

Production of Biofuel (Bioethanol) from *Vigna Radiata* Biomass

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ABSTRACT

Indonesia is one of a few country that has the high rate consumption of fossil fuels. Bioethanol is considered as an important renewable fuel to partly replace fossil-derived fuels. This sustainable technology has increased tremendously with decreasing world crude oil reserves while the energy prices continually increasing. One of the potential raw materials for bioethanol production is mung bean (*Vigna radiata*). Mung bean is seasonal crops and grow almost in all region of Indonesia. Mung beans can be raw material for bioethanol production because in 50 grams of mung beans contain 18.41% glucose. Bioethanol production begins with hydrolysis 50 grams of mung beans in 200 ml of water as much as 4 samples until it becomes pulp. The process was followed by the fermentation process by using yeast (*Saccharomyces cerevisiae*) for four days with variation of a weight of 1 gram, 2 grams, 3 grams and 4 grams. The last process is distillation, it used to separate water and ethanol. Sample 2 shows the optimum ratio for bioethanol production which is 50 grams of mung beans and 2 grams of yeast (50:2). The optimum result from experiment obtained 6.4615% ethanol and 1.3371 refractive index

INTRODUCTION

Indonesia is one of a few country that has the high rate consumption of fossil fuels. One of the reason of high rate consumption is because the increase in vehicle population. Based on data obtained from *Kepala Korps Polisi Lalu Lintas Irjen Pol Agung Budi Maryoto* through the site *Kompas*, the number of vehicles in Indonesia until the month of July 2016 reached 124.348.224 units. This condition is inversely proportional to the number of Indonesian fossil fuel reserves that likely to be depleted caused by the fossil fuels are non-renewable energy. To fullfill the needs of fossil fuels, Indonesia have to import the fossil fuels from producer country and causing the increase of state budget. The use of excessive fossil fuel also causes many serious environmental problem such as global warming and air pollution. Consequently, the level of human health become increasingly declining.

One of the way to solve this problem is replace the major source of energy, from fossil fuels that can not be renewable to biofuels as an alternative fuel that can be renewable. Biofuel can therefore be considered as the best alternative of decentralized energy source for developing countries especially in this era of insecurity and unpredictability in fossil fuel supply (Bugaje *et al.*, 2008).

Bioethanol is one of the biofuel that can be replace the fossil fuels. Bioethanol has better characteristics than gasoline. Some of the advantages of bioethanol which contains 35% oxygen, has a high octane rating that is 96-113, environmentally friendly because of low exhaust gas to compounds that have the potential pollutants such as carbon monoxide, nitrogen oxides and greenhouse gases (Hambali *et al.*, 2007). Bioethanol (C₂H₅OH) is a fluid biochemistry of fermentation of sugars from carbohydrates using microorganisms (Samah *et al.*, 2011). Bioethanol can be produced from any biological feedstock that contains appreciable amount of sugar or materials that can be converted into sugar such as starch or cellulose.

One of the potential raw materials for bioethanol production is mung bean (*Vigna radiata*). Mung bean is a seasonal crops and grow almost in all region of Indonesia so that it is easy to find. Mung bean plants are short-lived plants (60 days) that have high productivity. Mung bean can be used as raw materials for bioethanol production, it is because in 100 gram of mung beans contains 62,9 grams of starch (Indonesian health ministry publication)

LITERATURE REVIEW

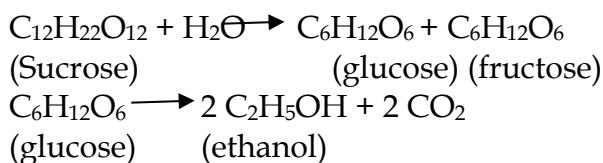
Starch is a homopolymer of glucose by α -glycosidic bond.. The size of the legume starch are smaller than other plant starch source, which ranged from 3-20 μm (Lin Jane *et al.*, 1992). This condition causes the starches from legume have a low gelatinization temperature and more easily for hydrolysed by acid or enzyme catalyst. Hydrolysis is used to change the starch of legume into glucose.

In the production of bioethanol, starch will be hydrolyzed into simple molecules or monomers glucose, starch hydrolysis conducted with an acid catalyst, a combination of acid and enzyme or enzyme combination with enzymes (Judoamijoyo 1990). Hydrolysis with an enzyme catalyst is using enzymes of microorganisms. *Saccharomyces cerevisiae* included in the family *Saccharomycetales* with the genus is *Saccharomyces* (Alexopoulos *et al.*, 1986).

Saccharomyces cerevisiae is one of the yeast that has been known to have a power conversion of sugar into ethanol. This yeast has a zymase enzyme and invertase enzyme. Invertase enzyme functioning as a breaker of sucrose into monosaccharides (glucose and fructose). Zymase enzymes will convert glucose into ethanol (Judoamidjojo *et al.*, 1989).

One molecule of glucose will establish two molecules of ethanol and CO₂, thus theoretically based on the weight of 1 gram of glucose will produces 0.51 grams of ethanol (Judoamidjojo, 1990).

Mechanism reaction of bioethanol :



The rate of ethanol fermentation reaction is influenced by several factors such as the composition of the substrate, the rate of consumption of nutrients, inoculation rate, physiological yeast, the activity of EMP lane enzymes, yeasts tolerance to high sugar and alcohol and the conditions during the fermentation (Watson, 1985 in Astuty, 1991).

METHODOLOGY

Grind the 200 grams of mung beans. After that, hydrolyze with 1000 ml of water into the container (pan) and heat it on the stove for 20 minutes until it becomes pulp. Then cool down until the temperature of 30°C. After that, add the mung bean pulp into 4 containers which each containers containing 200 ml and add yeast with a variation of a weight of 1 gram, 2 grams, 3 grams and 4 grams. Close tightly to make the process of anaerobic fermentation for 4 days. After the fermentation was completed, filter it to take out the liquid. Then distilling at a temperature of 78°C. And last, measure the refractive index of distillate by using a refractometer.

To determine the concentration of glucose, grind 50 grams of mung beans and boil it with 200 ml of water. And last, take the water from boiling process of mung beans as a sample to examine concentration of glucose by using a refractometer.

RESULTS AND DISCUSSION

The grinding process of mung beans is used to expand the contact surface area. In order to produce more glucose from carbohydrate. This hydrolysis process is conducted by heating for 20 minutes, so the carbohydrates that contained in mung beans turn into glucose.



Figure 1. Hydrolysis Process

Table 1. Standard Refractive Index of Glucose

% Glucose	Standard Refractive Index
5%	1,3304
10%	1,3408
15%	1,3477
20%	1,3514
25%	1,3619

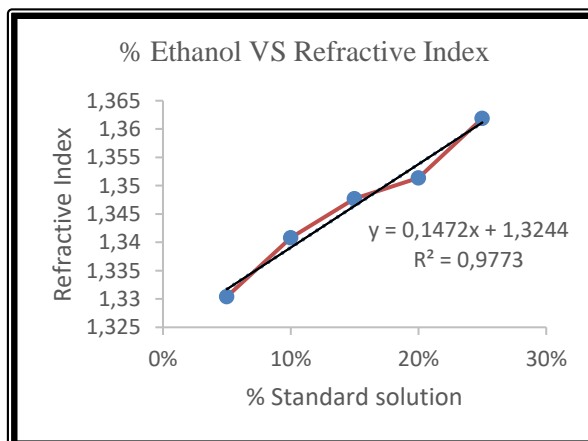


Figure 2. Standardization Curve of Glucose

The results of the refractive index of glucose obtained from 50 grams of mung beans after hidrolisis is 1,3515 with 30°C. From Figure 2. we can determine the percent glucose content of 50 grams of mung beans was calculated as follows:

Refractive index of sample (glucose) = 1,3515

Equation : $y = 0,1472x + 1,3244$

$$1,3515 = 0,1472x + 1,3244$$

$$0,0271 = 0,1472x$$

$$x = 0,1841 \times 100\%$$

$$x = 18,41\%.$$

The calculate result shows the content of glucose in 50 grams of mung beans is 18,41% so that the mung beans have potentially produce ethanol.



Figure 3. Fermentation Process For 4 Days

Add 1 gram of yeast to sample 1, sample 2 2 grams to sample 2, 3 grams to sample 3 and 4 grams to sample 4. Differences in yeast is used to compare the yeast to get a compatible ration in bioethanol production. Figure 3. shows the process of fermentation for 4 days. Number 1 shows the first day of fermentation, number 2 shows the second day of fermentation, number 3 shows the third day of fermentation and last number 4 shows the fourth day of fermentation. Figure 3. 3 shows during the process of fermentation, the plastic cover in container 1, 2, 3 and 4 on day 2, 3 and 4 shows that the plastic cover inflates. The inflate happens caused by the microorganism activity of *Saccharomyces cerevisiae* which produces CO₂ gas. After the fermentation process, filtering it to separate the solid and fluid. Take the liquid as filtrate. The filtrate contains ethanol and water.



Figure 4. Distillation Process

Distillation in figure 4. is used to separating the water and ethanol from filtrate. The distillation process is carried out at a temperature of 78 ° C for an hour and 30 minutes. The boiling point of ethanol is 78°C and water is 100°C. Ethanol will boil and become vapor earlier than water, so that there is a separation between them. Ethanol is in the erlenmeyer distillate while the water is in the erlenmeyer residues.



Figure 5. Bioethanol From Distillation Process

Figure 5. shows the results of ethanol as distillate. From the experiment obtained that sample 1 produces 2 ml of ethanol, sample 2 produces 3 ml of ethanol, sample 3 produces 2 ml of ethanol, and sample 4 produces 2 ml of ethanol. The last, analyze the refractive index of samples to determine the concentration of ethanol in each sample.

Table 2. Standard Refractive Index of Ethanol

% Ethanol	Standard Refractive Index
0	1,3333
2	1,3342
4	1,3354
6	1,3367
8	1,3381
10	1,3395

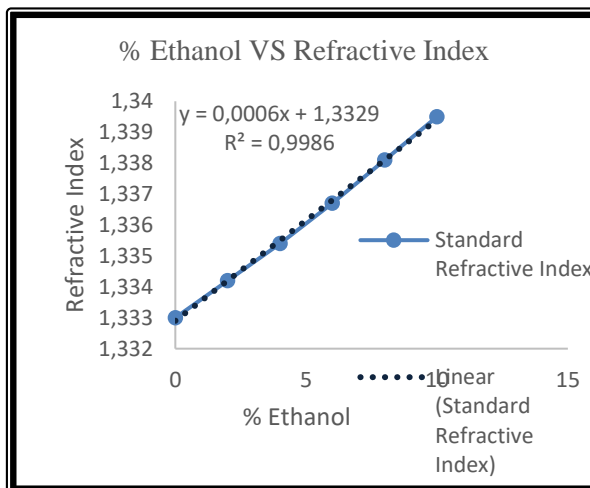


Figure 6. Standardization Curve of Ethanol

Based on standardization curve of ethanol, we can determine the concentration of ethanol in each sample calculated as follows :

Equation : $y = 0,00065x + 1,3329$

- a. Refractive index of sample 1 = 1,3341
 $y = 0,00065x + 1,3329$
 $1,3341 = 0,00065x + 1,3329$
 $0,00065x = 0,0012$
 $x = \frac{0,0012}{0,00065}$
 $x = 1,8462 \%$
- b. Refractive index of sample 2 = 1,3371
 $y = 0,00065x + 1,3329$
 $1,3371 = 0,00065x + 1,3329$
 $0,00065x = 0,0042$
 $x = \frac{0,0042}{0,00065}$
 $x = 6,4615 \%$
- c. Refractive sample of sample 3 = 1,3351
 $y = 0,00065x + 1,3329$
 $1,3351 = 0,00065x + 1,3329$
 $0,00065x = 0,0022$
 $x = \frac{0,0022}{0,00065}$
 $x = 3,3846 \%$
- d. Refractive index of sample 4 = 1,3355
 $y = 0,00065x + 1,3329$
 $1,3355 = 0,00065x + 1,3329$
 $0,00065x = 0,0026$
 $x = \frac{0,0026}{0,00065}$
 $x = 4 \%$

CONCLUSIONS AND RECOMMENDATIONS

In this experiment, we can prove that mung beans can be raw material for bioethanol production. It is because, in 50 grams of mung beans contain 18.41% glucose. Sample 2 shows the optimum ratio for bioethanol production which is 50 grams of mung beans and 2 grams of yeast (50:2). The optimum result from experiment obtained 6.4615% ethanol and 1.3371 refractive index.

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