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Production of Bioethanol from Bagasse with Variations in Mass of *Saccharomyces cerevisiae*

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Abstract

Energy availability is an absolute requirement in national development efforts at present or in the future. The existence of limited energy sources, while the need continues to increase requires alternative sources of fossil energy. Bioethanol is one of the bioenergy which is an alternative to replace the use of fossil fuels. This research aims to obtain bioethanol by utilizing bagasse as raw material. The manufacture of bioethanol consists of several stages, among others, preparation of raw materials by drying bagasse and then mashing it to obtain bagasse with a size of 100 mesh, thermal hydrolysis process with the help of sulfuric acid solution with varying concentrations, fermentation process carried out with the help of yeast, distillation process, and content analysis. ethanol. The method used is hydrolysis with sulfuric acid. Furthermore, the hydrolysis with sulfuric acid at 150 ºC for 1 hour to form a slurry. The fermentation process uses a mass variation of yeast *Saccharomyces cerevisiae* with a variation of 6.75, 8.75, 11.25, 13.75, and 16.25 g for 4 days with pH 5, room temperature and anaerobically. The best bioethanol content in the study with a mass variation of the yeast *Saccharomyces cerevisiae* with a pH of 5 and a fermentation time of 4 days was 98.93% with a yield of 57.6 mL.

Keywords: Bagasse, Bioethanol, Saccharomyces cerevisiae, Yeast mass, Fermentation

Abstrak

Ketersediaan energi merupakan kebutuhan mutlak dalam upaya pembangunan nasional saat ini maupun di masa yang akan datang. Adanya sumber energi yang terbatas, sedangkan kebutuhan yang terus meningkat membutuhkan sumber energi alternatif dari fosil. Bioetanol merupakan salah satu bioenergi yang menjadi alternatif pengganti penggunaan bahan bakar fosil. Penelitian ini bertujuan untuk mendapatkan bioetanol dengan memanfaatkan ampas tebu sebagai bahan bakunya. Pembuatan bioetanol terdiri dari beberapa tahapan antara lain persiapan bahan baku dengan cara mengeringkan ampas tebu kemudian dihaluskan hingga diperoleh ampas tebu dengan ukuran 100 mesh, proses hidrolisis termal dengan bantuan larutan asam sulfat dengan konsentrasi yang bervariasi, proses fermentasi yang dilakukan. keluar dengan bantuan ragi, proses destilasi, dan analisis kandungan. etanol. Metode yang digunakan adalah hidrolisis dengan asam sulfat. Selanjutnya dihidrolisis dengan asam sulfat pada suhu 150 ºC selama 1 jam hingga terbentuk slurry. Proses fermentasi menggunakan variasi massa khamir *Saccharomyces cerevisiae* dengan variasi 6.75, 8.75, 11.25, 13.75, dan 16.25 g selama 4 hari dengan pH 5, suhu ruang dan secara anaerobik. Pemurnian dilakukan dengan metode destilasi. kadar bioetanol terbaik pada penelitian dengan variasi massa khamir *Saccharomyces cerevisiae* dengan pH 5 dan lama fermentasi 4 hari adalah 98,93% dengan rendemen 57,6 mL.

Kata Kunci: Ampas tebu, Bioetanol, Saccharomyces cerevisiae, Massa Ragi, Fermentasi

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INTRODUCTION

Energy is very much needed in carrying out Indonesia's economic activities, both for consumption needs and production activities in various economic sectors [1]. Energy availability is an absolute requirement in national development efforts at present, because it can guarantee energy needs which are the main challenges for the Indonesian state [2]. Oil, natural gas and coal are fossil energies that are needed by society, but these energy sources are limited, so we must reduce our dependence on these energies [3]. Bioethanol is one of the bioenergy which is an alternative to replace the use of fossil fuels [4]. Some sources of bioethanol are sweet potato, corn, cassava, rice and others. Bioethanol energy source in Indonesia which, has great potential, namely from agricultural waste such as bagasse has the potential for alternative energy, rocessed into bioethanol [5]. Bagasse contains a potential lignocellulosic substrate for bioethanol production because it contains 19.9% content [6]. Bagasse which is classified as biomass, is very likely to be used as an energy source or lignocellulosic-based products such as paper, biogas, bioethanol and others [7].

This research will utilize bagasse into bioethanol as an alternative fuel. Meanwhile, made bioethanol using banana peels and bagasse with variations in yeast mass by thermal hydrolysis process [8]. Bioethanol production with the roots of alang-alang is carried out by hydrolysis and fermentation processes. The method used in this research is thermal hydrolysis [9]. This is because in bagasse there is 48% cellulose which must be broken down into simple sugar derivatives so that it can be used as raw material for making bioethanol. The steps used include the pretreatment process, hydrolysis using sulfuric acid, fermentation with variations in the addition of yeast *Saccharomyces cereviceae* and purification of the results by distillation. The operating conditions for temperature, fermentation time and pH of the research to be carried out refer to [10].

The Bagasse particle size of 100 mesh in the pretreatment and hydrolysis process has never been used in making bioethanol from bagasse by thermal hydrolysis method using sulfuric acid, so research will be carried out on this. The purpose of this study was to examine yeast mass on the yield and content of bioethanol produced from bagasse. The benefit of the research is to obtain bioethanol as an alternative fuel.

MATERIALS AND METHODS

Materials

This study aims to obtain bioethanol from bagasse. Bagasse used was taken from the Sugar Factory PT Laju Perdana Indah (PG Ogan). The research was conducted at the Laboratory of the Process Unit of the Chemical Engineering Study Program, Faculty of Engineering, University of Muhammadiyah Palembang. The apparatus used in this study include the digester, glass beaker, bunsen, stative and clamp holder, three-neck flask, hotplate, blenders, rotary evaporator, thermometers, shaker, balance sheet analysis, jars plastic, oven, measuring cup, flask, filter paper, furnace, and pH meter, hydrolysis tank and blender. While the materials used include bagasse, *Saccharomyces cerevisiae*, sulfuric acid (H_2SO_4) 0.3 M, urea, and distilled water .

Methods

Preparation of raw materials (pretreatment)

The bagasse which will be used as raw material is dried for 3 days under the hot sun and then heated in an oven at 105 °C for 1 hour, then crushed using a blender to form a powder. The bagasse powder then stored in an airtight plastic container to prevent contamination.

Thermal Hydrolysis Process

Bagasse samples that have passed the pretreatment stage are mixed with a sulfuric acid solution with a concentration of 0.3 M. The ratio between bagasse and sulfuric acid solution is 1:18 (w/v). Then it is hydrolyzed at 150 °C for 1 hour. After the hydrolysis process is complete, the digester is removed and cooled suddenly to stop the hydrolysis process. Cooling is done by immersing the digester in a container with water until it reaches room temperature. After that, it was continued by filtering hydrolysis results and the filtrate was taken for the fermentation process.

Fermentation Process

The results of the hydrolysis were put into the fermentation place as many as 5 pieces each with a volume of 30 mL. Then yeast was added to each sample with a variation of 6.75; 8.75; 11.25; 13.75 and 16.25 g. The addition of urea was carried out on each sample of 0.125 g , and stirred well before the anaerobic fermentation process was carried out. The operating conditions in the fermentation process were carried out at 25 °C , with a pH of 5 for 4 days [11].

Distillation Process

Results of fermentation is purified by distillation process by using a set of tools distillation at a temperature of 79-80 °C. The distillation process was carried out for 6 hours until the bioethanol no longer dripped. The resulting distillate was then measured in volume and the ethanol content produced was analyzed using the refractometer method.

Analysis procedure

Analysis of the ethanol content was carried out using the refractometer method with the following procedure [12]. The refractometer was preheated for 15 minutes, then prepared a standard solution of 40%, 50%, 60%, 70%, 80%, 90%, 96% ethanol and bioethanol samples. The standard solution was dripped on the object glass of the refractometer and closed . The same steps were also carried out for bioethanol samples. Directing the light to the slide that has been dripped with standard and sample solutions. Then press the nD button and wait for the recorder to generate a number. Take note of the numbers that are read , then calculate the bio-ethanol content with the following equation:

$$\text{Sample A (\%)} = \frac{(\mu \text{ sampel A} - \mu \text{ air})}{\text{m (slope)}} \quad (1)$$

$$\text{m (slope)} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} \quad (2)$$

RESULTS AND DISCUSSION

The bagasse used as raw material is prepared first, by drying the bagasse under the sun for approximately 3 days and then drying it in the oven at 150 °C for one hour. The dried sugarcane bagasse is then mashed to a size of 100 mesh or 0.149 cm. Bagasse that has been prepared and ready to use can be seen in Figure 1.

Figure 1. Bagasse (bagasse)

The Pretreatment process and hydraulic pretreatment process is a very important stage of the process which may affect the acquisition of ethanol yield. The pretreatment process is carried out due to several factors such as lignin content, particle size and hydrolysis ability of cellulose and hemicellulose [11]. The smaller the particle size will increase the porosity. The size of bagasse obtained from the processing process has met the requirements, namely 0.149 mm or 100 mesh, to be used in the hydrolysis process. bagasse size of 100 mesh is the optimal size for the hydrolysis process because it increases the contact area between bagasse and sulfuric acid solution. The hydrolysis process aims to break bonds and remove lignin and hemicellulose content as well as damage the crystal structure of cellulose into simple sugar compounds. The size of the raw material will affect the porosity so that it can maximize the contact between the material and the acid to increase the hydrolysis of hemicellulose [13]. Bagasse contains 22% lignin and 37% cellulose [7]. From the literature obtained it is known that bagasse contains lignin 21.42%, cellulose 48.12%. Lignin and cellulose are then hydrolyzed with the help of sulfuric acid to be simplified into sugars. The more lignin and cellulose content contained, the greater the amount of sugar that will be formed which will then be used as raw material.

The results of the measurement of bioethanol volume and bioethanol content in various yeast masses are shown in Table 1. Fermentation operating conditions at temperature (t) 25 °C, pH 5 and fermentation time (T) for 4 days and anaerobic process.

Table 1. Bioethanol yield and bioethanol content

Sample	Yeast Mass (g)	Bioethanol yield (mL)	Bioethanol content (%)
1	6.75	66.4	83.53
2	8.75	62.8	86.425
3	11.25	60.6	90.275
4	13.75	50.4	93.102
5	16.25	57.6	98.93

Influence yeast mass to yield bioethanol

The fermentation was carried out at room temperature operating conditions (25 ^{o}C) with yeast mass variation of 6.75, 8.75, 11.25, 13.75 and 16.25 g, fermentation time 4 days and pH 5. Fermentation time for 4 days and pH 5 were taken because they were the best conditions for fermentation with yeast *Saccharomyces cerevisiae* obtained at pH 5 and fermentation time for 4 days obtained maximum ethanol yield [14]. The yield of bioethanol carried out under the operating conditions as mentioned above is shown in Table 1 and Figure 2.

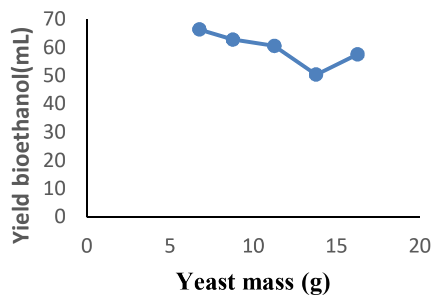

Figure 2. Effect of yeast mass on bioethanol yield

In Figure 1 it can be seen that the yield of bioethanol tends to decrease with the addition of yeast mass of 8.75 and 11.25 g, respectively. At the addition of 13.75 g the decrease was sharper but, at the addition of 16.25 g the yield tended to increase and almost approached the amount of yield with the addition of 11.25 g yeast with a yield volume of 57.6 mL.

Effect of yeast mass on bioethanol content

The effect of adding yeast mass is very influential on the bioethanol content. This is shown in Figure 3.

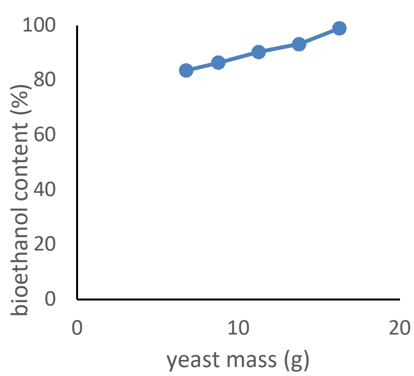

Figure 3. Effect of yeast mass on bioethanol content

Measurement of bioethanol content using the refractometer method. Bioethanol levels showed a significant increase in each addition of yeast mass. The more yeast mass added, the higher the bioethanol content produced , where the highest bioethanol content was 98.93 percent with the addition of 16.25 g yeast. The increase in bioethanol content due to the addition of yeast mass is caused by microorganisms that break down glucose into ethanol more and more, so that the resulting ethanol content increases [15]. These results are consistent with research conducted on Chinese rice using the yeast *Saccharomyces cerevisiae* which experienced an increase in ethanol content in the 4-day fermentation period and the addition of varying yeast mass [16].

CONCLUSION

Based on the research that has been done, it can be concluded that the mass of yeast has an effect on the yield and content of bioethanol. The more yeast mass added to the fermentation process, the yield and the resulting bioethanol content tend to increase. The best percentage of bioethanol with pH 5 and 4 days of fermentation is 98.93% with a yield of 57.6 mL.

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