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The Effect Of Variations In Starch Weight On The Manufacture Of Bioethanol From Plantain Waste (Musa Sapientum)

Kiagus Ahmad Roni*, Hasni Kesuma Ratih, Muhammad Al-Farabi, Yon Haryono
Chemical Engineering, Faculty of Engineering,
Universitas Muhammadiyah Palembang
E-mail : kiagusaroni@gmail.com

ABSTRACT- Banana tree is a plant that thrives in Indonesia. In 1980, the total banana production in Indonesia was 1.9 million tons and in 2015 it increased significantly to 7.3 million tons (Center for Agricultural Data and Information, 2016). Banana tree waste such as weevils, stems and midribs is not utilized optimally, even though the starch content in the waste has the potential to be processed into glucose which is then fermented to produce bioethanol. The research variables were starch weight in weevils, stems and midribs of plantain (Musa Sapientum) trees. The process of making bioethanol consists of pretreatment, hydrolysis, fermentation and purification. Pretreatment consists of making starch in the three analyzed samples, then at various starch weights of 100gr, 150gr, 200gr, 250gr, and 300gr, hydrolyzed using 0.5N sulfuric acid and fermented for 4 days. The product after fermentation will be purified by a distillation process at a temperature of 80^0C. The results showed that the levels of bioethanol obtained depend on the concentration of sulfuric acid added to the weight variations of the starch being hydrolyzed. In plantain weevil, it shows that in the 250 gram starch variation condition, the highest ethanol content obtained is 8.4432% and the refractive index is 1.33587. In plantain stems, the optimum dose of starch used was 250gr with ethanol content of 7.6422% and refractive index of 1.33298. In the last sample, the plantain tree midrib, the optimum dose was obtained at 250gr of starch with an ethanol content of 7.8732% and a refractive index of 1.33432.

Keywords: Bioethanol, Starch Weight Variation, Banana Tree Waste

1. INTRODUCTION

The energy sector has an important role in supporting the continuity of the national development process (Lubis and Sugiyono, 1996). According to data from Central Statistic Agency (2016), total energy consumption in Indonesia increased from 4,47 exajoule in 2012 and decreased to 4,44 exajoule in 2014, Energy is mostly used in the household, industrial, and transportation sectors, meanwhile, reserves of fossil fuels such as oil, natural gas, and coal, which have been the main sources of energy, are running low. This has led to concerns about fuel scarcity in the future. Thus, it is necessary to seek other alternative energy sources that come from raw materials that are continuos and renewable, such as bioethanol energy.

Banana are monocot plants belonging to the Musaceae family which is originated from Southeast Asia. In Indonesia, banana is the most consumed fruit compared to other fruits, because it can be found in almost all markets. Indonesia is the largest banana producer in Asia, because 50% of Asian banana production is produced as one of the national leading fruit commodities. As a superior commodity, banana is a fruit that is easily available, has high economic, cultural and nutritional value (Ermawati, dkk. 2016).

This research was directed to determine the optimum dose of the effect of variations in starch weigh on the manufacture of bioethanol from plantain waste *(Musa Sapientum)* consisting of weevils, stems and midribs, to the resulting ethanol content.

Bioethanol is bioenergy that can be renewed, less polluting. Meanwhile, the use of agricultural land to produce bioenergy crops will compete with the cultivation of food crops. Agricultural waste generally contains quite high starch, cellulose and hemicellulose. The chemical content of agricultural waste can be used as raw material in the process of making bioethanol (Khaidir, 2016). In addition, bioenergy production from cultivated plants will require higher costs compared to energy production from petroleum, and is less profitable. Therefore we need an alternative source of cheap and abundant raw materials (Ma, Cai, & Liu, 2017).

Bioethanol is obtained from the fermentation of materials containing sugar. The core stage of bioethanol production is the fermentation of sugar, whether in the form of glucose, sucrose, or fructose by yeast (Prihardana, 2007). Bioethanol is used in various industries as raw material for the beverage, pharmaceutical, cosmetics and fuel industries. In general, this bioethanol production includes three series of processes, namely: hydrolysis, fermentation, and purification or distillation.

Hydrolysis is a chemical reaction between water and another substance which produces one or more new substances and also the decomposition of a solution using water. This process involves the ionization of water molecules or the breakdown of other compounds (Pudjaatmaka and Qodratillah, 2002), The hydrolysis reaction of starch takes place according to the following equation :

$$(C_6H_{10}O_5)n + nH_2O \rightarrow n(C_6H_{12}O_6)$$

Starch Water Glukose

The reaction between water and starch is very slow, so a catalyst is needed to increase the reactivity of water. The catalyst can be in the form of an acid or an enzyme, in this research the catalyst used is a strong acid so it is classified as acid hydrolysis..

Alcohol fermentation is the process of breaking down carbohydrates into ethanol and CO2 produced by the activity of a type of microbe called yeast in an anaerobic state. (Prescott and Dunn, 1959). Changes can occur when these microbes come into contact with foods suitable for their growth. The fermentation process usually does not cause a bad smell and usually produces carbon dioxide gas. Fermentation results are influenced by many factors. Such as food or substrate, types of microbes and ambient conditions. Utilization of microorganisms varies depending on the basic ingredients and the final results to be obtained (Pessoa 2019).

Sugar fermentation by yeast, for example Saccharomyces cerevisiae can produce ethyl alcohol (ethanol) and CO2 through the following reactions:

$$C_6H_{12}O_6 \xrightarrow{ragi} 2\,C_2H_5OH + 2\,CO_2$$

Glukose Ethanol

This reaction is the basis of making tape, brem, tuak, wine, beer, bread and others. (Winarno, 1984)

The distillation process can be used to separate various mixture combinations, one of which is the ethanol-water mixture (Zhang dkk., 2019; Alheshibri & Craig, 2019). Bioethanol produced from the fermentation process still contains CO2 gases (resulting from converting glucose into bioethanol) and aldehyde as much as 35% by volume which needs to be cleaned by filtering out the bioethanol bound by CO2. The level of bioethanol from the fermentation process usually reaches 8 to 10%, so to obtain pure ethanol a distillation process is required. (Wasito, 1981).

The bioethanol resulting from the fermentation process is separated by filtering, then the filtrate is distilled so that it can produce bioethanol which is free from contaminants or impurities formed during the fermentation process. The distillation process will increase the ethanol content by up to 95%. The remaining water is removed by dehydration until the ethanol content reaches 99.5% (Sari and Moeksin, 2015). The results of the distillation that are carried out can be analyzed for levels by various methods of analysis such as Gas Chromatography.

2. METHODOLOGY

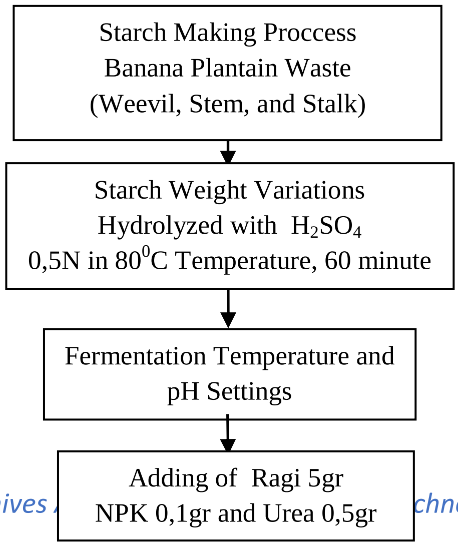
Times and Place

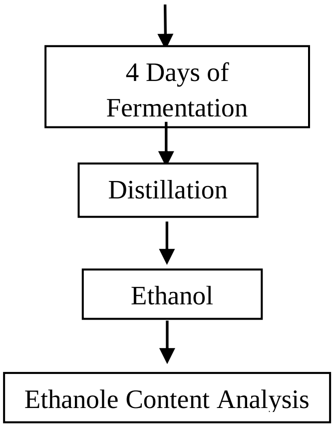
The research was conducted from 29 July - 21 August 2020 at the Chemical Industry Process Laboratory, Chemical Engineering Study Program, Muhammadiyah Palembang University. The research time was conducted from 08.00 - 18.00 WIB

Research Procedure

The research was carried out by weighing the starch weight variations of 100gr, 150gr, 200gr, 250gr, and 300gr, for each sample, namely the weevil, trunk and midrib of plantain trees. Then add 800 ml of water and 10 ml of 0.5N sulfuric acid catalyst into each erlenmeyer.

The starch hydrolysis process was carried out for 60 minutes at a temperature of 80^{o}C, then filtered and fermented by adding 5gr of Saccaromyces Cerevisiae yeast, 0.1gr NPK and 0.5gr urea. The fermentation time was carried out for 4 days. After the fermentation process is complete, the solution is distilled for 4 hours at 80^{0}C temperature so that the results will be analyzed for ethanol content using Gas Chromatography.





Picture 1. Research Flow Diagram

3. RESULT AND DISCUSSION

A. RESULT

After conducting research on the manufacture of bioethanol using plantain (Musa Sapientum) tree waste with variations in the weight of starch during the hydrolysis process of 100 grams, 150 grams, 200 grams, 250 grams, and 300 grams, the following data were obtained :

Table 1. Results of Observation of the Volume of Bioethanol produced from waste banana trees (*Musa Sapientum)*

Starch Weight (gr)	Bioethanol Volume (ml)		
	Weevil	Stem	Stalk
100	12,1	17,2	12,5
150	17,8	20,4	13
200	21,7	24,1	15,5
250	18,8	21,9	18
300	19,2	22,3	20,5

Table 2. Results of Observation of the Refractive Index of Bioethanol produced from waste banana trees (*Musa Sapientum))*

Starch Weight (gr)	Refractive Index		
	Weevil	Stem	Stalk
100	1,33312	1,33256	1,33263
150	1,33435	1,33315	1,33312

200	1,33469	1,33335	1,33424
250	1,33587	1,33378	1,33432
300	1,33473	1,33298	1,33498

Table 3. Results of Observation of the Bioethanol Content produced from waste banana trees (Musa Sapientum)

Starch Weight (gr)	Bioethanol Content (%)		
	Weevil	Stem	Stalk
100	4,2934	3,7898	4,1087
150	5,7873	5,2331	5,3872
200	6,1087	5,7876	6,1087
250	8,4432	7,6422	7,8732
300	5,1102	4,6574	7,5583

Table 4. Results of Observation of the pH of Bioethanol produced from waste banana trees (*Musa Sapientum)*

Starch Weight (gr)	pH		
	Weevil	Stem	Stalk
100	7,42	7,39	6,87
150	7,22	7,28	6,94
200	7,38	7,43	7,22
250	7,46	7,58	7,35
300	7,69	7,45	7,24

B. DISCUSSION

Effect of variations in starch weight on bioethanol volume

From the experiments conducted on the manufacture of bioethanol from plantain (Musa Sapientum) waste, the volume was different. The volume of bioethanol is obtained from a distillation process which is carried out for 4 hours using a simple distillation device found in the laboratory. Distillation itself is an operating method used in the process of separating a component from the mixture based on the boiling point of each component using heat as a separating force (Brown, 1987). Effect of variations in starch weight on bioethanol volume can be seen in **Figure 1**.

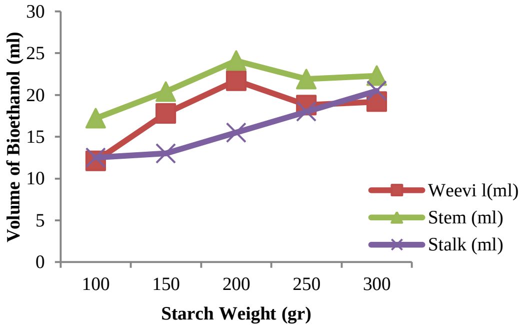


Figure 1.Effect of variations in starch weight on bioethanol volume

From the curve it can be analyzed that in the banana weevil waste with 200 grams of starch weight, the highest volume of bioethanol is obtained, namely 21.7 mL, for 200 grams of starch banana stem waste, the highest volume of bioethanol is 24.1 ml and in banana stalks, the weight of starch is 300 grams. , the highest volume of bioethanol was obtained, namely 20.5 mL. The things that are important factors in the volume yield of bioethanol are the distillation temperature and time required to distill the sample to produce a large volume with high levels. The distillation carried out in the experiment was for 4 hours. In the experiments conducted, a large or small volume of bioethanol does not necessarily have a high bioethanol content. The high levels of bioethanol in the sample resulted in good volume quality and vice versa.

Effect of variations in starch weight on Refractive Index

The variation of starch weight also affects the refractive index of bioethanol. A good refractive index in the sample should be close to the standard ethanol refractive index value, which is 1.3633 (SNI 06.3565-1994). By knowing the refractive index value of biothanol, it can be seen that the quality is the same or not the standard ethanol being compared. Determination of the refractive index on the sample using a tool in the form of a refractometer. The refractometer works by utilizing light refraction, so that the scale of the reading can be found in determining the refractive index of the sample. In the research conducted, the effect of starch weight on the refractive index of bioethanol can be seen in Figure 2.

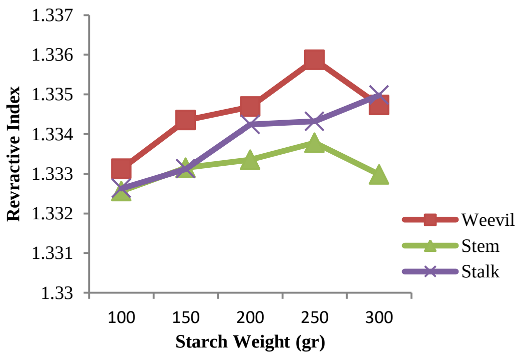


Figure 2.Effect of variations in starch weight on Refractive Index

In this experiment, the highest refractive index for banana weevil samples was 1.33587 with bioethanol content in gas chromatography analysis of 8.4432%. where the use of plantain (Musa Sapientum) weevil starch is 250 grams, in banana stem samples the highest refractive index was 1.33378 with a variation of starch weight of 250 gr and the resulting bioethanol content in gas chromathography was 7.6422% bioethanol content, and in the banana stalk sample, the highest refractive index obtained was 1.33498 with bioethanol content in the gas chromatic analysis of 7.5583%. this is because the refractive index of an optically active substance for a solution is linear, proportional to its concentration. In determining the refractive index, it can be concluded that the sample obtained still contains a lot of water and the sample obtained has low ethanol content so that in the process of determining the refractive index, it is still far from the standard ethanol refractive index value and tends to the refractive index value of water which is 1.333.

Effect of Variations in starch weight on Bioethanol Content

In a study conducted on starch weight variables of 100 grams, 150 grams, 200 grams, 250 grams and 300 grams of starch in plantain tree waste (Musa Sapientum) gave results on the levels of bioethanol obtained. Variations in starch weight were selected in this study, because the difference in starch weight used resulted in the process of changing starch to glucose in the hydrolysis process will differ according to the optimum dose. The effect of variations in starch weight on bioethanol content obtained can be seen in Figure 3.

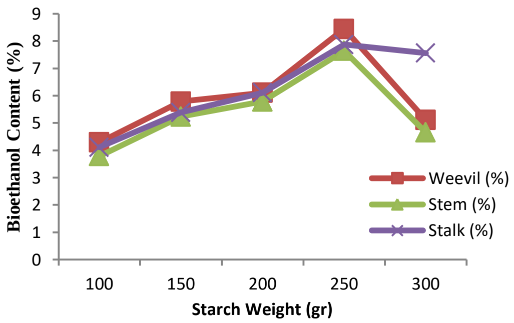


Figure 3.Effect of Variations in starch weight on Bioethnaol Content

Glucose produced in the hydrolysis stage will affect the fermentation process to produce bioethanol, the level of bioethanol produced is influenced by the amount of glucose converted in the fermentation process to become bioethanol and the bioetnaol purification stage by the distillation process.

Based on the results of the study, it can be concluded that the ethanol produced from the raw material of plantain (Musa Sapientum) weevil has not approached the SNI standard because the highest ethanol content produced in banana weevil waste was 8.4432 %% and the refractive index was 1.33587 with starch weight 250 gr, In banana stem waste, the starch weight of 250 g added to the hydrolysis process has the highest bioetnaol content, namely 7.6422%, and in the waste of banana stalks, the use of starch weight is 250 grams, which produces the highest ethanol content of 7.8732%. In this case, plantain tree waste, namely weevils, stems, and stalk are proven to have the potential to produce bioethanol, further studies are needed on a larger scale and the right ratio in processing raw materials and distillation equipment for better purification..

4. CONCLUSION

Based on research conducted on plantain tree waste (Musa Sapientum), it was found that the levels of bioethanol obtained depend on the concentration of sulfuric acid added to the variation of starch weight being hydrolyzed. In plantain weevils, it shows that under conditions of variation of

250 grams of starch, the highest ethanol content obtained is 8.4432% and the refractive index is 1.33587. On plantain stems, the optimum dose of starch used was 250gr with ethanol content of 7.6422% and a refractive index of 1.33298. In the last sample, the plantain tree stalk, the optimum dose was obtained at 250gr of starch with an ethanol content of 7.8732% and a refractive index of 1.33432..

The products obtained still contain a lot of impurities such as too high water content, this can be a reference for better purification processes such as graded distillation or fractionation distillation so that the ethanol content obtained has ethanol content with high purity.

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