Bioethanol Production from Mixture of Banana and Durian Peels

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Abstract

Bioethanol is ethanol produced by digesting sugar from carbohydrate sources with the assistance of microorganisms. This study was divided into four stages: durian and banana peel pre-treatment, hydrolysis, fermentation, and distillation. Banana and durian peels were mixed with a blender to make flour, then dignified with 1% NaOH and heated in an autoclave for 30 minutes at 120^oC before being cooled and stored. The pre-treatment results were mixed in an Erlenmeyer, then 1% H_2SO_4 sulfuric acid was added and heated in an autoclave for 45 minutes at 120^oC for the hydrolysis stage. At the fermentation stage, 30 g of cultured yeast (Saccharomyces cerevisiae) and nutrients were added to a hydrolyzed mixture of banana skin pulp and durian peel, which was then fermented for 6 days. The fermented solution is placed in the distillation flask during the distillation stage. The temperature is kept between 70 and 80 degrees Celsius. The distillation process took 1.5-2 hours until the ethanol ceased leaking, after which the distillate findings were measured. The variable ratio of banana peel : durian peel was 100:0 yielding the most significant results in this trial, with an ethanol production of 0.01485%.

Keywords: *Bioethanol, fermentation, durian peel, banana peel, yeast*

1. Introduction

The demand for fuel oil has grown in tandem with the Indonesian people's increasing population and technical sophistication. Fuel is derived from natural exploration that cannot be repeated, making it a highly uncommon substance to be found in the future. Fuel will become challenging to get in some locations due to increased use, according to the Directorate General of the Ministry of Energy and Mineral Resources, Republic of Indonesia. There is expected to be an increase of around 69,310 kiloliters per day in 2011.

Through Presidential Regulation No. 5 of 2006, the government enacted regulations on national energy policy for the development of alternative energy sources to replace fossil fuels (Priyandana, 2007). According to the rule, biofuel can be made from natural resources such as vegetable materials as an alternative biofuel to replace fuel oil. Domestic fuel requirements can and will always be met if renewable natural resources are used.

One of the byproducts of processing natural vegetable resources is bioethanol, which can be utilized as an alternative fuel. Bioethanol is produced by fermenting natural vegetable resources that contain cellulose. Bioethanol was initially used as a fuel in 1908 when tested on a Ford Model T automobile. However, because fuel oil was still plentiful and cheap, the public was not interested in bioethanol fuel.

Vegetable natural resources are abundant in Indonesia and have the potential to be exploited as raw materials in the production of bioethanol. Bioethanol can be made from glucose-containing starchy materials such as cassava, sugar cane, water hyacinth, sweet potato, and others. Aside from food waste, plant waste such as banana peels, pineapple peels, durian peels, cassava peels, and others containing cellulose can be used in bioethanol manufacturing. Compared to fossil fuels, bioethanol fuel does not pollute the environment.

Bananas and durian peels are fruit waste commonly seen in landfills and other dump sites. When the season arrives, there will be a plethora of durian fruit. Durian skin waste will also be generated in large quantities. Peels from fruits like durian and bananas are often thrown away, contributing to environmental contamination that can make areas unhealthy and unsightly. Durian skin is composed of 50-60% cellulose, 5-5% lignin, and 5-5% starch. While durian fiber is composed of 60–65% cellulose, 6-8% hemicellulose, and 5–10% lignin, banana skin waste fibers are much finer.

The cellulose content of the two fruit peel wastes can be converted into glucose as a raw material for bioethanol production. As a result, the authors are interested in undertaking research using durian and banana peel waste to make bioethanol a renewable energy source and to assist the development of the Indonesian bioethanol sector. This research aimed to evaluate the proportion of ethanol produced from a mixture of durian peel and banana peel trash.

2. Materials and Method

The experimental approach was used to establish the extent to which the effect of the modified composition in its treatment of ethanol was produced through the fermentation process of banana peels and durian peels. This investigation carried out several phases, including 1) initial preparation for the treatment of banana peels and durian peels; 2) hydrolysis; 3) fermentation; and 4) ethanol content determination.

Banana and durian peels are employed as lignocellulosic sources, NaOH and H_2SO_4 are used as hydrolyzers, sugar is used as a nutrient, and *Saccharomyces cerevisiae* is a fermenting fungus that will generate bioethanol. The investigation used 500 mL Erlenmeyer, measuring cups, 500 mL beakers, analytical balances, and rotary shakers. Fermentation containers (Erlenmeyer) and autoclave heaters were the primary equipment used in this study. At the same time, the bioethanol solution is purified with a distillation machine.

2.1 Variable

a) Comparison of banana peels and durian peels (g)
   Sample 1 = 0:100
   Sample 2 = 25:75
   Sample 3 = 50:50
   Sample 4 = 75:25
   Sample 5 = 100:0
b) Yeast = 30 g
c) Fermentation time = 6 days

The raw materials for banana peels and durian peels are pre-treated in the early stages of the bioethanol production process, followed by hydrolysis, fermentation, purification (distillation), and ultimately the measurement of ethanol concentration.

2.2 Pre-treatment of Banana and Durian Peel

Banana peels and durian skins are cleaned and cut into little pieces after being washed. After that, the banana and durian peels are dried in an oven at 80°C for 24 hours. To make it smaller, banana peels and dried durian peels are combined. This preliminary therapy tries to increase contact for the subsequent procedure.

Delignification is the process of preparing banana and durian peels for hydrolysis. The goal of this delignification is to convert hydrocellulose into cellulose. 100 g of banana and durian peels mixed with 1000 ml of 1% NaOH solution. The samples were cooked in an autoclave for 30 minutes at 120^{o}C before being cooled, and the banana and durian peels were stored. To make 1% NaOH, use the following equation.

$$V1 \text{ x } M1 = V2 \text{ x } M2$$
$$V1 \text{ x } 0.6 = 0{,}01 \text{ x } 1000$$
$$V1 = 16.67 \text{ ml}$$

so that as much as 16.67 ml of NaOH (60%) was mixed with 983.33 ml of distilled water.

2.3 Hidrolysis

After the raw materials have been pre-treated, the hydrolysis process begins. At this point, the cellulose will be converted to glucose using an acid and water solution. 500 ml of 1% H_2SO_4 was combined with delignified banana and durian peels. The mixture was heated in an autoclave for 45 minutes at 121^{o}C. The hydrolysis product is filtered, and the waste is eliminated. To create 1% H_2SO_4 using the equation.

$$V1 \text{ x } M1 = V2 \text{ x } M2$$
$$V1 \text{ x } 0.98 = 0{,}01 \text{ x } 500$$
$$V1 = 5.1 \text{ ml}$$

so that as much as 5.1 ml of sulfuric acid (98%) is mixed with 494.9 ml of distilled water.

2.4 Fermentation

Fermentation was completed in 6 days using *Saccharomyces cerevisiae* and 30 g of yeast weight. The Erlemeyer was sterilized in a 120^{o}C autoclave for 15 minutes. As a fermenter, an

Erlemeyer is utilized. 500 ml of banana and durian peels are placed in the fermenter, along with 30 grams of yeast and 5 grams of sugar as a nutrient. The mixture's pH is between 4 and 5, fermented for 6 days with 30 g of yeast.

2.5 Distillation

The purification stage is the isolation of bioethanol generated from starting media fermentation. The distillation unit consists of a series of tools, and the fermented product is placed in a spherical distillation flask. The distillation flask is then heated on a hotplate (electric heater). The temperature is kept constant at 80^oC and heated for 1.5 to 2 hours. The distillate (ethanol) purified product is then weighed and kept in a closed container.

2.6 Ethanol Content Analysis

The distillate produced during the distillation process is a combination of ethanol. The samples were then examined using gas chromatography. Each peak in the chromatogram from the results of gas chromatography tests on the sample has a specific resistance time.

3. Results and Discussion

3.1 Ethanol Content

The ethanol concentration was determined using a set of gas chromatography techniques. The test is performed by preparing a gas chromatograph and injecting the sample and standard solutions. The ethanol peak was measured using the chromatogram results (Table 1).

Table 1. Ethanol Content

No	Mixed Amount of Durian and Banana Peel	Banana peel waste (g)	Durian skin waste (g)	Yeast (g)	Fermentation time (days)	Volume (ml)	Ethanol Content
1	100 g	0	100	30	6	3.5	0.00045
2	100 g	25	75	30	6	6.2	0.00016
3	100 g	50	50	30	6	2.6	0.00071
4	100 g	75	25	30	6	14.4	0.00106
5	100 g	100	0	30	6	2.4	0.01485

The test results obtained by gas chromatography are shown in Figure 1. If sorted from the highest to the lowest, the highest ethanol yield is obtained from a mixture of 100% banana peel and 0% durian peel, 0.01485%. This is due to the cellulose content on banana peels being higher. The ethanol yield of a mixture of 75% durian peels and 25% banana peels is 0.00106%, the ethanol yield of a combination of 50% banana peels and 50% durian peels is 0.00071%, the ethanol yield of a mixture of 0% banana peels and 100% durian peel is 0.00045%, and the lowest is the yield of ethanol mixed with 25% banana peel and 75% durian peel is 0.00016% because durian peel waste contains less cellulose with more mixed composition than the banana peel composition causing the ethanol content produced by a mixture of 100% durian skin will be less.

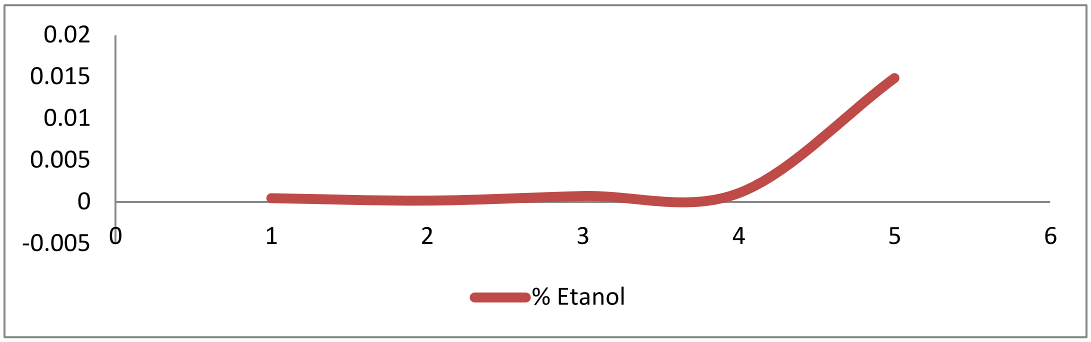

Figure 1. Ethanol Content in Different Fermentation Times

Due to the higher cellulose content in banana peels, the ethanol content achieved from a mixture of 100% banana peels and 0% durian peels reached the most significant values in this investigation. In this experiment, the ethanol concentration increased after 30 grams of yeast were added. Because yeast (yeast) is added, the rate at which glucose is converted into ethanol by microorganisms and results in increased CO2 production increases as well.

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$

Glucose (*Saccharomyces Cerevisiae*) Ethanol

The amount of alcohol produced was significantly impacted by the fermentation time utilized in this investigation (6 days). The reaction to form ethanol can be seen from the following reaction.

$$(C_{12}H_20O_{10})\ n \rightarrow n\ (C_{12}H_{22}O_{11})$$

Starch Maltose

$$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

Maltose Water Glucose Glucose

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$

Glucose (*Saccharomyces Cerevisiae*) Ehtanol

4. Conclusion

Based on the discussion, it can be concluded that:

1) Because the cellulose content of banana peels is more significant than that of durian peels, unmixed banana peel waste produces a higher ethanol content of 0.01485%.
2) Bioethanol produced from a mixture of banana peels and durian peels after a 6-day fermentation period and the addition of 30 grams of yeast has a low ethanol level.
3) Bioethanol produced from 100 g durian peels is 0.00045%, a mixture of 25 g banana peels

and 75 g durian peels is 0.00016%, a mixture of 50 g banana peels and 50 g durian peels is 0.00071%, a mixture of banana peels 75 g, and 25 g durian peel is 0.00106%, and 100 g banana peel is 0.01485%.

It is important to do additional research with modifications in fermentation duration more than once. Furthermore, further research with alterations in the amount of yeast or yeast used is required.

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