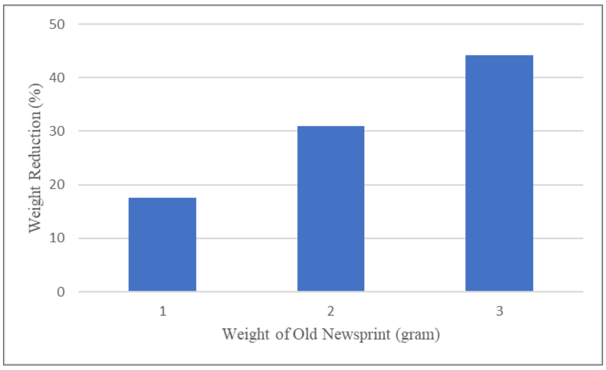

Figure 3 Percentage of Bioplastics Water Absorption

In addition to a series of tests obtained above, the physical condition of the bioplastic or the appearance of the bioplastic product varies, however, it is dominated by dark brown color. The bioplastic sample with a mass of old newsprint of 1 gram has a texture that is thinner than the other two bioplastic samples. It can be folded easily.

4. CONCLUSION

The greatest tensile strength value is in the bioplastic sample with a mass of 3 grams of old newsprint of 6.6 MPa. The highest elongation value was in the bioplastic sample with a mass of 1 gram of old newsprint of 12.2%. The results of the water absorption test of the three samples of old newsprint showed a constant value at 70, 80 and 90 minutes with the best absorption ability in the bioplastic sample with a newsprint mass of 2 grams. The highest weight reduction of bioplastic is 44.18%. The physical condition of the three samples showed a fairly good appearance seen from the physical condition which was not sticky, elastic and strong enough.

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REFERENCE

[1] Wahyuni, Tri. (2016). *Indonesia Penyumbang Sampah Plastik Terbesar Ke-dua Dunia.. https://www.cnnindonesia.com/2019* [Online]. Tersedia. Diakses 10 November 2019, Pukul 15.00 WIB.

[2] Lazuardi, G. P., & Cahyaningrum, S. E. (2013). *Pembuatan Dan Karakterisasi Bioplastik Berbahan Dasar Kitosan Dan Pati Singkong Dengan Plasticizer Gliserol (Preparation And Characterization Based Bioplastic Chitosan And*

Cassava Starch With Glycerol Plazticizer). Unesa Journal of Chemistry, 2(3).

[3] Utomo, A. P. (2017). *Pengaruh Berat Pati Umbi Singkong Karet (Manihot glaziovii) dan Volume Gliserol Terhadap Kualitas Bioplastik*. Jurusan Tenik Kimia : Universitas Muhammdiyah Surakarta. Skripsi.

[4] Marudin, E. J., & Asngad, A. (2017). *Pemanfaatan Singkong Karet Untuk Pembuatan Bioplastik Dengan Penambahan Plasticizer Gliserol Dan Sorbitol Yang Berbeda* (Doctoral dissertation, Universitas Muhammadiyah Surakarta).

[5] Coniawati, P., Laila, L., & Alfira, M. R. (2015). *Pembuatan Film Plastik Biodegredabel dari Pati Jagung dengan Penambahan Kitosan dan Pemplastis Gliserol.* Jurnal Teknik Kimia, 20 (4).

[6] Angraini, Fetty. (2013) *Aplikasi Plasticizer Gliserol Pada Pembuatan Plastik Biodegradable dari Biji Nangka.* Skripsi. Jurusan Kimia. Universitas Negeri Semarang.

[7] Sinaga, R. F., Ginting, G. M., Ginting, M. H. S., & Hasibuan, R. (2014). *Pengaruh Penambahan Gliserol terhadap Sifat Kekuatan Tarik Dan Pemanjangan Saat Putus Bioplastik Dari Pati Umbi Talas*. Jurnal Teknik Kimia USU, 3(2), 19-24.

[8] Prasetyo, A. E., Widhi, A., & Widayat, W. *Potensi Gliserol Dalam Pembuatan Turunan Gliserol Melalui Proses Esterifikasi*. Jurnal Ilmu Lingkungan, 10(1), 26-31.

[9] Aripin, S., Saing, B., & Kustiyah, E. (2017). Studi Pembuatan Bahan Alternatif Plastik Biodegradable Dari Pati Ubi Jalar Dengan Plasticizer Gliserol Dengan Metode Melt Intercalation. Jurnal Teknik Mesin Mercu Buana, 6(2), 79-84.

[10] Hartatik, Y. D., Nuriyah, L., & Iswarin, S. J. (2014). Pengaruh Komposisi Kitosan terhadap Sifat Mekanik dan Biodegradable Bioplastik Brawijaya Physics Student Journal, Vol. 1, 1-4.