Jurnal TEKNO
(Civil Engineeering, Elektrical Engineeering and Industrial Engineeering)
Vol. 18, No : 1, April 2021 , p-ISSN:1907-5243, e-ISSN: 2655-8416

The Influence of Starch Weight Variations in Making Bioethanol from Plantain Turber Waste (Musa Sapientum)

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Abstract

Bioetanol (C2H5OH) merupakan cairan biokimia (biofuel) dari proses fermentasi gula menggunakan sumber karbohidrat dengan bantuan mikroorganisme. Bioetanol digunakan sebagai bahan bakar alternatif dan sumber bahan bakar nabati yang ramah lingkungan dan terbarukan, salah satu alternatif bahan bakunya adalah bioetanol dari bahan baku limbah bonggol pisang. Penelitian ini bertujuan untuk mengetahui pengaruh variasi berat pati pada pembuatan bioetanol dari limbah bonggol pisang raja *(Musa Sapientum)*. Berat pati yang divariasikan dalam proses hidrolisis sebesar 100 gram, 150 gram, 200 gram, 250 gram dan 300 gram, dimana larutan asam sulfat yang digunakan sebesar 0,5N. Pada tahap fermentasi larutan hasil hidrolisa menggunakan ragi roti *Saccaromyces Cerevisiae* dengan lama fermentasi selama 4 hari. Untuk mengetahui kadar kemurnian bioetanol yang didapat maka dilakukan analisis dengan menggunakan gas kromatografi, penentuan indeks bias menggunakan refraktometer, dan penentuan volume bioetanol yang didapat. Dari penelitian ini diperoleh bahwa berat pati optimum yang didapatkan adalah pada penggunaan 250 gram pati bonggol pisang dengan kadar bioetanol sebesar 8,4432%, volume yang didapatkan 18,8 mL, pH sebesar 7,46 dan Indeks Bias sebesar 1,33587. Dari data analisa tersebut, bioetanol yang didapatkan memiliki kuantitas dan kualitas yang kecil dibandingkan dengan etanol standar.

Kata kunci: bioetanol, bonggol pisang, bahan bakar alternatif, berat pati, fermentasi

1. INTRODUCTION

Bioethanol can be produced from biomass containing starch or cellulose components, such as cassava, tubers, and sago starch [2]. In the industrial world, ethanol is generally used as a raw material for industrial alcohol derivatives, a mixture of liquor, as well as pharmaceutical and cosmetic raw materials [4]. Apart from that, it is a source of biofuel which has properties similar to premium oil [7].

Bioethanol has better characteristics compared to petrochemical-based gasoline [3], namely (a) Contains 35% oxygen, so it can increase combustion efficiency and reduce greenhouse gases (b) Has a higher octane value, so it can replace functions additives, such as methyl tertiary butyl ether and tetra ethyl lead (c) have an octane value of 96-113, while the octane value of gasoline is only 85-96 (d) Bioethanol is environmentally friendly, because the exhaust gas is low on compounds that have potential as pollutants , such as carbon monoxide, nitrogen oxides, and greenhouse gases (e) Bioethanol is easy to decompose and is safe because it does not pollute water (f) As a renewable energy source and the production process is relatively simpler than the gasoline production process[8]

Banana plants consist of roots, Turbers, stems, leaves, flowers and fruit. The roots are in the form of root fibers that originate in the stem tubers (Turbers). Most of the roots are in the underground part which grows to a depth of 75 to 150 cm in the soil. The roots that are on the side of the tuber (Turber) grow sideways or horizontally [5]. The image of the plantain (Musa Sapientum) hump used can be seen in Figure 1.

Figure 1. Banana Raja Tubers (*Musa Sapientum*)

Starch contained in banana stem tubers can be used as a source of carbohydrates and can even be dried to become ash. Where the ash from these tubers contains soda which can be used as an ingredient in soap and fertilizer. Banana hump starch can also be used as raw material for bioethanol production, because it has a high enough sugar content [11]. Banana stems or humps can be used to extract starch, this starch is similar to tapioca starch [6]. The potential for large banana tubers starch content can be used as an alternative fuel, namely, bioethanol. Banana Tubers has the following composition.

Table 1. Chemical composition of banana Turber per 100 grams of material

Component	Wet	Dry
Calory (cal)	43	245
Protein (g)	0,6	3,4
Lemak (g)	-	-
Carbohidrat (g)	11,6	66,2
Ca (mg)	15	60
P (mg)	60	150
Fe (mg)	0,5	2
Vitamin A (SI)	-	-
Vitamin B (mg)	0,01	0,04

Vitamin C (mg)	12	4
Water (%)	86	20

This bioethanol production includes three series of processes, namely: hydrolysis, fermentation and distillation. In the hydrolysis stage, which involves ionizing water molecules or the decomposition of other compounds [13], hydrogen will form one component and hydroxyl to another. The hydrolysis reaction of starch takes place according to the following reactions :

$$\underset{\text{Starch}}{(C_6H_{10}O_5)n} + \underset{\text{Water}}{nH_2O} \rightarrow \underset{\text{Glucose}}{n(C_6H_{12}O_6)}$$

The reaction between water and starch takes place very slowly so that a catalyst is needed to increase the reactivity of water. The catalyst can be in the form of acids or enzymes, so starch hydrolysis is divided into two, namely acid hydrolysis and enzymatic hydrolysis. The next step is fermentation, sugar fermentation by yeast, for example Saccharomyces cerevisiae can produce ethyl alcohol (ethanol) and CO2 through the following reactions:

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\textit{Saccharomyces cerevisiae}} \underset{\text{Ethanol}}{2\,C_2H_5OH} + 2\,CO_2$$

Ethanol produced from the fermentation process still contains CO_2 gases (resulting from converting glucose into bioethanol) and aldehyde as much as 35% by volume which needs to be cleaned by filtering the bioethanol which is bound by CO_2. The bioethanol content from the fermentation process usually reaches 8 to 10%, so that a distillation process is required to obtain pure ethanol [10].

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 [1]. The results of the distillation that are carried out can be analyzed for levels by various methods of analysis such as Gas Chromatography [12].

In previous research conducted on variations in the concentration of sulfuric acid and fermentation time in the manufacture of bioethanol from banana Turber waste (Musa Paradisiaca), it was found that the optimum dose of the concentration of added sulfuric acid in the study was at a concentration of 0.5 N sulfuric acid and time. The best fermentation for 4 days, by producing 13.9 mL of bioethanol with the largest ethanol content of 5.9426% and a refractive index of 1.33463. From this research, there is still no further study regarding the effect of variations in starch weight on the manufacture of bioethanol from plantain Turber waste in order to obtain the optimum dose and good results in the production process [14].

In the research to be carried out, it is hoped that by knowing the effect of variations in starch weight on the manufacture of bioethanol from plantain Turber waste, it can be used as a reference in the process of making maximum biomass, and can provide useful and economic value to banana Turber waste, as well as replacing fuel. oil to biofuels, or in these conditions can be used as an effective cynicitizer to kill germs that spread disease.

Vol. 18, No : 1, April 2021 , p-ISSN:1907-5243, e-ISSN: 2655-8416

2. METHODS

The processing of bioethanol from banana tubers waste is carried out by hydrolysis using sulfuric acid and fermentation with microorganisms (yeast). Both processes are carried out in stages, by hydrolyzing starch to glucose, then followed by a fermentation process so that it will produce bioethanol, as well as a distillation process so that bioethanol will be obtained with good purity levels. This research was conducted in a laboratory scale with two variables, namely fixed variables and independent variables with starch weight of 100 grams, 150 grams, 250 grams, and 300 grams. The following figure 2 explains the flowchart of the research process.

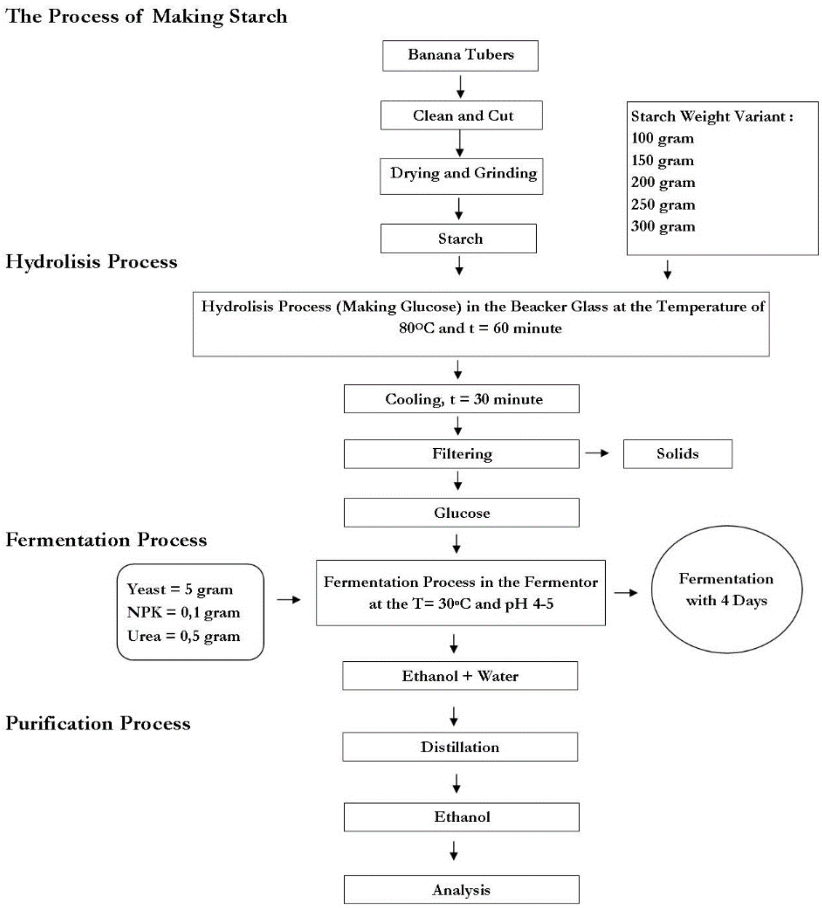

Figure 2. Research Process Diagram

3. RESULTS AND DISCUSSION

3.1 Effect of Starch Weight Varization on Bioethanol Volume

The important factors for bioethanol volume are temperature and time to produce large volumes with high levels. The distillation process carried out in the study lasted 4 hours. The following is a graph of the curve obtained.

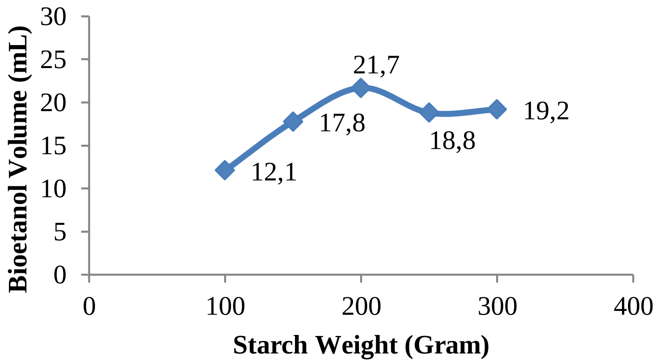

Figure 3. Effect Curve of Starch Weight Variation on Bioethanol Volume

From the curve it can be analyzed that at 200 grams of starch, the highest volume of bioethanol is obtained, namely 21.7 mL. 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.

3.2 The Effect of Starch Weight Variations on the Degree of Acidity (pH)

Determination of the degree of acidity (pH) in the bioethanol sample produced using an instrument in the form of a pH-meter. This can be improved so that it can be compared to ethanol according to SNI standards ranging from 6.5 to 9.0. The effect of variations in starch weight on the degree of acidity (pH) of the bioethanol produced can be seen in the figure below.

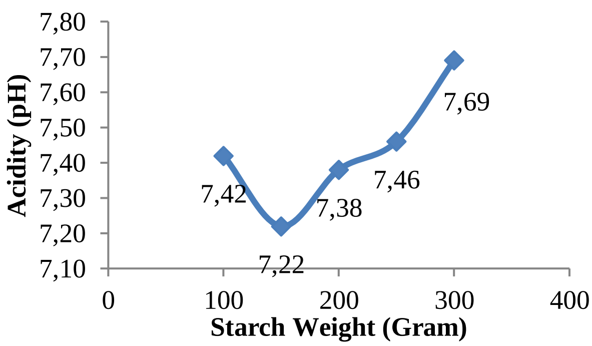

Figure 4. Influence Curve of Starch Weight Variation to Degree of Acidity (pH)

In the picture above, it can be seen that all the samples used produce a pH of 7, where the largest pH is in the use of 300 grams of starch with a pH value of 7.69

and the smallest pH is in the use of starch of 150 grams, namely pH 7.22. The pH of the bioethanol yield is influenced by the fermentation that runs for 4 days. pH in fermentation greatly affects the conversion of glucose into bioethanol.

3.3 Effect of Starch Weight Variation on Bioethanol Refractive Index

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.

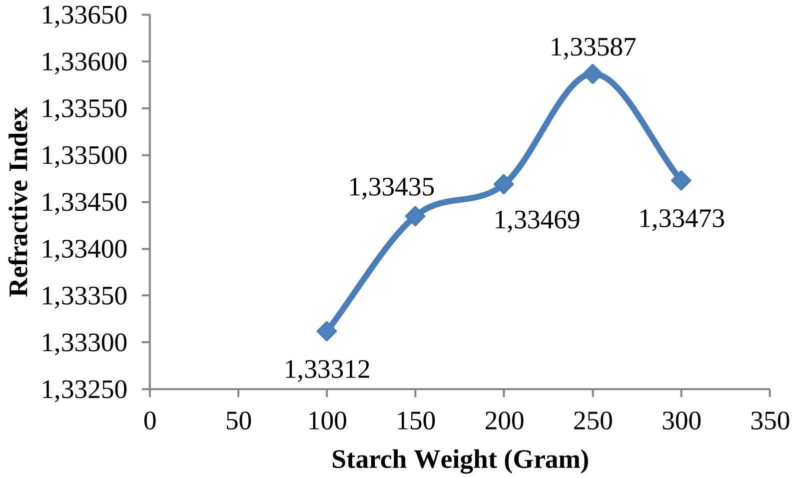

Figure 5. Influence Curve of Starch Weight Variation against the Bioethanol Refractive Index

In Figure 5, the highest refractive index value obtained is 1.33587 with bioethanol content in gas chromatography analysis of 8.4432%, where the use of plantain (Musa Sapientum) Turber starch is 250 grams. In the picture above, it can also be seen, the value of the refractive index of bioethanol has increased in 250 grams of banana Turber starch, and has decreased at 300 grams of starch used. This is directly proportional to the levels of bioethanol obtained using gas chromatography.

3.4 Effect of Starch Weight Variations on Bioethanol Levels

In the hydrolysis process, sulfuric acid acts as a catalyst which will help accelerate the conversion of banana Turber starch to bioethanol so that later glucose is obtained with good levels which are then fermented using baker's yeast. The sulfuric acid used in the study was 0.5 N with a hydrolysis temperature of 800C for 60 minutes with a variable starch weight of 100 grams, 150 grams, 200 grams, 250 grams and 300 grams.

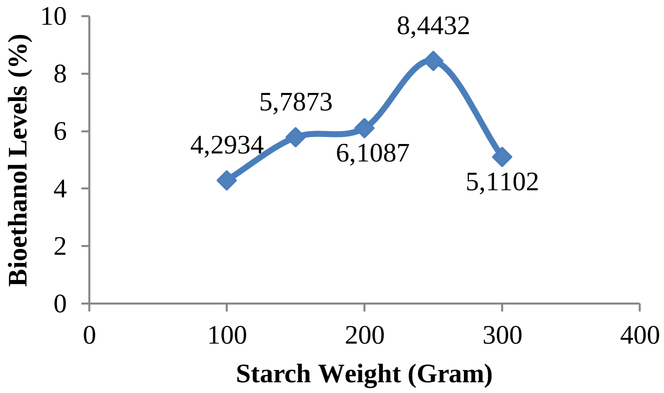

Figure 6. Influence Curve of Starch Weight Variation against Bioethanol Levels

On the curve, it was found that at 100 grams of starch weight, the bioethanol content formed was 4.2934% and increased in the next sample, namely the use of starch of 150 grams and 200 grams, namely 5 levels of bioethanol, respectively. 7873% and 6.1087%. The highest bioethanol content which can be seen from the curve above is the use of 250 grams of starch with a bioethanol content of 8.4432%. Then in the use of 300 grams of starch, the bioethanol content decreased, namely by 5.1102%. It can be analyzed that the sulfuric acid which converts banana Turber starch will only be optimal when using 250 grams of plantain (Musa Sapientum) Turber starch, or if the new use of sulfuric acid solution is used into each sample during the hydrolysis process it will be very influential in conversion of starch to glucose.

4. CONCLUSION

Utilization of banana turber waste (Musa Spientum) has great potential as a source of starch in the manufacture of bioethanol, so that it can increase the use value of the banana weevil itself. In this study, the optimum results were obtained to produce good bioethanol levels, namely at 250 grams of starch weight because in the conditions the addition of starch produced 18.8 mL of bioethanol with the largest bioethanol content, namely 8.4432%, pH of 7.46 and refractive index. amounting to 1.33587.

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