Determinant of the optimum concentration cellulose baggase in making film bioplastic

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Abstract. The hoarding rubbish synthetic plastic caused pollution and damage in life circles, to cope it can be done with synthesizing the plastic from agriculture substance or called biopolymer (bioplastic). It was that potentially as bioplastic was biopolymer from agriculture substance baggase that contain cellulose 40 %. This research aimed to determine the optimum concentration cellulose baggase in making bioplastic film with adding chitosan and sorbitol plasticizer and also to know the result of characterization film bioplastic. The steps in this research were; the extraction of cellulose, making film bioplastic, tensile strenght test and used characterization spectrofotometer FTIR. In this research showed that optimum concentration cellulose baggase in making film bioplastic was 2% with adding chitosan and sorbitol plasticizer. The optimal result of tensile strenght test was 0,089 Kgf/cm² with elongation percent 15,90 %. The analyzing FTIR in all of variation that looked almost same with characterization with tapes -OH, -NH and C=O.

1. Introduction
The hoarding plastic waste in the world improved anytime [1], especially in indonesia exactly in urban areas including the largest plastic waste producer. According to the Ministry of Environment and Marine Affairs (KLHK) in 2016, each year approximately 1,3 billion tons of plastic waste is produced around the world. This excessive plastic consumption, putting Indonesia ranked second in the world of plastic waste to the Sea after China. Excessive plastic consumption was potentially a material that threaten the continuity of living things on earth, because it faced many environmental problem such as cannot be recycled and cannot be deciphered naturally by microbes in the soil. So there was a hoarding of plastic waste that caused pollution and damage to the environment [2].

The effort that can be done to reduce the consumption of plastic was to synthesize a polymer (the material of polymer or plastic manufacture) easily decomposed or was called biodegradable plastic (Bioplastic) [3]. In Indonesia the utilization of agricultural and industrial waste was still very less developed, while the waste generated very much and still contain benefits, one of which was a natural polymer found in waste bagasse.
Sugarcane waste was one of the wastes that contain natural polymers, especially cellulose [4], bagasse was found in many areas in Indonesia because it grows fertile and the main ingredient in the sugar industry, to get it was not so difficult too abundant. Sugarcane waste in Indonesia on average obtained 35-40% of each processed cane [5]. Cane production in Indonesia in 2007 amounted to 21 million tons, the potential for pulp produced about 6 million tons of pulp per year. The bagasse contained up to 44% cellulose, which cellulose content of more than 40% can already be used as raw material for making bioplastik [6]. Cellulose was the basic ingredient of plants that belong to the primary metabolite, forming the material structure of most plant cell walls.

2. Experimental

2.1 Materials
Chitosan was purchased from CV. Chi Multiguna, cellulose derived from bagasse from PT. PN XIV (Persero) Takalar Sugar Factory Pa’rappunganta Village Kec. Polobangkeng Utara.

2.2 Cellulose Extraction of Sugar Cane
The bagasse cleaned, washed and dried under direct sunlight. Then it mashed with a blender and sieved with a sieve of 40 mesh, then the sample was put into a maceration container and dissolved with CH\(_3\)OH to 7 days or the solution was not longer colored by replacing CH\(_3\)OH every 2 days. After the maceration process, the sample filtered with using whatman filter paper no. 42. The residue from the filtration process washed with H\(_2\)O and dried. Then it fed into a 1000 mL glass and 17.5% NaOH added until the sample submerged, then it heated for 60 min. After that, it filtered again and washed with H\(_2\)O. It hydrolyzed using HCl for 3 h, then washed with H\(_2\)O then dried in oven at 105 °C for 1 hour [7].

2.3 Making Bioplastic Films with Addition of Chitosan and Sorbitol
Chitosan of 0.8 g put into a 250 mL glass and dissolved with CH\(_3\)COOH 0.6 M, then it also put into ultrasonic for 8 min and sterilized until the temperature dropped to 50 °C. The results were added to 0.4, 0.6, 0.8, 1 and 1.2 g cellulose which had homogenized with sorbitol. The mixture stirred using a magnetic stirrer for 15 minutes, then it heated to 80 °C for 7 minutes. After that, it poured on a mold plate (glass plate). Repeat the procedure on cellulose by the addition of chitosan and cellulose with the addition of sorbitol [8].

3. Result and discussion

3.1 Cellulose bioplastic film
Cellulose extraction carried out on bagasse originating from Takalar District of South Sulawesi. The bagasse were macerated, delignified and hydrolyzed, it result in \(\alpha\)-cellulose [7]. Based on research conducted in the manufacture of cellulosic bioplastic film with the addition of sorbitol and chitosan, the bioplastic film obtained a little stiff but flexible, yellowish brown, can be removed from the mold as a whole and the surface is rather slippery.

![Figure 1](image-url) Bioplastic Films (a) with addition of sorbitol (b) with addition of chitosan (c) with addition of sorbitol and chitosan
The production of bioplastic film with the addition of sorbitol and chitosan aimed to increase the mechanical characteristic the bioplastics. Cellulose variations performed to increase tensile strength and percent elongation of the bioplastic film itself, where cellulose molecules form linear long chains and have a tendency to form intra- and inter-molecular hydrogen bonds. The hydrogen bond can be derived from chitosan and sorbitol and greatly affects tensile strength and percent elongation of bioplastic films. The result obtained when compared with research [6], have similarities that are flexible and can be released intact, but the color of the bioplastic film there was a difference because in the study added bleach so the film was white.

3.2 Tensile Strength and Elongation
Mechanical test also performed to measure tensile strength at the time the three samples loaded [9]. The result of the tensile strength of the three bioplastic showed in the figure below:

![Figure 2. Tensile strength of cellulose bioplastic bagasse](image)

![Figure 3. Elongation of cellulose bioplastic bagasse](image)

The figure 2 performed to measure tensile strength at the time the three samples loaded [9]. The bioplastic from cellulose with the addition of chitosan and sorbitol greatly affect the value of tensile strength. The functional groups on the cellulose chain can interact with the -O and -N groups, forming hydrogen bonds where the hydrogen bond is longer than the covalent bond but the bond was weaker. The more hydrogen bonds that form the longer the chain [10]. Therefore, in the addition of chitosan and sorbitol interactions occur between the hydrogen bonds cellulose, chitosan and sorbitol.

In cellulose with the addition of chitosan and sorbitol, tensile strength of 0.4 g concentration of 0.071 Kgf/cm² and an increase of 0.6 g with a tensile strength of 0.089 Kgf/cm². The elongation tensile we improved 0.191 Kgf/cm² by 0.8 g of cellulose, 0.241 Kgf/cm² by 1.0 g of cellulose, 0.245 Kgf/cm² by 1.2 g of cellulose. The increasing in tensile strength test on these five concentrations was caused by the more free OH on the cellulose given with chitosan. In cellulose with the addition of chitosan and sorbitol, the resulting tensile strength increases. In addition to OH in cellulose there was also a free OH from sorbitol that will bind to cellulose and chitosan [11]. Sorbitol also had the ability to increase the tensile strength of bioplastic films.

The highest tensile strength obtained was 1,868 Kgf/cm². This means that, this film when compared with research [12] still have much different of 2,5-36,7 MPa as well as in the research [11] that was equal to 9,12 MPa.
The figure 3 performed to measure the percent elongation of the three bioplastic samples until they disconnected [13]. On cellulose with the addition of chitosan and sorbitol elongation of 0.4 g concentration of 12.73% and an increase of 0.6 g with an elongation percentage of 15.90%. The increasing in percent elongation test at these three concentrations, were due to the more free OH on cellulose binding to sorbitol and vice versa [14]. Then decreased at 0.8 g cellulose concentration by 13.57% and continued to decrease at concentrations of 1.0 g and 1.2 g by 13.46% and 12.66%. The decreasing in elongation test caused by decreasing biopolymer flexibility due to decrease of hydrogen bond between chitosan and cellulose which can be decided by sorbitol. The optimum concentration obtained in bioplastic film was 15.90%, the results obtained and also have been resemblance to the results of the research [15], a percentage of elongation of 13.46%. This means, the percent of elongation produced with increasing considerably.

3.3 Characterization of functional groups using FTIR
The analysis FTIR performed to prove that the results of the bioplastic film making process have distinctive bioplastic functional groups.

![Figure 4. Functional groups (a) The baggase cellulose (b) Cellulose bioplastic film with the addition of chitosan and sorbitol.](image)

The figure 4, cellulose of bagasse had an absorption in the area of 3450.86 cm⁻¹ showing the -OH group, reinforced with an area of 1161.91 cm⁻¹ showing the C-O group. In the cellulose figure of bagasse with the addition of chitosan and sorbitol, the -OH group (alkoholic group) shown at the peak of 3452.08 cm⁻¹ [16], this uptake was almost identical to the N-H group because it has a nearly equal absorption region. In addition, there was a C-O-C group at the peak of 1087.05 cm⁻¹ or indicating a glycosidic bond in cellulose. That is, bioplastic film was a film with a physical mixing method, where in each mixing there was not new functional group formed, but the intensity of the uptake is different. This is clearly seen in the uptake of cellulose, cellulose with chitosan and sorbitol, in which the addition of chitosan resulted in increasing absorption intensity due to the hydrogen bond that was formed more and more and will decrease due to the addition of sorbitol, thus reducing the hydrogen bond. Moreover, the -OH group appearing in the uptake area of 3452.08 cm⁻¹ proves that bioplastic film can be decomposed by microorganism activity in the soil [17]. The resulting FTIR characterization was similar to research [15], where O-H appeared at wavelengths of 3080 cm⁻¹ and N-H at 1664 cm⁻¹.

4. Conclusions
The optimum concentration of cellulose of bagasse in the making of bioplastic film with the addition of chitosan and sorbitol plastisizer is at cellulose concentration 2% (w / v) with percent elongation of 15.90% and tensile strength of 0.089 Kgf/cm². The result of FTIR characterization show that there were functional groups -OH, -NH and C-O-C.
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