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POTENCY OF BIOTHANOL PRODUCTION FROM THE BANANA *Musa sp.* WASTE

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ABSTRACT

Research about production bioethanol from the banana's *Musa sp.* has been done. Production bioethanol from the starch/carbohydrate the banana's *Musa sp.* initiated by convertion process of the carbohydrate into glucose. Glucose product then fermented by yeast with variation weight there are; 10, 15, 20 g respectively, then fallowed by destilation and redestilation process to produce the pure ethanol. To analyze the degree of purity of ethanol carried of by HPLC *(High Perfomance Liquid Chromatography)*. The result of the research showed that on variation of yeast 10, 15 and 20 g can produce ethanol are 74.50%, 70.12%, 66.31% respectively.

KEYWORDS: *Fermentation, HPLC, ethanol, carbohydrate, banana's Musa sp.*

INTRODUCTION

Petroleum supplies in the world increasingly depleted and needs are increasing with the development of technology. Need efforts to search continuously alternative energy sources. One alternative sources of energy is promising alternative energy-based plants (vegetable) [1,2,9].

The increase of price oil-based fossil fuels in 2005 became an important momentum for development of biofuels. This condition is a positive impact on the use of biofuels which was originally less attention, it will eventually become most important part of this now. It is believed that biofuels can be used as an alternative energy source to reduce dependence so great on fuel derived from fossil [3,4,5,11].

One promising energy source is ethanol. Bioethanol has several advantages compared with fuel from petroleum. Bioethanol flammable and has a large heat clean fuel, which is approximately 2/3 of the calorific burn cleaner gasoline [10,12]. At a temperature of 25 C and a pressure of 1 bar, net calorific fuel ethanol is 21.03 MJ / liter while petrol 30 MJ / liter. Pure ethanol can also be completely soluble in petrol in any ratio and is a high-octane blending components. Bioethanol can be made from the starch/ carbohydrate $(C_6H_{10}O_5)_n$ which is hydrolyzed to glucose and then fermented with *Saccharomyces cerevisiae* microorganisms at temperature of 27-30^oC (room temperature) The results of this fermentation of ethanol contains approximately 18%. Furthermore distilled at 78^oC (minimum boiling point of alcohol), that will produce ethanol with a concentration of approximately 95.6%. To obtain absolute ethanol then ethanol 95.6% CaO is added to bind the water [6]. Production of bioethanol from plants containing starch or carbohydrates can be done through the process of converting carbohydrates into sugar or glucose by several methods such as by acid and enzymatic hydrolysis. Enzymatic hydrolysis method is more commonly used because it is more environmentally friendly than the acid catalyst. Glucose were then carried out a process of fermentation or fermentation by adding yeast or yeast in order to obtain bioethanol [7,8]. Diverse sources of starch/ carbohydrate can be converted into bioethanol, among others, sago, rice, and bananas.

Bananas as one of the fruit trees that can grow well in almost all islands in Indonesia. One type of cultivated banana is a banana forty days (Musa.sp). Almost every yard and moor encountered this plant. There were planted neat and well cared for. Actually, if the banana crop cultivated commercially, the benefits are not inferior to other plants that are considering this fruit has begun to export [8].

However, unfortunatly due to lack of care in post-harvest handling, mechanical damage, physiological and microbiological ensued. When the fruit is ripe bananas from the tree, the starch will change, into several types of sugars include dextrose, levulose and sucrose. Sugars that can influence the taste of the fruit when ripe bananas [13]. Bananas is composed of water 75.6%; dextrose 4.6%; levulose 3.6%; sucrose 12.2%; 1.3% starch; fat 0.2%; meneralen 0.8% and 0.6% crude fiber [8].

Bananas *Musa sp.* is a type of banana which is very easy to find on the market. When the harvest time

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price of bananas has become very cheap and thrown away to rot, so it can be used to be converted into bioethanol. Moreover, the presence of carbohydrate content and high in sugars bananas *Musa sp*., then it will be used as a source of carbohydrates in the manufacture of bioethanol [8].
Based on the description above, has been done research for bioethanol production from banana *Musa.sp.*

MATERIALS AND METHODS

Materials

Materials used in this study is the banana *Musa sp*. waste, *Saccharomyces cerevisiae*, distilled, K_2HPO_4, glucose anhidrate (Merck), NaOH pa (Merck), Magnesium Sulphate Anhydrite.a (Merck), Sodium Potassium tartaric.

Sample preparation

Bananas *Musa sp.* were already very ripe taken then weighed 500 g. After it is cut into small pieces to facilitate the smoothing process using a blender. Added water also by 1.5 L. So we get the banana pulp to be fermented with yeast variation of 10 g, 15 g and 20 g.

Analysis glucose levels

Determination of glucose levels before and after fermentation, samples taken as many as 200 mL before fermentation and after fermentation into each of two test tubes, then add 800 mL of water and 1 mL of DNS and then heated to boiling on a water bath. Cooled with ice water for 10 minutes. Once cool add water as much as 8 mL then measured absorbance at 540 nm wavelength.

Determination of water content

Prior to analysis, the cup is inserted in a drying oven at a temperature of 105 – 110ºC for one hour and then cooled. Once cool, the cup is weighed. 1 piece of banana samples were weighed, then a banana cut into small pieces put in a drying oven temperature of 105 – 110ºC for 8-24 hours. The dried bananas are removed from the oven and cooled. Once cool, weighed and the process is carried out to obtain a constant weight.

Fermentation

Fermentation conducted by taking samples into porridge then inserted into each of three bottles simple fermentation that had been installed and the air hose Valcon containing water to control the fermentation process as seen from air bubbles yanng arise. Then each bottle added 9.6 g $(NH_4)_2SO_4$, 2.8 g K_2HPO_4, 0.9 g $MgSO_4$, then added with variations of yeast. Into the first bottle was given as much as 10 g of, the yeast was given a second bottle of 15 g, and the third bottle given as much as 20 g yeast. Then controlled fermentation process occurs by counting and note the number of bubbles that come out every 15 minutes.

Distillation step I

Into the distillation flask 250 ml of the supernatant 300 ml entered fermented, then distilled to separate the components made ethanol from water. All distillate fraction boiling at temperatures ≤100 ° C is collected. This step done each 2 times in 3 bottle fermented there.

Distillation step II

Similar with procedure in tep 1 is done by collecting the distillate in suhu≤85 ° C, made by mixing both distilled into the distillation flask 300 ml and made redestilasi against each variation yeast.

Analysis of bioethanol

Bioethanol analysis carried out by using high performance liquid chromatography (HPLC)

RESULTS AND DISCUSSION

Determination of glucose

Results of determine the glucose concentration of sample solution before and after fermentation using UV-VIS spectrophotometer PD-303S is shown in table 1

Table 1. Determination of Glucose Concentration

Sample	Concentration of glucose (mg/mL)
before fermentation	1.229
after fermentation	0.014

The data in table 1 show that the difference in glucose concentration where the concentration before fermentation greater than after fermentation.

This is result occured because glucose is present in bananas *Musa sp.* have break down into simpler sugars that used in the fermentation process. So once the fermentation process is complete glucose levels to be reduced.
Decomposition process of glucose into pyruvate, alcohols, lactic, or CO_2 and water can go through several metabolic roads, depending on the state of environment, the state of the cell, or a wide body. One kind of living bodies can perform one or more metabolic pathways of glucose decomposition required depending on whether the decomposition

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process. In this case each of the bodies of the living has its own control system. One of the terms associated with the decomposition of glucose metabolism is fermentation, which is a chemical compound enzymatic process produces gas, in this case is the decomposition of carbohydrates produce ethanol and CO_2 without exclusion of oxygen [14].
Determination of Water Content
Determination of water content using one banana forty days, by formula:

$$Water\ content = \frac{(Weight\ wet\ sampel - Weight\ dry\ sampel)}{Weight\ total\ sampel} \times 100\%$$

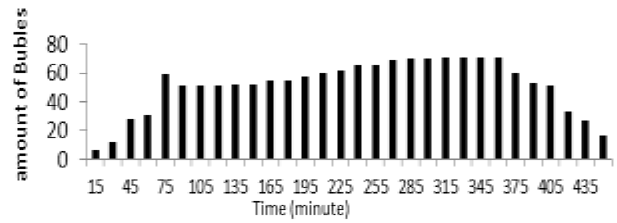
The obtained water content of 78.7%. This shows that the water content bananas Musa sp.did not differ much from water content of bananas in general, ie 75.6%.

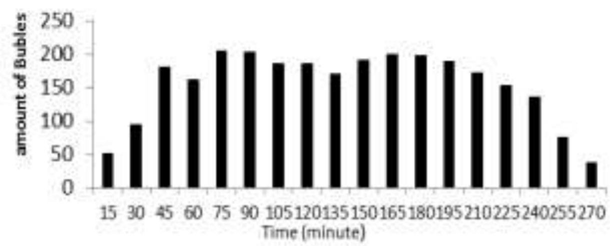
Fermentation
Fermentation process is conducted by treatment with yeast fermentation based on variations in weight of 10 g, 15 g and 20 g. The process of yeast fermentation done any weight variation is not coincide, this is done in order to to control fermentation process and determine the speed of fermentation on the 3rd fermentation by varying the weight of this yeast.

Figure 1. Fermentation Process

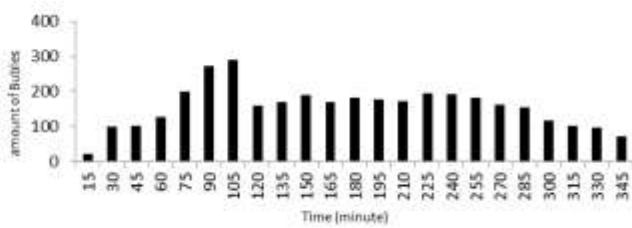
In the fermentation process is shown in figure 1, by varying the weight of yeast, can be seen the difference in the speed of fermentation. This is shown by the rate of formation of CO_2 from the fermentation of each minute, where the variation of the fastest 20 g yeast. Fermentation speed is shown in Figure 4. In yeast 10 g weight variation rate of CO_2 formation arise regularly, the highest amount of bubbles arising in this yeast variety is the bubble 71 and back down to the number of bubbles beginning at minute 450 (Fig. 2.a). Meanwhile the weight variation rate of formation of yeast 15 g CO_2 arising began irregular making it difficult to count the number of bubbles which initially rose regularly back down but then rise again until it reaches a majority of 200 bubbles (Fig. 2.b), eventually down back to the beginning of the minute amount of bubbles to 270.

(a)





(b)



(c)

Figure 2. Profile speed fermentation process with determining the amount of bubbles formed (CO2). (a) the speed of weight variation yeast fermentation 10 g, (b) speed of weight variation yeast fermentation 15 g, (c) the speed of the process of yeast fermentation 20 g weight variation.

Variations last yeast weight is 20 g, which speeds the formation of CO_2 that arise very quickly and achieve the highest bubble is a bubble 290, back down slowly to the initial number of bubbles into 345. From the results Then the fermentation process followed by distillation.
In some microorganisms such as yeast, glucose is oxidized to produce ethanol and CO_2 in a process called fermentation alcohol. Metabolic pathway is similar to process of glycolysis to pyruvate formation. The next two stages of enzymatic reaction is the reaction changes pyruvic acid to acetaldehyde and CO_2, and the reaction of acetaldehyde into

alcohol. in first reaction decarboxylated pyruvate converted to acetaldehyde and CO_2 by pyruvate decarboxylase. Furthermore, acetaldehyde is reduced by NADH by the enzyme alcohol dehydrogenase, to produce ethanol. Thus the ethanol and CO_2 is the end result of fermentation alcohol. In the tabel 1shows that, which produces more CO_2 is the variation of yeast 20 g, the number of 290 bubbles (CO_2), the amount of CO_2 that is formed then acetaldehyde is formed too much, but acetaldehyde formed is not converted into ethanol, so that the concentration of ethanol low.

Analysis of Bioethanol Fermentation

Results of fermentation by varying weight of yeast followed by distillation process at a temperature of ≤100^{o}C, followed by redestilasi or distillation process back on temperature ≤85^{o}C. This was done to further purify the ethanol that will be obtained, so it is not mixed with impurities that may come along with the ethanol evaporates during the process of distillation. These results indicates that effect of the weight of yeast against alcohol levels, which are shown in table 2.

Table 2. Results of bioethanol with weight variations of yeast

Sample	Ethanol Content (%)
P_1	74.50
P_2	70.12
P_3	66.31

Note:

P_1 : Distillation product with yeast variation 10g
P_2 : Distillation product with yeast variation 15g
P_2 : Distillation product with yeast variation 20g

Alcohol can be produced from several materials by fermentation with the aid of microorganisms, as zimosa producing enzymes which catalyze biochemical reactions in organic substrates changes, one of them is *Saccharomyces cereviseae*. The fermentation process using Saccharomyces cereviseae more widely used commercially to produce alcohol as compared with bacteria and fungi. This is because *Saccharomyces cereviseae* can produce large amounts of alcohol. This is shown from the results obtained are in table 2 shows that the addition of yeast weight causes the resulting alcohol decreases. With the addition of 10g yeast produces alcohol content of 74.50%. Then dropped to 70.12% in addition to the addition of yeast 15g and 20g yeast increasingly fell to 66.31%. This is due to the comparison *Saccharomyces cereviseae* that there are more than nutrients available, so Saccharomyces cereviseae more use nutrition to survive than to overhaul the sugar into alcohol (Retno and hemorrhoids, 2011).

CONCLUSION

Based on research carried out can be concluded that:

1. The water content of bananas *Musa sp.*was 8.7% is not much different from the content of bananas in general, there is 75.6%.
2. Glucose banana forty days before fermentation 229 mg / ml and glucose levels after fermentation is 0.014 mg / ml.
3. The content of bioethanol produced for P_1 variety of yeast 10g) is 74.50%, P_2 (variety of yeast 15g) is 0.12%, and P_3 (variety of yeast 20g) is 66.31%, this hows that the more yeast used, the smaller levels of ethanol produced.

REFERENCES

[1] M. Galbe, G. Zacchi, A review of the production of ethanol from softwood, Appl. Biotechnol. 59 (2002) 618–628.

[2] R.C. Kuhad, R. Gupta, Y.P. Khasa, A. Singh, Bioethanol production from Lantana camara (red sage): pretreatment, saccharifcation and fermentation, Bioresour. Technol. 101 (2010) 8348–8354

[3] Philippidis, G.P., Smith, T.K., Wyman, C.E., 1993. Study of the enzymatic hydrolysis of cellulose for production of fuel ethanol by the simultaneous sacchari?cation and fermentation process. Biotechnol. Bioeng. 41, 846–853.

[4] Saxena, A., Garg, S.K., Verma, J., 1992. Simultaneous sacchari?cation and fermentation of waste newspaper to ethanol. Bioresour. Technol. 39, 13–15.

[5] J. Shen, F.A. Agblevor, Modeling semi-simultaneous sacchari?cation and fermentation of ethanol production from cellulose, Biomass Bioenergy 34 (2010) 1098–1107

[6] Nurfiana, F., Umi, M., Vicki, CJ., dan Sugili.,P., 2009, Production of bioetanol from Durian seed as alternatif Energy source, Yokyakarta, ISSN 1978-0176. Acessed at 15 April 2012.

[7] Retno Tri Dyah., dan Wasir Nuri, 2011. Production of bioethanol from banana skin, Yokyakarta, ISSN 1693 – 4393.Acessed at 15 April 2012.

[8] Sumartono, 1982. The Bananas. Published Cv Bumi Restu, Jakarta.

[9] R. Kataria, S. Ghosh, Sacchari?cation of Kans grass using enzyme mixture from Trichoderma reesei for bioethanol production, Bioresour. Technol. 102 (2011) 9970–9975

[10] R. Gupta, S. Kumar, J. Gomes, R.C. Kuhad, Kinetic study of batch and fed-batch enzymatic saccharifcation of pretreated substrate and subsequent fermentation to ethanol, Biotechnol. Biofuels 5 (2012) 16

[11] H.A. Choudhury, S. Chakma, V.S. Moholkar, Mechanistic insight into sonochemical biodiesel synthesis using heterogeneous base catalyst, Ultrason. Sonochem. 21 (2014) 69–181

[12] Elander, R.T., Putsche, V.L., 1996. Ethanol from corn: technology and economics. In: Wyman, C.E. (Ed.), Handbook on Bioethanol:Production and Utilization. Taylor & Francis, Washington, DC, pp. 329–349

[13] Suyanti,S., dan Ahmad,S., 2005. Banana Cultivation and Processing Market Prospects. Published by Penebar Swadaya, Jakarta.

[14] Muhamad, W.,1985. *Biochemistry: Energy Metabolism, Carbhidrate, and Lipid*. Published by ITB, Bandung.

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