Bioethanol Production From Cassava Peel By Ultrasonic Assisted Using HCl as Catalyst

Sirajuddin, Bandi Soepratono, Edy Budiarso, Wiwin Suwinarti

Abstract: Cassava peel is lignocellulose material that has the potential to be processed into alternative fuels is bioethanol. This study aims to determine the concentration of HCl as catalyst, hydrolysis time optimum use of ultrasonic waves to the yield of glucose and determine the optimum fermentation time to convert glucose into ethanol. Hydrolysis process 25 grams of sample was added 150 ml of HCl as catalyst with concentration variations HCl 0.75 N, 1.00 N and 1.25 N, hydrolysis time variation 6, 15, 30, 60 and 90 minutes using an ultrasonic wave frequency at 35 KHz and a temperature of 30^0C. The resulting hydrolyzate was analyzed using methods luff schrool. The highest yield of fermentable glucose 150 ml using 5 g of yeast and 2 grams of NPK with time variations of 2, 4, 7, 10, 12 days. Destilled.dan fermented then analyzed using Cromatography Gas (GC). The highest glucose yield hydrolysis process is a catalyst concentration of 1.2 N HCl and 30 minutes of 34.59%. While the highest bioethanol yield in the fermentation process is 4 days at 20.77%.

Keywords: bioethanol, cassava peel, catalyst, fermentation, glucose, hydrolysis ultrosonic

1 Introduction

Depletion of fossil fuel reserves and pollution problems caused, encourage countries of the world to diversify energy by utilizing alternative and renewable energy sources. Bioethanol is an alternative fuel and environmentally friendly. Bioethanol production in the world increased from 50 million m3 in 2007 to more than50 million m3 in 2012 [1].Brazil and the United States represent about 80% of the world supply. Bioethanol can be produced from plant biomass such as cassava (Manihot esculentum), corn (Zea mays), sweet potato (Ipomoea batatas)and lignocellulosic materials[2], Cassava production in Indonesia is very large and is the second largest producer of cassava in Asia after Thailand, while the fifth place in the world after Nigeria, Brazil, Thailand, and the Congo with a total production of 24,177,372 tons / year. While especially cassava production in East Kalimantan Province each year is high at 88.128 tons. [3] Waste cassava is generally derived from the stem, leaves and peel. Every 1 kg of cassava can produce 10-15% peel waste [4]. Cassava peel is lignocellulose material that contain starch (Stach) (44 -59%), fiber (17.5 - 27.4%) which is the production of bioethanol [5]. In the industrial world, bioethanol is commonly used as an industrial raw material alcohol derivatives, a mixture of liquor, as well as pharmaceutical raw materials and cosmetics.

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Based on alcohol content, ethanol divided into 3 grades as follows:

1. Grade industry with 90-94% alcohol content
2. Neutral with alcohol content of 96 to 99.5%, generally used for liquor or pharmaceutical raw materials.
3. Grade fuel with alcohol levels above 99.5%.

Bioethanol has better characteristics compared with petrochemical-based gasoline fuel being able to lose around 90% CO_2 and 60-80% SO_2 when blended with 95% gasoline [6,7] and can increase the octane number of the fuel [8] Bioethanol is produced by fermentation of glucose derived from the hydrolysis process [9,10] Hydrolysis is a chemical process that aims to break down cellulose and hemicellulose into monosaccharides which would then be fermented into ethanol. In general the hydrolysis technique is divided into two, namely: acid hydrolysis enzymatic hydrolysis. Several types of chemicals used in the hydrolysis process include sulfuric acid, formic acid, and organic solvents such as n-propylamine, ethylenediamine, n-butylamine etc. [11, 12].

Hydrolysis reaction:

$$(C_6H_{10}O_5)_n + nH_2O \longrightarrow nC_6H_{12}O_6$$

The use of ultrasonic waves in the hydrolysis process can improve the efficiency in the process [13-17]. Ultrasonic waves are higher than sound wave that is more than 20 KHz[18]. The advantages of using ultrasonic include: [19]

a) It only requires a short reaction time
b) Catalyst needs fewer
c) Boost conversions and improve yield
d) Little energy consumption

Fermentation is a biological process to convert glucose into bioethanol using bacteria. Several types of bacteria that are often used in the fermentation process include Saccharomyces cerevisiae, Zymomonas mobilis. Stages core bioethanol production is fermentation of sugar by yeast, in which sugar is converted into ethanol and carbon dioxide.

$$C_6H_{12}O_6 \xrightarrow{\text{yeast / yeast}} C_2H_5OH + 2CO_2$$

The desired product is bioethanol is separated from the other components to make use of the distillation process. Research on the utilization of cassava peel into bioethanol has been done as to optimize the results of bioethanol using different organisms in fermentation processes [20,21], the use of dilute acid hydrolysis process [5]. This study aims to determine the concentration of HCl catalyst, hydrolysis time optimum use of ultrasonic waves to the yield of glucose and determine the optimum fermentation time to convert glucose into ethanol.

2 Materials and Methods

2.1 Materials and Devices Research

The materials used in this study include waste of cassava peel, yeast (Saccharomyces Cerevisiae), HCl 37%, NPK, NaOH 4 N, Aquadest, filter paper No. 42, universal indicator, Luff Schrool solution, 0.1 N $Na_2S_2O_3$, KI, 25% H_2SO_4. The equipment used in this study include Ultrasonic 35 KHz, chemical glasses (50 mL, 100 mL, 500 mL), volumetric flasks (100 mL, 500 mL, 1000 mL), measuring pipettes (5 mL, 10 mL, 25 mL), 25 mL volume pipette, 250 mL Erlenmeyer flask, stirrer motor, propeller stirrer, digital balance, blender, simple fermentor, simple distillation tools, stirring rod, bulp, stative, clamp.

2.2 Research Procedures

The study started from the stage of taking raw material for cassava peel waste. Initial treatment which includes physical treatment such as cleaning, drying and reducing size. Then, 25 grams of sample were hydrolyzed with 150 ml HCl catalyst with concentration (0.75; 1.00; 1.25 N) for 6, 15, 30, 60 and 90 minutes at 30^0C using ultrasonic waves 35 KHz at 100 rpm stirring speed. The hydrolyzate formed then analyzed for glucose content to obtain glucose yield from various treatments using Luff Schrool Solution. Glucose obtained from hydrolysis results were then fermented using tape yeast into a simple fermentor for 2, 4, 7, 10 and 12 days. Then the sample was distilled with a temperature of 78^0C until the bioethanol evaporated. The distillate formed is then analyzed using GC to determine the yield of bioethanol.

RESULT AND DISCUSSION

3.1 Effect of the HCl Concentration and Hidrolysis Time on Glucose Yield

Hydrolysis process cassava peel performed in a reactor, incorporating ultrasonic wave and the time control with concentration variations HCl 0.75 N, 1.00 N and 1.25 N, hydrolysis time variations 6, 15, 30, 60 and 90 minutes.

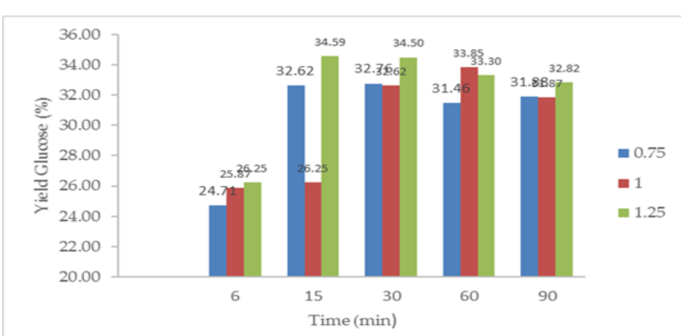

Figure 1. *The Effect of HCl Concentration and Hidrolysis Time on Glucose Yield*

Based on the figure 1 the yield of glucose increases with the increasing of catalyst concentration (HCl). This is due to the increase in HCl concentration to accelerate the rate of hydrolysis because the constant rate of reaction is directly proportional to the concentration of H + ions. in acidic atmosphere. From Figure 1 show that hydrolysis, when 6 minutes, glucose begins to form due to the hydrolysis reaction by acid and continues to increase until it reaches the peak at 30 minutes hydrolysis time. 30 minutes is the optimal time for the catalyst to break the long chain of cellulose into a glucose. After 60 and 90 minutes time addtition, the yield of glucose produced decreased. The decrease in glucose yield is caused by the glucose formed will be degraded into simpler components which are toxic to microorganisms.

3.2 Effect of time of fermentation on ethanol yield

The fermentation process is carried out using the highest glucose yield obtained from the hydrolysis process. In this study hydrolyzate from the results of hydrolysis was fermented using Saccharomyces cerevisiae yeast of 3 grams/100 ml of hydrolyzate with various fermentation times of 2, 4, 7, 10 and 12 days, respectively. Various times are to obtained the fermentation time to get optimum bioethanol yield.

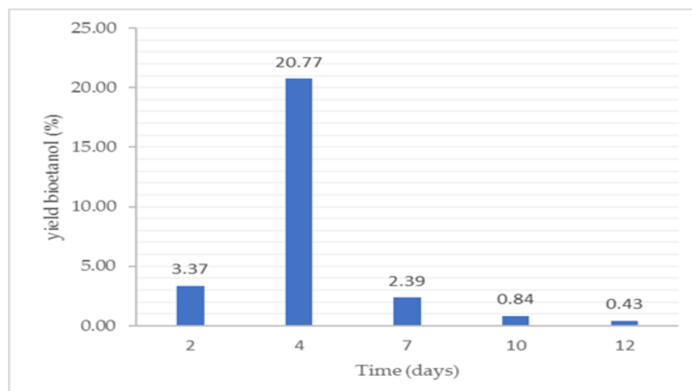

Figure 2 *The effect of Fermentation Times on Bioethanol Yield*

From Figure 2, show that at 2 days of glucose fermentation, bioethanol is formed due to microbial work and continues to rise to peak in 4 days of fermentation. The 4 day fermentation time is the optimal time for microbes to degrade glucose into bioethanol because this phase is a growth phase for microbes. After the addition of 7 days, bioethanol content has decreased. This is because the microbes begin to experience the phase of death and the formation of other compounds such as acetic acid, levulinic acid, glycerol, and others.

4 Conclusion

1. The hydrolysis process obtained the optimum HCl concentration of 1.2 N, and the hydrolysis time of 30 minutes resulted in the highest glucose yield of 34.59%.
2. The highest fermentation process is obtained by bioethanol yield of 20.77% with fermentation time for 4 days.

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