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Preparation of Bioethanol from Pineapple Peel (ananas comosus L. Mer) Waste with the Addition of Hydrochloric Acid and Citric Acid Catalysts

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Abstract: Bioethanol is ethanol derived from biological sources. Bioethanol can be produced from plants that contain many starch and cellulose compounds using the help of yeast activity. One of them is pineapple peel which can add a variety of basic materials for bioethanol production which is economical and easy to obtain. This study aims to analyze the effect of acid hydrolysis on glucose content, analyze the effect of fermentation time and the effect of yeast weight on bioethanol characteristics. This research has been done before and only focused on one catalyst. What has never been done is comparing the two catalysts. The research was conducted using hydrolysis fermentation and distillation using hydrochloric acid and citric acid catalysts with yeast weight variation of 12, 15, and 17 grams, fermentation time variation of 2, 3, 4, and 5 days. In this research, glucose test, density analysis, yield analysis, and GC-MS were conducted. The results of this study showed that the best results in the treatment of hydrochloric acid catalyst at a yeast weight of 15 grams, and obtained glucose levels of 6.90% for hydrochloric acid and 5.10% for citric acid, density test obtained the highest results at a yeast weight of 15 grams 4 days 0.8288 gr / ml for hydrochloric acid catalyst and the lowest density obtained at a yeast weight of 17 grams 5 days 0, 8168 gr/ml, yield analysis obtained at the amount of 15 grams of yeast with a fermentation time of 14 days of 4.3536% in the treatment of hydrochloric acid catalyst and 3.8557% in the treatment of citric acid catalyst fermentation time of 3 days, GC-MS test showed that ethanol contained in the test sample.

Keywords: Bioethanol; Cytric Acid; Density; Hydrochloric Acid; Yield

1. Introduction

The need1and consumption of the community1for petroleum fuel (BBM) which is increasing is inversely proportional to its availability. in various countries in the world in recent years1has experienced a sharp increase1because BBM has become a1vital necessity for humans. Most1technology or even almost all1transportation tools use1petroleum fuel as a source1ofenergy. Not only in developed countries, but also in developing countries such as Indonesia. However, the fuel used today is increasingly scarce. This is because the quantity of petroleum continues to deplete as a result of continuous exploitation and its non-renewable nature. The process of petroleum formation takes a long time which results in the oil crisis and soaring prices.

To reduce the use of fuel in the future, new and renewable energy sources that are environmentally friendly have been developed so far. Renewable energy is energy that can be renewed and will never run out if managed properly. Types of renewable energy include biomass, water energy, wind energy, ocean energy, solar energy and geothermal energy.

Bioethanol is ethanol derived from biomass or biological sources, such as corn, straw, arrowroot, sap, sorghum, sugar cane, cassava, sweet potato, and wood. The raw materials for making bioethanol consist of materials containing carbohydrates, glucose and cellulose. However, the use of large amounts of raw materials can interfere with food needs because materials containing carbohydrates, glucose, and cellulose are mostly food ingredients. Therefore, there must be other more effective and efficient raw materials that do not function as food ingredients alone, one of which is pineapple peel[1].

As production increases, so does the waste obtained. Currently, the utilization of pineapple peel waste has not been optimally used. Pineapple peel waste is generally used as feed material for livestock. To increase the economic value of pineapple peel waste, it can be utilized as raw material for making ethanol by fermentation method using yeast and purification by distillation. Consuming pineapple fruit can produce pineapple peel waste of 34.61% by weight, which contains carbohydrate content of about 10.54%. From research on ethanol production with pineapple peel juice, it is known that the glucose content of pineapple peel juice is 17%[2].

In the previous writing by[3]entitled “Making Bioethanol Using Pineapple Peel Waste” this research was more focused on the use of one catalyst. This research has been done before and only focuses on one catalyst. What has never been done is to compare the two catalysts.

2. Materials and Methods

Materials and tools needed in this research include pineapple peel, hydrochloric acid, citric acid, yeast (saccharomyces cerevisiae), distilled water, NPK, urea, blender, hotplate, Erlenmeyer, beaker glass, measuring flask, measuring cup, filter paper, thermometer, aluminum foil, analytical balance, stirrer, three neck flask, condenser, pycnometer, knife.

The process of making bioethanol consists of smoothing pineapple skin using a blender, pineapple skin that has been mashed in hydrolysis with hydrochloric acid and citric acid, making fermentation strater and fermentation, then the distillation process. The variables in this study are variations in the ratio of catalysts in the form of hydrochloric acid and citric acid with fermentation times of 2, 3, 4 and 5 days and yeast weights of 12, 15 and 17 grams. The analysis carried out is density test, yield analysis, and GC-MS (Gas Chromatography) test.

In the process of refining pineapple peel using a blender, then pineapple peel pulp is hydrolyzed using acid1chloride catalyst and citric acid with a concentration of 0.3 N with a temperature of 80°C for 2 hours, then fermented using1stater with variations in yeast weight 12%, 15%, and 17% and fermentation time of 2, 3, 4, and 5 days. Next, the distillation process was carried out at a temperature of 80°C for 2 hours.

3. Results and Discussion

3.1. Effect of different catalysts on the glucose content

The effect of different catalysts on the glucose content1 produced can be seen in Figure 1 as follows.

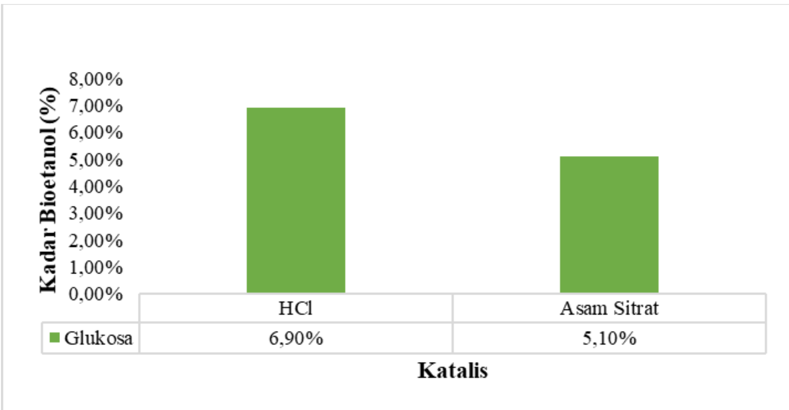


Figure 1. Effect of Different Catalysts on Glucose Content

Based on Figure 1, it is known that the process of hydrolysis of pineapple peel using acid catalyst variations, namely hydrochloric acid and citric acid at a constant hydrolysis temperature of 80ºC, it can be seen in the figure above that the manufacture of bioethanol with hydrochloric acid catalyst from pineapple peel material is the best, where during the hydrolysis process, the highest glucose content is obtained compared to citric acid catalyst, namely with hydrochloric acid catalyst of 6.90% while citric acid is 5.10%, which means that this hydrochloric acid catalyst is a type of strong acid that is more reactive in hydrolyzing the pineapple peel pulp content into glucose.

Where the hydrolysis process itself is a process of breaking polysaccharides in lignocellulosic biomass, namely cellulose and hemicellulose into constituent sugar monomers. Hydrochloric acid is also a strong oxidizing agent. In addition, the hydrolysis process using hydrochloric acid catalyst produces greater levels of furfural than citric acid catalyst, this can occur because hydrochloric acid has more H+ ions than citric acid so that bond breaking into monomers takes place better. Therefore, in this study, it was found that the highest glucose content was produced by hydrochloric acid which is a strong acid. Therefore, if the level of glucose produced is high, it will affect the ethanol content, so that the level of bioethanol obtained is also greater.

3.2. Bioethanol Density Analysis

The effect of yeast weight and fermnetation time on the density of biethanol produced at various variations of acid catalysts can be seen in Figure 2 and 3.

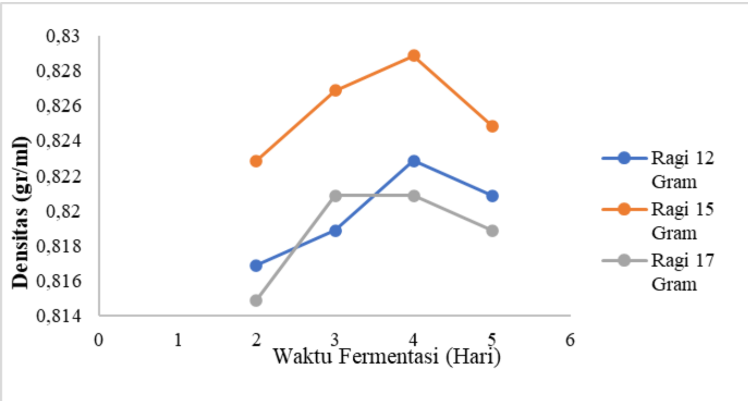


Figure 2. Effect of Yeast Weight and Fermentation Time on Density of Hydrochloric Acid Catalyzed Biethanol

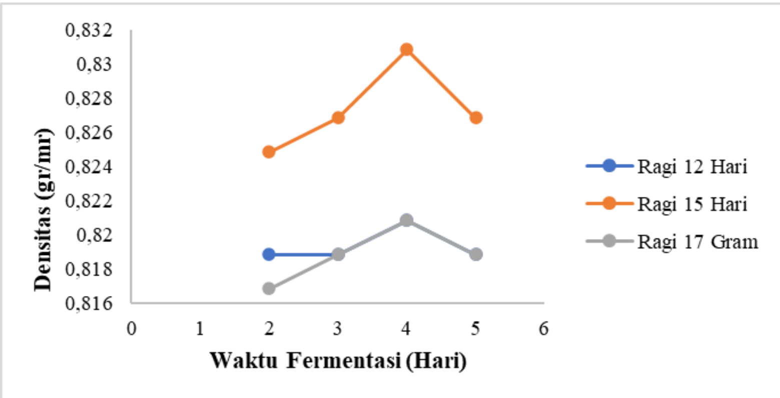


Figure 3. Effect of Yeast Weight and Fermentation Time on Density of Citric Acid Catalyzed Biethanol

Density value is the mass of asubstance in each unitof volume. The higherthe density ofan object, the greater the mass perunit volume. From Figure 2 dan 3 above, it can be seen that the highest density levels are found in Figure 2, namely in hydrochloric acid catalysts where the density levels continue to increase compared to citric acid catalysts, in the highest hydrochloric acid catalyst obtained1at the amount1of yeastusage1 of 15 grams with a fermentationtime1 of 4 days, namely 0.8288 gr / ml. The results of this study have different densities on changes in fermentation time, the longer the fermentation time, the greater the density[4].

The highest density was found in the treatment of hydrochloric acid catalyst at a yeast weight of 15 grams and fermentation time of 4 days, namely 0.8288 gr/mol. While the lowest density was found in the treatment of citric acid catalyst 0.8168 at 17 grams of yeast weight and fermentation time of 5 days. The more the amount1of yeast given and the longer fermentationtime then the density1of bioethanol obtained1is also greater, this shows that the amount of yeast1and fermentationtime1 at the time of fermentation is very influential1on the density1of bioethanol produced where in this condition the bacteria1more actively working to convert1glucose1into bioethanol [4].

3.3. Bioethanol Yield Analysis

The effect of yeast weight and fermentation time on bioethanol yield can be seen in1Figure 4 and 5.

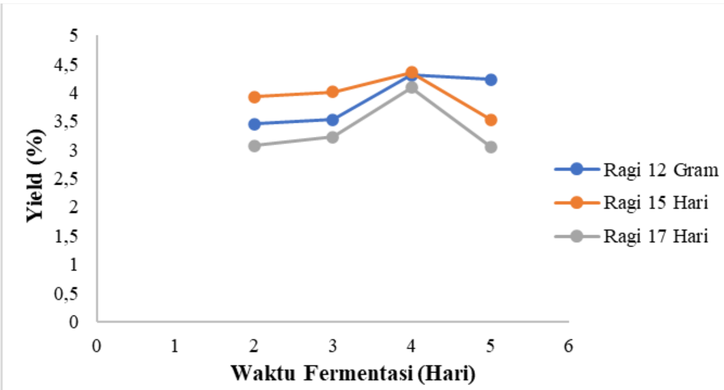


Figure 4. Effect of Yeast Weight and Fermentation Time on Yield of Hydrochloric Acid Catalyzed Biethanol

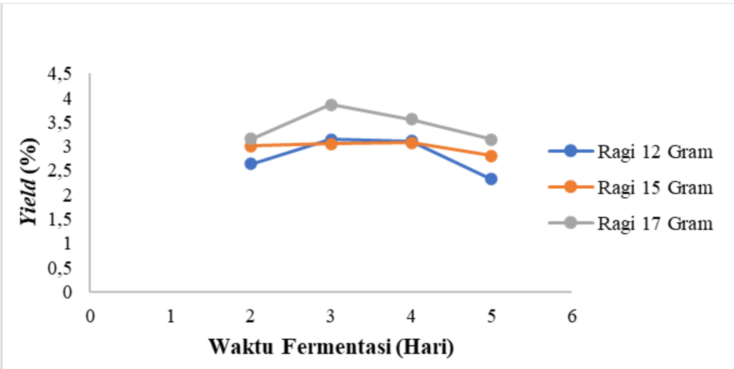


Figure 5. Effect of Yeast Weight and Fermentation Time on Yield of Citric Acid Catalyzed Biethanol

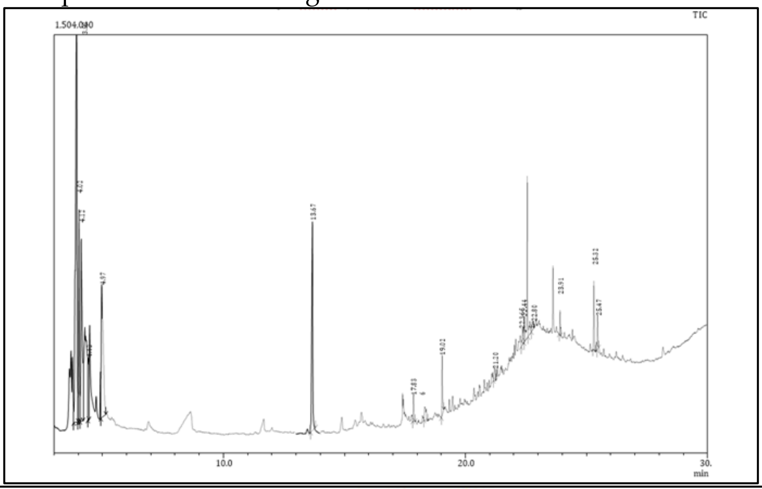
Fermentation time1and yeast weight affect the yield of biethanol, the yield increases1with the length of fermentation time. According to[5], the higher theamount of yeast and the longerthe fermentation, the higherthe yeast yeast contained in the material. This means that the greater the amount of starch hydrolyzed1into glucose, and yeast yeasts1that break down glucose1into alcohol are more1in number, due to the longer fermentationtime1so that the resulting alcohol1content is higher.

It can be seen from Figures 4 and 5 that the highest bioethanol yield was obtained at the amountof 15 grams of yeast with fermentationtime of 4 days by 4.3536% in the treatment of hydrochloric acid catalyst and 3.8557% in the treatment of citric acid catalyst fermentation time of 3 days. In this study showedthe optimal effect of yeast at the amount of yeast 15 grams where the greater the amount of yeast given and the longer the fermentation time then the bioethanol yield obtained1the greater, This is because the amountof yeast and fermentation time at the time of fermentation is very influential on the amount of bioethanol yield obtained, but in the treatment addition of 17 grams Saccaromyces cerevisiae and fermentation time 5 days obtained lower bioethanol yield in comparison with the addition of 12 grams Saccaromyces cerevisiae.

This is because the amount of nutrients available is not proportional1to the amount of Saccharomyces cerevisiae which is more, so1Saccharomyces cerevisiae lacks food1which results in the bioethanol yield produced will also decrease.

3.4. Content Analysis

This analysis is a qualitative1and quantitative analysis that can be used to determine the type of content contained in bioethanol and its quantity. Bioethanol that has been analyzed by GC-MS shows two dominant peaks as shown in Figure 6.



Peak Report TIC							
Peak#	R.Time	Area	Area%	Height	Height%	A/H	Name
1	3.925	6114705	34.16	1393135	25.87	4.39	Ethanol (CAS)
2	4.029	1521261	8.50	762925	14.17	1.99	Acetic acid
3	4.124	2563125	14.32	656010	12.18	3.91	Silanediol, dimethyl-
4	4.420	574323	3.21	219849	4.08	2.61	2-Propanone, 1-hydroxy- (CAS) Acetol
5	4.970	2219525	12.40	478963	8.89	4.63	Silanediol, dimethyl-
6	13.676	2367800	13.23	753749	13.99	3.14	Methyl-d3 1-Dideuterio-2-propenyl Ether

Figure 6. GCMS Analysis

Based on Figure 6 ethanol composition using GC-MS, shows that the first peak compound with a retention time of 3.925 the presence of ethanol content in the bioethanol test sample, the peak compound at number 2 with a retention time of 4.029 also has a sizable composition in the sample, this peak detects acetic acid content. Where the compound 2 peak in this sample is in accordance with the results of research[6] that during the fermentation process is not only produced ethanol_saja, but there are side products that formed, namely acetic acid and formic acid. Based on the results of GC-MS test analysis, it shows that pineapple peel is able to produce bioethanol.

4. Conclusions

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References

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[2] Author 1, A.; Author 2, B. Title of the chapter. In *Book Title*, 2nd ed.; Editor 1, A., Editor 2, B., Eds.; Publisher: Publisher Location, Country, 2007; Volume 3, pp. 154–196.
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