ELECTROLYTE
Vol 2 No 1 2023, pp 65-72
e-ISSN 2828-3147
https://doi.org/10.54482/electrolyte.v2i02.205

EFFECT OF CALCIUM CARBONATE ($CaCO_3$) ADDITIVES ON THE QUALITY OF CELLULOSE-BASED BIODEGRADABLE PLASTICS BACTERIA-POLYETHYLENE GLYCOL (PEG) OF COCONUT WATER (*Cocos Nucifera*)

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ARTICLE INFO

Submit
03 November 2022
Received
04 November 2022
Revised
30 November 2022
Accepted
15 December 2022
Published
30 June 2023
(IN PRESS)

ABSTRACT

Biodegradable plastics are plastics that are easily degraded by microorganisms. This study aims to determine the effect of adding calcium carbonate additives to biodegradable plastics based on PEG bacterial cellulose from coconut water *(cocos nucifera)*. This study use 14% polyethylene glycol 400 as a plasticizer with variations in the volume of $CaCO_3$. The maximum result from testing the mechanical properties obtained is the addition of 8 gr $CaCO_3$ with a tensile strength value of 54.85 MPa, which already meets the SNI standard for synthetic plastic, which is in the range of 24.7-302 MPa. In the biodegradation test, it was found that the 15 day burial was degraded by more then 50%, where the more $CaCO_3$ was added, the plastics biodegradability decreased, but this is much better than plastic mad from synthetic materials, which can take decades.

Keywords: Bacterial Cellulose, Biodegradable Plastic, $CaCO_3$, Coconut Water, PEG

1. INTRODUCTION

The increasing use of plastics in life can increase the pressure on the available capacity in disposal of plastic waste, the need for biodegradable plastics and the decomposition of plastic waste are becoming increasingly important from year to year [1-3]. Plastic is often used as packaging because the material is easy to shape, lightweight and the price is cheap. Therapeutic use of plastic is a problem for health and the environment. This happened usually because the materials used in plastics are non-renewable or non-biodegradable. Therefore, it is necessary to have alternative packaging materials that can be degraded naturally or what can be called biodegradable plastics [4-5].

Biodegradable plastics are usually made from renewable materials such as starch, protein, cellulose, which are compounds found in plants or animals [6-8]. Cellulose occupies almost 60% of the components that make up plant structures. The amount of cellulose in nature is very abundant and can be obtained from agricultural products [9]. Cellulose is synthesized by microorganisms, some bacteria usually synthesize bacterial cellulose (SB) in the form of nata through polymerization of glucose molecules and converted into-1,4-glucan chains in the interior of SB. One of the bacteria The one that produces cellulose is *Acetobacter xylinum* through coconut water fermentation [10].

Coconut water has many nutrients such as sugar, protein, fat and minerals that are beneficial for development bacteria [11-12]. The addition of plasticizers in the manufacture of *biodegradable* plastics serves to increase the elasticity of plastics [13-14]. One of the *plasticizers* that can be used is Polyethylene Glycol (PEG) because PEG has good mechanical and physical properties, such as solubility in water and organic solvents, low toxicity, and high hydrophilicity [15].

In the research conducted by Tiara Angelina (2019) on "The Effect of Adding Polyethylene Glycol (PEG) to Bacterial Cellulose- Based Biodegradable Plastics from Coconut Water *(Cocos Nucifera)"* the results were quite good but did not meet SNI, to improve the quality of plastics can be added calcium carbonate ($CaCO_3$) additive, where $CaCO_3$ can improve plastic quality such as increasing tear resistance and elongation at break [16].

Based on these problems, researchers are interested in conducting research on "The Effect of Addition of Substance Calcium Carbonate ($CaCO_3$) Additive To Plastic Quality Biodegradable Cellulose-Based Bacteria-Polyethylene Glycol (PEG) from Coconut Water *(Cocos Nucifera)".*

The carbon elements present in coconut water are simple carbohydrates such as sorbitol, glucose, sucrose, fructose and others. While the nitrogen element in the form of protein is composed of amino acids such as aline, arginine, alanine and serine. Coconut water also has micro elements such as minerals needed by the body, these minerals are Sodium (Na), potassium (K), Calcium (Ca), Magnesium (Mg), Ferum (Fe), cuprum (Cu), phosphorus (P) and sulfur (S) [17].

Coconut can produce nata de coco through a fermentation process involving microbes known as nata seeds. Nata seeds are often also known as Acetobacter xylinum. These bacteria form acetic acid. These bacteria will convert glucose into cellulose. This cellulose will make nata white, bacteria can be propagated by making a starter. Nata can grow in coconut water that has been enriched with carbon (C) and nitrogen (N) through a controlled process [18].

Bacterial cellulose (SB) is a cellulose formed by acetic acid bacteria and has advantages over plant cellulose. Its advantages are good network structure, high purity, high decomposition and high mechanical strength. Bacterial cellulose also has a very high water content (98-99%), is an excellent fluid absorption, does not cause allergies and can be sterilized by name without changing the characteristics [19-21].

Plasticizer is a non-volatile material that has a boiling point and is able to change the physical properties of the material when added to other materials. The addition of plasticizers can reduce hydrogen bonds between polymers to overcome the brittle nature of the plastic layer, and increase plastic flexibility and reduce plastic inhibitors [22]. Plasticizers are usually added to polymer materials to modify the three-dimensional structure, reduce intermolecular attractive forces and increase the mobility of polymer chains [23]. The bond that will be formed is a hydrogen bond between the polymer and the plasticizer. Polyethylene glycol (PEG) is a natural plasticizer that can be used for the synthesis of biodegradable plastics.

Calcium carbonate (CaCO3) is a natural material that is commonly found in limestone, the carbonate mineral commonly found in limestone is aragonite, which is a metastable mineral because it can turn into calcite in a certain period of time, calcite is the most stable so it is widely used in industry. paints, paper, textiles, detergents, plastics and cosmetics [24]. $CaCO_3$ is one of the fillers that can be used in the manufacture of biodegradable plastics to overcome the lack of plastic properties. $CaCO_3$ can increase the stiffness of plastics that are too flexible so that they can change the brittleness and not easily torn, reduce solubility and tend to bend. This study aims to determine the effect of adding calcium carbonate additives to biodegradable plastics based on PEG bacterial cellulose from coconut water *(cocos nucifera).*

2. EXPERIMENTAL

2.1 Medium manufacture

The coconut water medium was made aseptically by adding 600 mL of coconut water, 30 grams of sugar, 6 grams of urea and 12 ml of acetic acid, then adding 14% Polyethylene Glycol (PEG) 400 plasticizer and varying $CaCO_3$ into the pan. The medium is heated to boiling. The boiling medium was transferred to a plastic container and then covered with newsprint that had been sterilized first. Then the medium was allowed to come to room temperature

2.2 Production of Bacterial PEG Cellulose (SPEGB-$CaCO_3$)

The fermentation mediums were cooled at room temperature in plastic containers, inoculated with starter A. Xylinum in a ratio of 10:1 (%v/v) and fermented at room temperature until at least 0.5 cm bacterial cellulose was formed. During the inoculation process the container should not be shaken.

2.3 Washing and purification of bacterial cellulose (SBPEG-C)

Bacterial cellulose that has been formed is washed with running water for +/- 24 hours, then soaked with 2% NaOH (%w/v) for +/- 24 hours. After that wash again with running water until clean. The cleaning process is carried out so that the bacterial cellulose that has been formed does not become smelly and rotten due to the growth of fungi. Bacterial cellulose was successfully characterized by the formation of thick white sheets, not moldy, not perforated, and there were no black spots on the cellulose.

2.4 Characteristics of biodegradable plastic

Tensile strength can be measured using the Tensile Strength Industries model SSB 0500. Analysis of the tensile strength of plastics is carried out through data obtained from a tensometer. The magnitude of the tensile strength can be calculated using the equation:

$$t = Fmax/Ao$$

Where:

F max = Force exerted by the tool (N)

Ao = Cross-sectional area (mm2)

T = Tensile strength (Mpa)

2.5 Biodegradation

Biodegradation analysis of SB plastic sheet was carried out with a plastic sheet in the soil with a size of 5 x 5 cm at a soil depth of 15 cm. The measurement process was carried out for 15 days. Prior to burial, the mass of plastic was weighed, then buried in the ground for 15 days with weighing intervals every 3 days. The decomposed plastic can be calculated using the following equation:

$$\%Biodegradasi = \frac{m-mo}{mo} x100\%$$

Where:

mo = Mass of sample before burial

m = Mass of the sample after being buried

3. DISCUSSION

3.1 Tensile strength test

Tensile Strength value is at SBPEG-CaCO3 8 gr, which is 54.85. the addition of $CaCO_3$ can increase the tensile strength value in plastic because it can bind the empty space particles contained in the plastic pores so that when testing the tensile strength of the plastic provides a large force. However, with the addition of $CaCO_3$ 4 g the tensile strength value decreased, this was due to several factors such as temperature, immersion and unstable pressure during plastic formation. Based on the SNI for plastic with a value of 24.7-302 MPa, the tensile strength values that meet the SNI for plastic are SBPEG-$CaCO_3$ 2 g, 6 g and 8 g. Plastic with the addition of $CaCO_3$ 8 g is the best quality.

DOI: https://doi.org/10.54482/electrolyte.v2i02.205

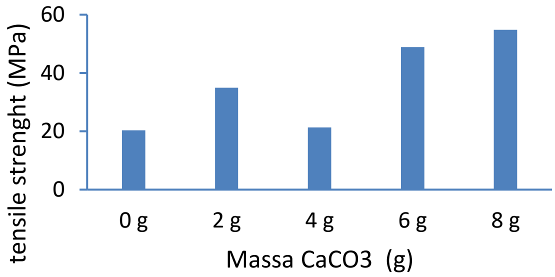

Figure 1. Tensile Strength Test Graph

3.2 Biodegradation test

Biodegradable plastic is characterized by damage and mass reduction after burial. Biodegradable plastics are easily degraded because they contain hydroxyl (OH) and carboxyl (CO) groups. which is easily degraded in nature. Apart from the nature of the constituent components of biodegradable plastic, it is easily degraded naturally due to the help of microorganisms in the soil such as bacteria or other decomposers that help accelerate the rate of degradation of biodegradable plastics.

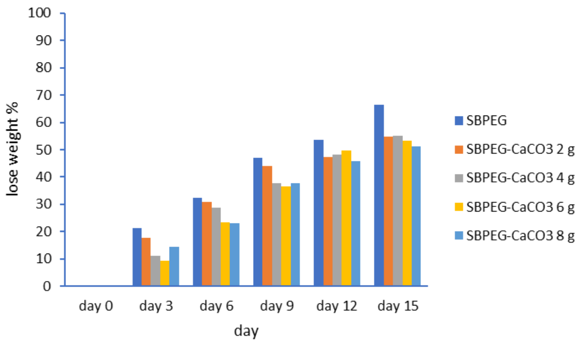

Figure 2. Biodegradation test graph

4. CONCLUSION

The effect of adding $CaCO_3$ additives to SBPEG on the biodegradation test where the results obtained at 15 days of burial were degraded by more than 50% where the more $CaCO_3$ added to the plastic the longer it would biodegrade, but this is still much better than plastic made from synthetic materials which can reach decades. The best quality of SBPEG-$CaCO_3$ plastic was found in the addition of $CaCO_3$ 8 g with a tensile strength value of 54.85 MPa. The conclusion section should emphasize the main contribution of the article to literature. Authors may also explain why the work is important, what are the novelties or possible applications and extensions. Do not replicate the abstract or sentences given in main text as the conclusion.

ACKNOWLEDGEMENTS

The authors would like to thank the Department of Chemistry, Faculty of Mathematics and Natural Sciences, Padang State University for allowing and providing chemical laboratory facilities in the completion of this research.

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