JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

NEW DEVELOPMENTS IN BIOPLASTICS

[1]Dhara Upadhyay

Assistant Professor, Chemical Engineering Department, V.V.P. college of Engineering, Rajkot, Gujarat

Abstract:

Bioplastics are a type of plastic that can be made from natural resources such as vegetable oils and starches. Bioplastics from natural raw material present a biodegradable alternative to conventional petrochemical-based plastic and are environmentally safe and reducing dependency on fossil reserves. As an alternative, the use of bioplastics is being promoted, consisting in obtaining natural polymers from agricultural, cellulose or potato and corn starch waste. Advantages of bioplastics includes reduction in carbon footprint, energy savings in production, reduces non-biodegradable wastes, do not contain additives that are harmful to health, do not change the flavour or scent of food content. The method stages of this study were cellulose extraction, alkali treatment, bleaching, and analyzing by Fourier Transform Infra-Red (FTIR). Bioplastic film were synthesized using cellulose, chitosan and sorbitol with variaion in cellulose and chitosan masses to obtain bioplastic films with high mechanical strength. The obtained bioplastic films were tested mechanically by using Universal Testing Machine (UTM). The result of this research showed that cellulose obtained from the extraction was 59.2%, odorless, and white powder. Bioplastics are driving the evolution of plastics. There are two major advantages of biobased plastic products compared to their conventional versions: they save fossil resources by using biomass which regenerates (annually) and provides the unique potential of carbon neutrality. Furthermore, biodegradability is an add-on property of certain types of bioplastics. It offers additional means of recovery at the end of a product’s life. There has been extensive research and publicity around the damage traditional plastics are doing to the environment so the fact that bioplastics are produced from renewable resources and degradable materials means that can reduce pollution in a very real way.

1. Introduction

Environmental problems especially those caused by plastic waste are one of the unresolved issues in Indonesia. Indonesia produces 187.2 million tons of waste in 2010 and is expected to increase every year. Various activities to reduce plastic waste have been carried out through the use of paid plastic bags, the use of drinking bottles and shopping bags themselves. However, these activities did not produce significant result. So we need a solution that is replacing synthetic plastic using bioplastics, where bioplastics are plastics made from natural materials such as starch, protein, and cellulose so that they are easily broken down by microorganisms.

Cellulose can be the main choice as a raw material for making bioplastics because the source of cellulose can be obtained from waste so that it can also be a solution to overcome enviromental problems. One source of cellulose is rice husk. Rice husk contains cellulose which is quite high 57%, so it has the potential to be used as a raw material for making bioplastics. The purpose of this research is to synthesize cellulose-based bioplastic films with variation in cellulose mass and chitosan to obtain high mechanical strength.

2. Experimental

2.1. Materials

The material used in this study was rice husk obtained fom Gowa Regency, Indonesia, chitosan, sorbitol, methanol, $NaOH+Na_2CO_3$ 5%, H_2SO_4 10%, NaOCl 2%, and CH_3COOH 1%.

2.2. Instrument

The tols used in this study are glassware, smoothing machines, filters, ovens, vacuum Buchner, Forier Transform Infra-Red (FTIR), and Universal Testing Machine (UTM).

2.3. Method

2.3.1. Extraction cellulose of rice husk. Rice husk is a clened from impurities and dried in the sun. Dried rice husk has been mashed and sieved with a size 80 mesh. Rice husk powder was macerated with methanol solvent for seven days. Maceration residue was added with 300 mL of 5% (w/v) NaOH+ Na_2CO3 solution. The mixture is added with a solution of 10% H_2SO_4 until it reaches pH 3-4. The residue is dried in an oven at 50◦C to a constant weight.

2.3.2. Characteristic of cellulose. Cellulose from the extraction of rice husk was observed physical properties such us odor and discoloration and its functional group was analyzed using FTIR.

2.3.3. Synthetic of bioplastic with cellulose mass variation. Cellulose with a mas variation of 0.2, 0.4,

0.6, 0.8, and 1.0 g was added to the chitosan solution (0.8 g in 50 mL CH_3COOH 1%) in each beaker and stirred until homogeneous. Sorbitol mixture is added and stirred again. The mixture is printed on glass plate and the flattened and dried in oven at 60◦ C.

2.3.4. Synthetic of bioplastik with mass chitosan variation. Optimum mass cellulose variation was put into chitosan solution with mass variation 0.8, 1.2, 1.6, 2.0, and 2.6 gram in 50 mL CH_3COOH 1% in each beaker and stirred until homogeneous. Sorbitol mixture is added and stirred again. The mixture printed on a glass plate and then flattened and dried in an oven at 60◦ C.

2.3.5. Bioplastic mechanical test. The bioplastic produced from cellulose mass variation and chitosan mass variation was tested by tensile strength and elongation by using Universal Testing Machine (UTM).

3. Results and Discussion

3.1. Extraction Cellulose of Rice Husk

Cellulose extracted in the form of brown powder. Cellulose extraction consist of several stages, including the removal of lignin (delignification), hydrolysis, and bleaching. The delignification processes use an alkali treatment that is $NaOH+Na_2CO_3$ 5% (w/v) produces a deep brown colour. The brown colour indicates that lignin is still trapped with cellulose. The next stage is hydrolysis marked by bubbles appearing which indicates the hydrolysis process has occurred. The last stage is the bleaching process to remove the remnants of lignin that are still bond to cellulose. The cellulose obtained was in the from white and odourless powder in figure 1

Figure 1. Cellulose extracted

The cellulose obtained is by previous studies and is the same a commercial cellulose, cellulose content obtained from rice husk extraction was 59.2% higher than the previous observation of 57%.

3.2. Characterization Cellulose of Rice Husk

Figure 2 shows the FTIR cellulose extracted from rice husk. The peak that appears is around 3440-3500 cm^{-1} showing O-H group. These result show the hydroxyl group on cellulose. The peaks that appear in the area of 1080-1094 cm^{-1} indicate the C-O group on cellulose. Clusters that appear on the spectrum can be observed in Table 1.

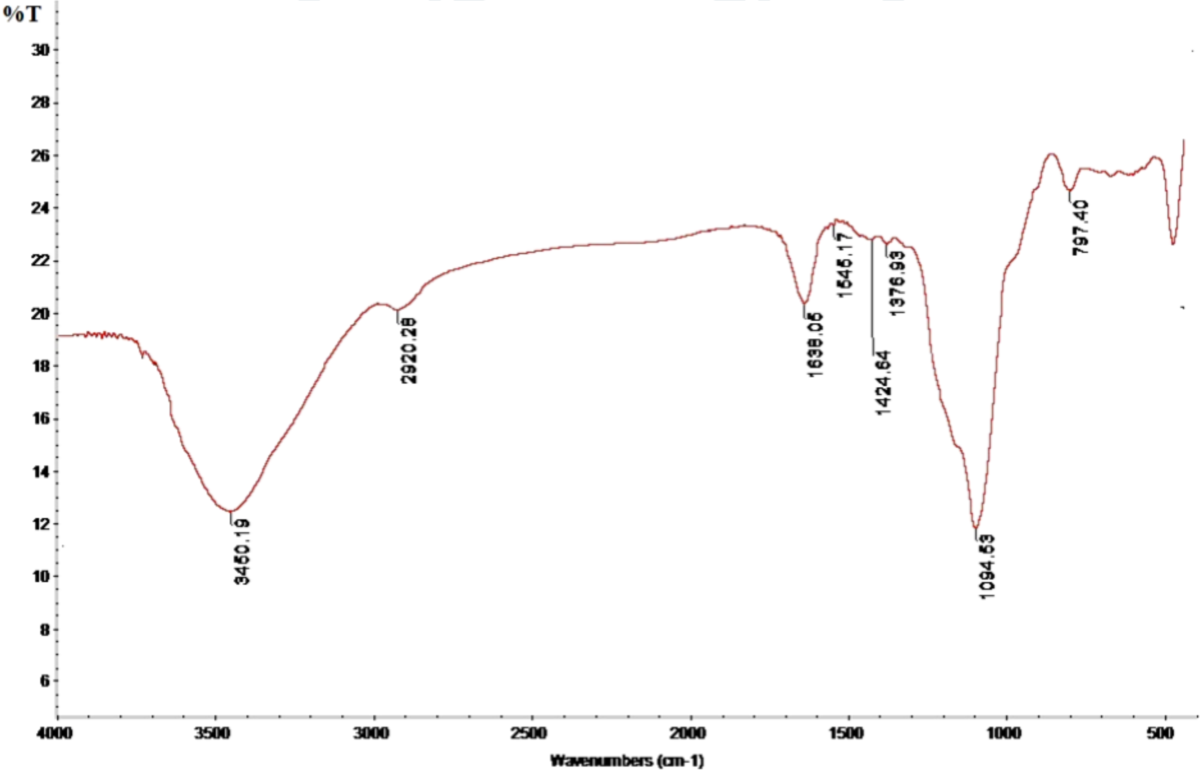


Figure 2. FTIR cellulose spectrum

Table 1. The FTIR absorption band of cellulose

Funcional Groups	Wave Number (cm^{-1})
O-H	3450.19
C-H	2920.28
C-O	1094.53

3.3. Bioplastic mechanical test

Cellulose obtained from the extraction of rice husk is used in synthesis bioplastic. Cellulose is composited with chitosan and sorbitol. The resulting bioplastic can be observed in Fig. 3.

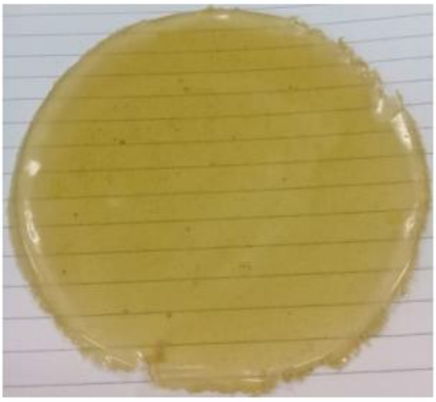
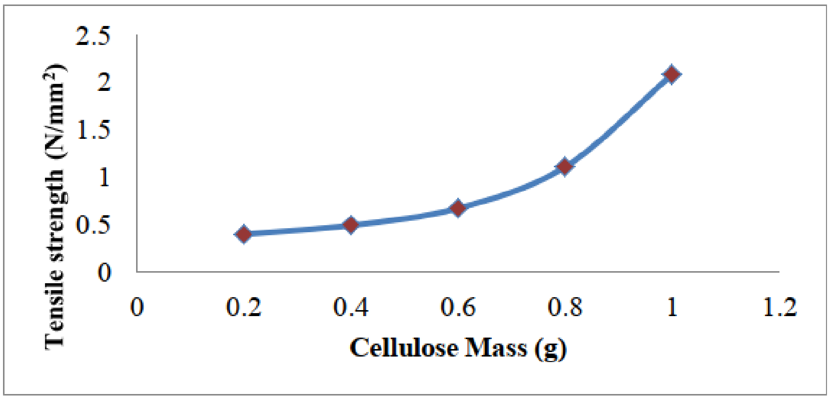
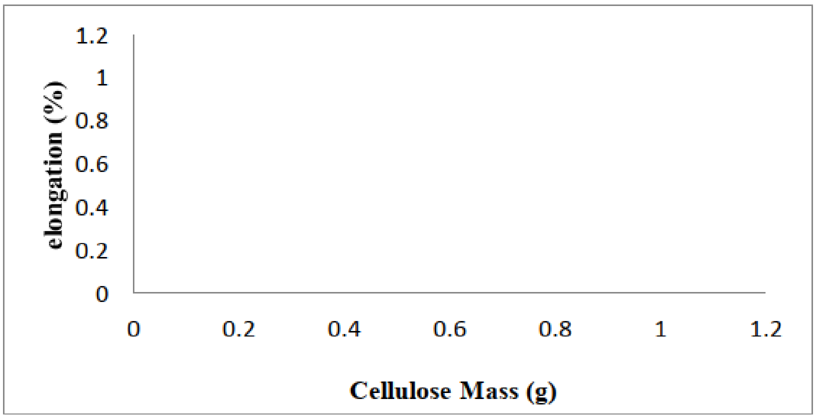


Figure 3. Film Bioplastic

Mechanical tests include tensile strength and elongation. Tensile strength indicates the tensile strength of bioplastic films produced by the compilation is given a load. The lowest tensile strength was found in bioplastic films with a variation of cellulose mass of 0.2 g which was 0.3947 N/mm2, while the highest value was in the mass of cellulose 1.0 g that was 2.0804 N/mm2. But seen from the variation of cellulose mass 0.6-0.8 g constant that is 14.88-14.90%, then cellulose mass 0.8 g is used to process chitosan mass variation. The results obtained can be obtained in Fig. 4.



(a)



(b)

Figure 4. Tensile strength (a) and elongation (b)

In chitosan mass variation, the lowest tensile strength was found in bioplastic films with 0.8 g chitosan mass variation, namely 1.1058 N/mm2, while the highest value was in chitosan mass 1.2 g which was 5.4147 N/mm2 with an elongation value of 28.17%. The results obtained can be observed in Fig. 5. This is consistent with the theory that chitosan acts as an amplifier in bioplastics. Addition of chitosan can increase the tensile strength of bioplastics. The high tensile strength is caused by interactions between chitosan and cellulose polymers in the form of hydrogen bonds. Tensile strength decreased in the mass variation of chitosan 2.0 g which is 2.338 N/mm2 due to the increase in mass of chitosan not followed by the formation of interactions with the bioplastic polymer chains.

4. Conclusion

Cellulose extracted from rice husk was 59.2%, white powder and odourless. The best bioplastic in cellulose variation was obtained at 0.8 g mass with tensile strength yield of 1.1058 N/mm2 and bioplastic at chitosan mass variation 1.2 g with tensile strength result of 5.4147 N/mm2.

References:

[1] Jambeck J R, Roland G, Chris W, Theodore, Singler, Miriam P, Anthony A, Ramani N and Lavender L 2015 Plastic waste inputs from land into the ocean Marine Pollution 347 768-771.

[2] Ravindra V, Gadhave, Abhijit Das, Prakash A and Pradeep T 2018 Starch Based Bio-Plastic The Future of Sustainable Packaging J. Polymer Chem. 8 21-33

[3] Felix M, Valma C, Albert R and Anonio G 2016 Influence of sorbitol on mechanical and physico-chemical properties of soy protein-based bioplastic processed by injection molding J.Polymeros 26 277-81

[4] Chadijah S, W O Rustiah and Munir 2018 Determination of the optimum concentration cellulose baggase in making film bioplastic J. Phys.: Conf. Ser. 979 012026

[5] Johar N, Ishak A and Alain D 2012 Extraction preparation and characterization fibre and nanocrystals from rice husk J.Industrial Crops and Product 37 93-9

[6] Das A M, Ali A A and Hazarika M P 2014 Synthesis and characterization of cellulose acetate from rice husk eco-friendly condition J. Carbohydr. Polym. 112 342-9