

Analysis and Characterization of Bioethanol From Banana (*Musa Acuminata Balbisiana*) Peel Pulp By Yeast Enzymatic Production

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Abstract

Banana (*Musa acuminata balbisiana*) peel had some potential using, especially in bioethanol. It was indicated that Banana peel (*Musa acuminata balbisiana*) had carbohydrates abundance. Banana (*Musa acuminata balbisiana*) peel can be cropped in some season, not only in a specific seasons. So that, Banana (*Musa acuminata balbisiana*) peel could be gotten easily. Banana (*Musa acuminata balbisiana*) peel as the trash is usually thrown away or animal feed needed. Banana (*Musa acuminata balbisiana*) peel had carbohydrate higher content, so it gave a lot of potential in bioethanol application. But, we needed to understand about the results of fermentation process. Characterization had been done to understand the fermentation of Banana peel product. The raw materials gotten from dried Banana peel with the amount of 50 gram in each of 100 ml beaker glass. The yeast solution had been made in 15% (w/v), 25% (w/v), and 35% (w/v) in water solvent. The fermentation process was carried out during 96 hours, then the clear liquid was separated by decantation process from the mixture. The distillation process was done to purify the product on 80 °C. The distillate was measured by Fourier Transform Infrared (FTIR) spectroscopy to identify the specific peaks. The FTIR measurement was used Octagonal Cell Windows FTIR Prestige 21 Shimadzu. The FTIR spectrum showed characteristic peaks of bioethanol at 3404.01 cm⁻¹ (-OH bonds); 2933.54 cm⁻¹ (-C-H bonds); and 1011.06 cm⁻¹ (-C-O bonds). From the FTIR analysis could be concluded that fermentation of Banana peel gave bioethanol

Keywords: Bioethanol, Banana peel, yeast, fermentation process, Biocatalyst

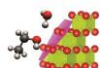
1 Introduction

Bioethanol had been known as alternative fuel beside of crude oil application [1,2]. Bioethanol gave more advantages in energy efficiency or its raw material. Bioethanol could be obtained from mono glucose or carbohydrates hydrolysis steps reaction [3–5]. Banana (*Musa acuminata balbisiana*) peel was thrown away or animal food using. High carbohydrate composition could had been any advantages as bioethanol resources [6,7].

Bioethanol synthesis process had be developed to give optimize product in quality and quantity by various methods. The optimizing of bioethanol synthesis process can be done by the raw material and hydrolysis mechanism reaction. Hydrolysis reaction of glucose was done by using kind of catalysis to improve its product. The acid-base catalyst such as H₂SO₄, ClSO₃H, NaOH

could be used to hydrolyze carbohydrates, but it had any lack of in separation of its product [8–10].

Biocatalysts was familiar in some reaction. Enzyme was used as biocatalysis had regioselective in the reaction mechanism and did not need extrem condition ih high temperature and pressure, especially for glucose hydrolysis [11–14]. Biocatalysts effectivity was be solution to separate product from the reactant in reaction mixture, but it had any weakness in reusability, unstable in pH and temperature changing, also not economical [15]. The main problem to obtain bioethanol is purify it from its mixture from reactant, it can be solved by immobilization and impregnation [16, 17]. There were some methods to increase reusability of enzyme, but there was not economically especially need chemical matrix or impregnation media.



Yeast (*Saccharomyces cerevisiae*) could be gotten easily, it obtained hydrolysis enzyme to convert carbohydrate to bioethanol in water solvent effectively [18, 19]. In this research, Banana peel pulp was fermented by yeast solution. The product was analyzed by using Octagonal Cell Windows FTIR Prestige 21 Shimadzu. Novelty of this research was about synthesis bioethanol in Banana (*Musa acuminata balbisiana*) peel pulp.

2 Materials and Methods

2.1. Materials

Banana peel (*Musa acuminata balbisiana*) was gotten from Suruh village, Salatiga region. Commercial yeast (*Saccharomyces cerevisiae*) and water. The apparatuses were used seems like 100 ml Erlenmeyer, magnetic stirrer, Erlenmeyer, distillation set, and Octagonal Cell Windows FTIR Prestige 21 Shimadzu.

2.2. Methods

Banana pulp peel Preparation

Banana (*Musa acuminata balbisiana*) pulp peel were made by grinding. The amount of 50 gram Banana peel pulp were put on each of three 250 mL beaker glass.

Yeast Solution Preparation

Yeast solution were done by various concentration of yeast are 15% (w/v), 25% (w/v), and 35% in water solvent.

Fermentation Process

Fermentation was done by blending 15% (w/v), 25% (w/v), and 35% (w/v) banana pulp peel in water solvent. The mixture was homogenized by stirring then keep on room temperature for 96 hours.

Purification

After 96 hours, the clear liquid have been separated from the mixture of banana pulp peel and it solvent by using filtration process. The clear liquid filtrate obtained was separated by distillation process at 78 °C. The distillates were characterized by Fourier Transform Infrared (FTIR) spectroscopy.

FTIR Characterization

The distillates were characterized by Octagonal form Cell Windows FTIR Prestige 21

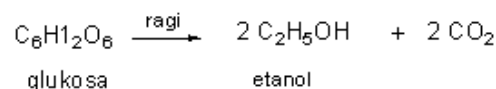
Shimadzu to understand some specific peaks for bioethanol structure.

3 Result and Discussion

The fermentation process was a monoglucose hydrolysis reaction to Ethanol (C₂H₅OH) synthesis [5], [18], [20]. Banana (*Musa acuminata balbisiana*) peel had a carbohydrates content of 1-20 g/ 100 g as glucose resources, thus bioethanol producing [21,22].

Yeast (*Saccharomyces cerevisiae*) solution was made by dissolving yeast in various concentrations of 10% (w/v), 20% (w/v), and 30% (w/v) in water solvent to understand physically that by various concentrations bioethanol could be made [23]. This study used Banana (*Musa acuminata balbisiana*) peel pulp porridge. the purpose of which is to do cellular destruction to obtain maximum carbohydrates [15].

Banana (*Musa acuminata balbisiana*) peel pulp porridge was fermented for 96 hours at degree room temperature. Fermentation process was done in two steps, carbohydrates hydrolysis to glucose and glucose hydrolysis to ethanol was presented as shown below:



The clear liquid with ethanol aromatic specific was obtained from Banana (*Musa acuminata balbisiana*) peel pulp in yeast solution mixture fermentation process. The distillation process had been done to purify ethanol from water content at 80 °C. Distillat was characterized by using Octagonal form Cell Windows FTIR Prestige 21 Shimadzu. The FTIR spectrum of distillat was presentaed in Figure 1.

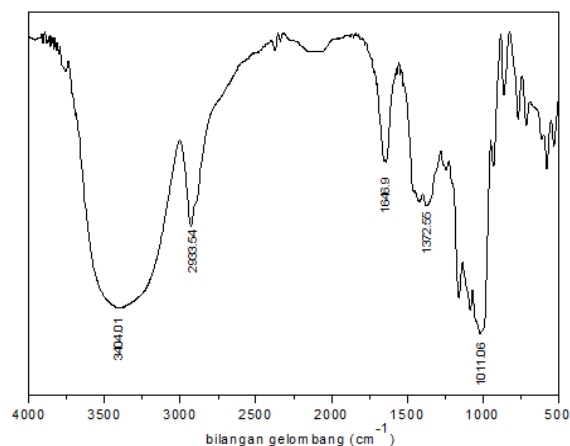


Figure 1. FTIR spectrum of Banana peel pulp fermentation distillat

The successfully of fermentation process of Banana (*Musa acuminata balbisiana*) peel pulp was indentified by FTIR spectrum. The FTIR spectra showed specific peaks of ethanol in range 500-4000 cm^{-1} . The ethanol spectra were showed in waves number of 3404.01 cm^{-1} corresponded to streching vibration of hydroxyl bonds (-OH), the peaks of wavenumbers of 2933.54 cm^{-1} towards to the streching vibration of -CH bonds for CH_3 and CH_2 region, and the peaks of wavenumbers of 1011.06 cm^{-1} toward to -CO bonds in alcohol structure [24,25].

The FTIR spectra hepled to make sure about bioethanol liquid from Banana (*Musa acuminata balbisiana*) peel pulp. The structure of ethanol as for as bioethanol was very important to identify rather than scent test. By understanding about bioethanol potentially in Banana (*Musa acuminata balbisiana*) peel pulp, so it can be explored to use as alternative energy resources. Yeast was kind of enzyme sources for hydrolitic reaction and can be gotten economically. Yeast powder was solved in water to optimize the amount of enzyme-bond water [26]. Water solvent can help to open the lid of enzyme, so the active center could activate.

4 Conclusion

In this study, bioethanol could be obtained from the fermentation of Banana (*Musa acuminata balbisiana*) peel pulp in various concentration. The structure of bioethanol was confirmed by FTIR spectrophotometer measurements to identify some specific peaks of ethanol as a bioethanol.

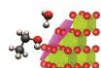
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