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Effect of Delignification Process on Cellulose, Hemicellulose, and Lignin Content on Liquid Glucose Production from a Mixture of Corn Cobs (*Zea mays*) and Sugar Cane Bagasse (*Saccharum officinarum*)

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ABSTRACT. Dependence on the use of fossil energy is continuously increasing every year. This is very risky, considering the dwindling availability of fossils in nature. It is necessary to use alternative energy as a substitute for fossil energy, such as bioethanol, one of the biofuels sourced from living things, especially plants. Bioethanol is based on the fermentation of glucose with bacteria that produce ethanol. Some essential ingredients for making bioethanol require a hydrolysis process to produce glucose so it can be fermented into bioethanol. This research focuses on the hydrolysis process to produce liquid glucose from a mixture of corn cobs and bagasse with several different treatments to determine glucose levels, cellulose, hemicellulose, and lignin levels. On the cellulose content itself, in the delignification process, the cellulose content obtained was 64.8% which was 11.1% higher than not through the delignification process, which was only 53.7%. The level of lignin is the same, the delignification process reduces the lignin content by 10% by not going through the delignification process by 21.3% compared to those undergoing the delignification process by only 10.3%. Hemicellulose is the same, with a 2% difference.

1. INTRODUCTION

Indonesia's population figures have increased rapidly yearly to increase energy use for everyday life. It's hazardous considering that fossil energy is non-renewable, so its availability in nature is dwindling. Based on data from the Central Statistics Agency [1] in 2017, gasoline usage in oil and gas mining companies is 21,498 kiloliters. Whereas in 2018, this value increased by 21,914 kiloliters. Therefore, it is necessary to develop new energy to replace fuel oil as an alternative to minimize dependence on fossil energy from nature.

Development of alternative energy itself to reduce and change dependence on conventional fuels, which are currently running low. One type of renewable energy is bioethanol, a biofuel made from living things, especially plants. Bioethanol is obtained from fermentation and is usually followed by distillation [2].

Bioethanol has various benefits. Besides being used as an alternative fuel oil, bioethanol is often used in the pharmaceutical sector, such as medicines and cosmetics, and in-home industries, such as kerosene substitutes. Making bioethanol is quite affordable because the raw materials are plentiful and easy to find in everyday life [3]. Corn cob [4] and bagasse [5] can be utilized because it contains a lot of lignocellulose, cellulose, hemicellulose, and lignin [6]. Lignocellulose can become glucose because cellulose forms straight and branched chains from a combination of glucose by releasing water [6]. Extraction of materials is possible from sugarcane and sweet corn wastes, which are thrown away due to a lack of understanding about their processing and utilization. Meanwhile, manufacturing bioethanol from corn cobs does not require combining other materials [7]. If the processing is proper, it will be helpful for everyday life and have pretty high value from an economic standpoint, especially when it goes through the delignification process to have high-purity cellulose [8].

Based on the description above, this study aimed to determine the effect of the delignification process on the levels of cellulose, hemicellulose, and lignin in the production of liquid glucose from a mixture of corn cobs and bagasse.

2. MATERIALS AND METHODS

2.1 Tools

The tools used in the study included 50 mesh sieves, beakers, digital balances, measuring cups, thermometers, hotplate magnetic stirrers, ovens, and porcelain cups.

2.2 Materials

The materials used in the study included corn cobs, bagasse, aquadest, 98% NaOH and 98% H_2SO_4 obtained from Indrasari Chemical Store, Semarang.

2.3 Material Pre-treatment and Delignification

Material pre-treatment starts with several stages:

1. Corn cobs and bagasse are dried in an oven at 105°C and crushed and sieved into a powder
2. Mix with a ratio of 1:1 and calculate the levels of cellulose, hemicellulose, and lignin.
3. The delignification process begins with a mixture of corncobs and bagasse soaked with NaOH 10% w/v distilled water in a beaker glass for 4 hours at 50°C
4. The soaking results are washed with distilled water at 40°C. Then, they are dried in an oven with a temperature of 90°C until they ha constant weight. The cellulose, hemicellulose and lignin levels are calculated.

2.4 Hydrolysis Process

A mixture of corn cobs and bagasse either delignified or not hydrolyzed using 0.5 M H_2SO_4 for 1 hour and 2 hours at 80 °C and 100 °C according to the variables. The hydrolysis results were analyzed for glucose content using a UV-Vis spectrophotometer and the degree of acidity (pH).

2.5 Variables

The experimental variables can be seen in Table 1 below.

Table 1. Experimental Variable

Run	Delignification Process	Hydrolysis Temperature (°C)	Hydrolysis Time (Hour)
1.	No	80	1
2.	No	80	2
3.	No	100	1
4.	No	100	2
5.	Delignification Process	80	1
6.	Delignification Process	80	2
7.	Delignification Process	100	1
8.	Delignification Process	100	2

3. RESULTS AND DISCUSSION

The experimental results can be seen in Table 2 below.

Table 2. Experiment Results

Process	Cellulose	Hemicellulose	Lignin
Not Delignified	53,7%	15,9%	21,3%
Delignification	64,8%	13,9%	10,3%

3.1 Analysis of Cellulose, Hemicellulose, and Lignin

Analysis of cellulose, hemicellulose and lignin was carried out using Chesson data sourced from a mixture of sifted corncobs and bagasse, which also underwent a delignification process using NaOH for 4 hours. From these results, then enter into Chesson data calculations as follows.

Hemicellulose Content: $\frac{(b-c)}{a} \times 100\%$

Cellulose Content: $\frac{(c-d)}{a} \times 100\%$

Lignin Content: $\frac{(d-e)}{a} \times 100\%$

Based on these calculations, we can find the cellulose content in the delignification process, which purifies lignin to impact the existing cellulose levels. The cellulose content obtained is 64.8% which is 11.1% higher than not going through the delignification process. only as much as 53.7%. This experiment is directly proportional to the lignin content in which the delignification process reduces the lignin content by 10% without going through the delignification process by 21.3% compared to the delignification process by only 10.3%. Hemicellulose is also directly proportional to cellulose and lignin but not too significant, with a difference of only 2%.

The results and calculations using Chesson data show that the delignification process reduces the lignin content. It increases the cellulose content, following the research by Gusrita and Komalasari [9], where the cellulose content will increase because the delignification process will purify lignin.

3.2 Analysis of Glucose and pH Levels

Table 3. Experiment Results

Run	Absorbance Spectrophotometer UV-Vis	pH
1.	0,335	5
2.	0,447	5
3.	0,463	5
4.	0,548	5
5.	0,371	5
6.	0,483	5
7.	0,492	5
8.	0,569	5

One way to test glucose levels in a product is to use a UV-Vis spectrophotometer. This glucose level test uses a UV-Vis Spectrophotometer with absorbance readings at a wavelength of 490 nm.

Based on the data listed, it is known that the delignification process, temperature, and hydrolysis heating time affect the glucose levels in the mixture of bagasse and corncobs, as research put forward by Mardina et al. [10]. In the delignification process, glucose levels will be higher than those that do not undergo the delignification process. Based on research conducted by Mardina et al. [10], the delignification process affects the height and purity of cellulose, where cellulose itself affects glucose levels. After all, it contains β units of d-glucose.

For the heating temperature, the higher the temperature will cause more glucose levels because the movement of molecules is faster and affects the hydrolysis reaction, which runs faster. This experiment also occurs in the time variable where the longer the time, the higher the glucose level due to the more extended contact of the molecules, so the amount of mixture of bagasse and corn cob hydrolyzed to glucose will increase. For the pH test, use a universal indicator with the sample pH tending to be the same at number 5.

4. CONCLUSION

In this study, the effect of the delignification process on the production of liquid glucose from a mixture of corn cobs and bagasse was obtained on glucose levels, cellulose, hemicellulose and lignin content contained therein. Regarding the cellulose content, during the delignification process, the cellulose content was obtained as much as 64.8%, which is 11.1% higher than not through the delignification process, which was only 53.7%. Similarly, the lignin content, the delignification process reduces the lignin content by 10% without going through the delignification process by 21.3% compared to that which undergoes the delignification process by only 10.3%—Hemicellulose too with a 2% difference. For the pH test, use a universal indicator with the sample pH tending to be the same at number 5.

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