



## The Effect of NaOH Concentration and microwave exposure time to the content of cellulose, hemicellulose and lignin of Corn Cob

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**Abstract.** Currently ethanol produced from molasses, cassava and maize, thereby competing with the need for food, animals feed and other industrial raw materials, so that the supply of raw materials is not continuity. If this continues, it will certainly have an impact on food prices spike, it will create new problems on the economy of the community, and one of an alternative raw material for bioethanol production is cellulose biomass. To convert biomass into bioethanol through several stages, including pretreatment, hydrolysis and fermentation. The content of lignin in biomass will disturb the enzymatic hydrolysis process, so it is necessary to encourage the delignification in the pretreatment stage. Microwave - alkali pretreatment can reduce more lignin and hemicellulose in rice straw, so it needs to be an effort to change the composition of lignocellulose and improve the hydrolysis of corn cob is fermented to become ethanol. Pretreatment of corn cobs research was done using randomized block design arranged in factorial, and repeated 2 times. The first factor is the concentration of NaOH for 0,5 N, 1 N and 1,5N. The second factor is the time of exposure to microwave heat radiation for 10, 20 and 30 minutes. The results showed that cellulose content increases with prolonged exposure concentrations of NaOH and microwave, as well as to the content of hemicellulose and lignin decreased along with the increase of exposure duration of Microwave and the increase of NaOH concentrations.

Keyword : Corn cob, bioethanol, delignification, cellulose, lignin and hemicellulose.

### Introduction

Fuel prices continue to rise and the world's oil reserves are increasingly limited, encouraging efforts to obtain alternative fuel. Bioethanol (C<sub>2</sub>H<sub>5</sub>OH) is one of the biofuels that are already being developed as an alternative fuel that is more environmentally friendly, and it is from renewable source.

Currently ethanol produced from molasses, cassava and maize, thereby competing with the need for food, animals feed and other industrial raw materials, so that the supply of raw materials is not continuity. If this continues, it will certainly have an impact on food prices spike, it will create new problems on the economy of the community, and one of an alternative raw material for bioethanol production is cellulose biomass. Of the many types of cellulose biomass, one of its kind that has not been fully utilized is a corn cob. Corn cob contains 41 % of cellulose, 36% of hemicellulose and 16 % of lignin (Lorenz and Kulp, 1991). To convert the corncobs into ethanol, it must through several stages. Mainly is to convert cellulose to become simple sugars, and the fermentation of simple sugars into ethanol.

The process of converting cellulose into simple sugars can be done chemically or enzymatically. Enzymatic hydrolysis is more specific and can produce a relatively pure glucose syrup compared to chemical hydrolysis method. However, enzymatic hydrolysis does not run well if corncobs still contains lot of lignin and hemicellulose in corn cob. Pretreatment process is required to reduce the content of lignin and hemicellulose in corn cob. According to Ethaib S. et al. (2015) the combined microwave - chemical pretreatment of different feedstock resulted in higher sugar releaser and alkaline solution for lignin removing.

### **Materials and Methods**

The main materials used for this study was obtained from the corn cobs farmers around the village of Karangploso, Malang. Chemicals used for analysis in the study has a degree of purity of pro analysis (P.A) purchased from PT. Dianum Surabaya.

### **The Preparation of Materials**

Corncob dried under the sun for 12 hours and then cut into pieces with a size of 1 cm and dried in an oven using a temperature of 100 °C for 6 hours, after the dried corn cobs, corn cobs grinded using a disk mill and sifting was done using a sieve size of 50 mesh.

### **Results and Discussion**

#### **The composition of lignocellulose in corn cob before pretreatment**

Table 1. Corn cob before pretreatment

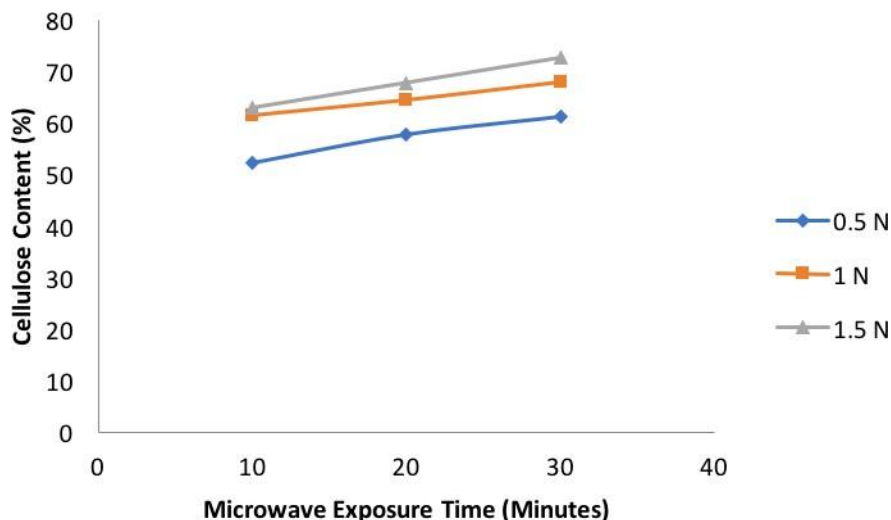
| Komposition   | Percentage (%) |
|---------------|----------------|
| Cellulose     | 28,77          |
| Hemicellulose | 31,58          |
| Lignin        | 28,97          |

The compositions of corn cob which being use in this research are 28,77% of cellulose, 31,58% of Hemicellulose, 28,97% of lignin. According to Lorenz and Kulp (1991), corn cobs composed of 41% cellulose, 36% Hemicellulose, 16% lignin and 7% water content and other components. The differences in the results of this caused by the differences in the ingredients (corn cobs). According to Jorgensen (2007), the composition is influenced by variety, age and condition of plant growth. In this study analyzed corn cobs is the hard part.

### **Cellulose Content**

Cellulose content of corn cob after the pretreatment increased compared with the levels before the pretreatment of corn cob cellulose 28.77 % Effect of concentration and duration of exposure to high levels of microwave cellulose after pretreatment can be seen in Figure 1. Figure 1 shows that the highest levels of cellulose in corn cobs with NaOH solution (NaOH 1,5N) and give exposure to microwave for 30

minutes which is as much as 72.64 %, while the lowest cellulose content in corn cobs by 0,5N NaOH solution and exposure to microwave for 10 minutes, amounting to 52.31%.



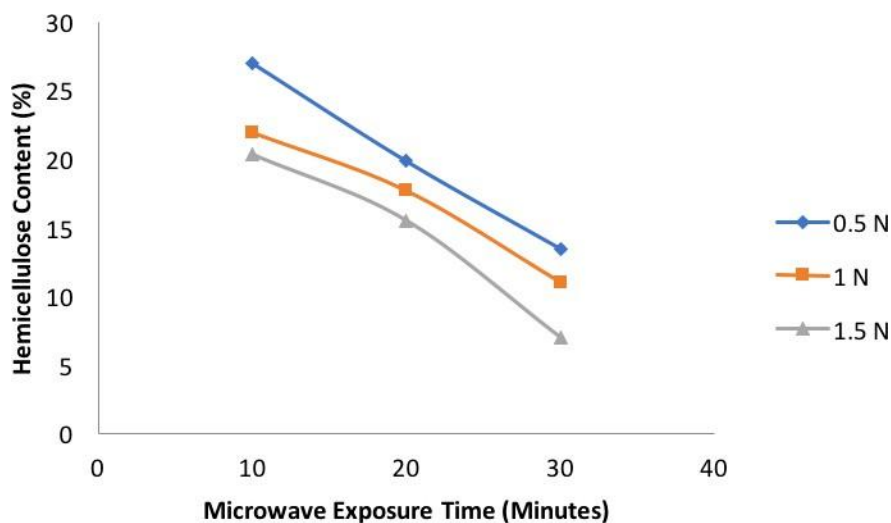
**Figure 1.** The Effect of NaOH concentration and duration of Microwave exposure to the cellulose content of Corn Cob.

According to Zheng (2009), the mechanism of alkaline pretreatment is the reaction of saponification inter molecular ester crosslinks xylan hemicellulose and other components such as lignin hemicellulose. Xiong (2000) states that microwave radiation capable of damaging the crystal structure of cellulose. Azuma (1984) states that the microwave radiation pretreatment in an alkali solution for 30 minutes on the rice straw is capable of producing cellulose up to 69.2 %. The process of destruction of the structure of the lignin and hemicellulose resulted in an increased number of free cellulose material.

As explained by Dallinger and Kappe (2007), microwave radiation is able to accelerate chemical reactions because the radiation is able to produce molecular internal heating more efficient. In corn cobs solution containing a strong base (NaOH), energy can be spread through ionic conduction which causes heating. Microwave heating increases for liquids or solids that can transform the electromagnetic energy into heat.

### Hemicellulose Content

Hemicellulose levels decrease with increasing concentration of NaOH and the longer the exposure to microwave. The percentage decrease of 31.58% hemicellulose can be reached 6.99% as shown in Figure 2.

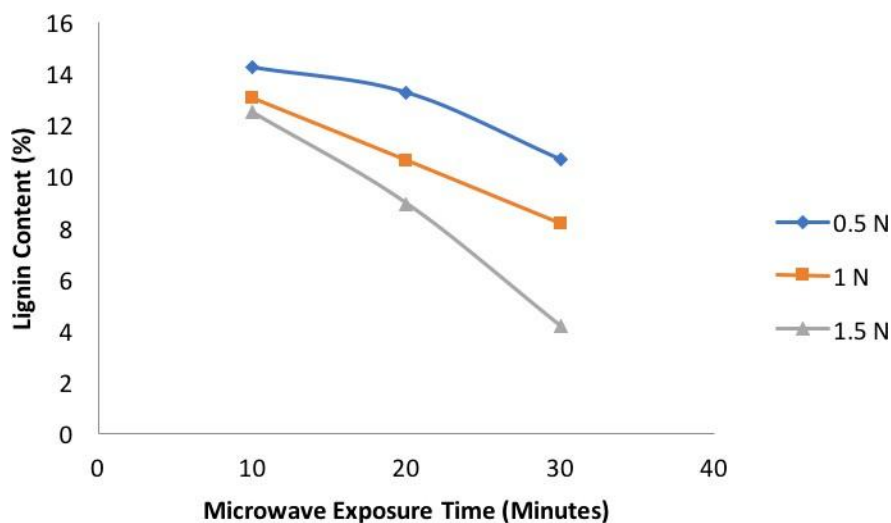


**Figure 2.** The Effect of NaOH Concentration and Long Exposure of Microwave to the hemicellulose content of Corn Cob.

Hemicellulose levels decreased with the increase of NaOH concentration and the longer the exposure to microwave radiation. Decreased levels of hemicellulose in corn cobs reached up to 54.78% at the NaOH concentration of 1.5 N. This shows that more and more present in the NaOH solution system will cause damage to the ties that connect with the hemicellulose and cellulose to lignin, for example hydrogen bonds, ester or ether. The destruction of the bonds in the lignocellulosic components in an alkaline solution (NaOH) and the termination of the bond due to the heat generated by microwave exposure. According to the Sun (2002) the mechanism of lignocellulose hydrolysis by NaOH is the saponification of intermolecular ester bonds at the crosslink between xylan, hemicellulose and other components, such as lignin and hemicellulose.

### **Lignin Content**

The decreased levels of lignin occurred along with an increase in the concentration of NaOH and the longer the exposure to microwave as shown in Figure 3. The content of lignin after pretreatment process ranged from 14,24% to 4,12%.



**Figure 3.** The effect of NaOH Concentration and Long Exposure Microwave on Lignin Content of Corn Cob.

The longer the corn cob exposure to microwave and in the alkaline solution resulting lignin degraded even more, it is due to the effect of the heat generated during the exposure time of microwave, the longer the exposure time, the heat effect is also increased so as to degrade the bond in lignin more as well so lignin content declines as the longer exposure to microwave radiation. Zhu et al. (2005) also states that microwave radiation can improve lignin degradation reactions in solution of NaOH.

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