Making of bioethanol banana weevil as renewable energy

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Abstract. In Indonesia where population is increasing significantly each year, managing the usage of fuels and searching biofuels alternative is an important thing to study. Banana is abundant in every region which resulted in waste. The fermentation of banana pseudo stem to bioethanol is interesting to proceed in mass production. S. cereviceae is used as a yeast and the ethanol content was estimated from samples by using gas chromatography. The results shown that all types of banana can be utilized to produce bioethanol. Based on three types of banana used in this study, uter banana produces more bioethanol and higher level percentage than becici and kapok bananas. The longer the fermentation process, the higher the bioethanol content.

Keywords: bioethanol, banana, renewable, energy.

1. Introduction

Global warming is one of the world's problems that up to now this cannot be solved yet. The reason is the increasing amount of carbon dioxide gas in Earth's atmosphere due to several things, such as massive deforestation, low human awareness for planting trees, burning garbage, and increasing the use of fossil fuels. Current use of fossil fuels is still a priority for all needs of human beings, including for industrial activities, power plants and fuel transportation vehicles.

Ethanol has been known as a possible alternative to partially replace fossil fuels in transportation sector [1]–[5]. However, ethanol is generally made chemically, but this method is less environmental friendly. Therefore, ethanol needs to be produced using the help of microorganisms through the fermentation process. Fermented ethanol uses microorganisms known as bioethanol. Bioethanol can be prepared by fermentation of ingredients starch or sugar. Ethanol is an organic compound consists of carbon, hydrogen and oxygen, so it can be seen as a compound derivative hydrocarbons having hydroxyl groups of formula C2H5OH.

Banana (Musa acuminate), a monocotyledonous annual herbaceous plant, is one of the main crops in Indonesia that could be used for bioethanol production [1]–[5]. Banana plant produces a bunch of fruits once in its life cycle, generating large amount of lignocellulose residues. In fact, for each t of banana produced, 2.13 t of fresh lignocellulose residue (pseudo stem, leaves and peels) is generated [6]. Normally, this waste is frequently thrown away into the environment without any treatment causing environmental problems such as the spread of diseases or polluting groundwater [7]. There is still little research about the potency of banana peels [5] and banana pseudo stem as the source of bioethanol [4], [8].
The fermentation process uses a microorganism capable of producing alcohol. Commonly used microorganism is Saccharomyces cerevisiae. One of the inoculums or starter containing S. cerevisiae microorganism known as yeast tablet. Yeast tablet is used to make various kinds of fermented foods such as glutinous tape or cassava, tempeh, and liquid or solid brem. Yeast tape is a slightly flat, dry, white, mid-about 2.5 cm with a thickness of about 0.5 cm, made from a mixture of rice flour and spices, spices. Some herbs used include garlic, pepper, galangal, chili, cinnamon, and cayenne pepper. Often a small piece of sugar cane and a little lemon juice is added. Mix several types of microorganisms on yeast tape provides an advantage in fermenting banana cobs into bioethanol. This is due to the presence of enzymes produced by other microorganisms that may help hydrolyzing starch into glucose. The fermentation process is influenced by many factors, including yeast concentration and fermentation time.

The different nutritional content of different types of bananas might produce different amounts of bioethanol. Therefore, it is necessary to do the selection about what kind of banana that could produce the optimum bioethanol. Then, the next is how to provide the best efficiency to get the optimum result in producing bioethanol.

2. Materials and Method
The first paragraph after a heading is not indented (Bodytext style). The tools used in this study are: gas stove, spatula, blender, bucket, knife, transparent hose, plastic bottle, solder, glue gun, filter, filter paper, drop pipette, analytical scales, rod stirrer, petri dish, beaker glass 250 ml and 500 ml, volumetric flash 10 ml & 100 ml, porcelain mortar and pestle, Erlenmeyer 250 ml and 500 ml, funnel conical, separatory funnel, measuring cylinder 10 ml and 100 ml, and measuring pipette 10 ml.

![Figure 1. Fermentation tool set](image)

![Figure 2. Bioethanol Production Process Flow Chart of tuber bananas](image)
The mechanism of the flow diagram as follows:

1. One type of banana pseudo stem was divided into three samples; the weight is 1 kg each.
2. Samples were washed to remove the sand, then dried.
3. The dried sample was blended until slurry.
4. The fermentation process used yeast with 0.6% concentration for three days (1st sample), six days (2nd sample), and nine days (3rd sample).
5. The yield of ethanol fermentation was still contained of sediment, therefore, filter paper was used to purify it.
6. The result was then analyzed through Gas Chromatography.

3. Materials and Method

Indonesia is the largest banana producer in Asia with more than 200 types of bananas and spread in every region. Moreover, banana can grow in all seasons along years [9]. This banana waste need to be processed to give more economical value as well as reduce environmental pollution. Fermentation of banana pseudo stem by using S. cereviceae and the ethanol content was estimated from samples by using gas chromatography.

| Type of Bananas | Fermentation Time | Raw Materials | Results |
|-----------------|-------------------|---------------|---------|
| Kepok           | 3 days            | 500 gr        | 100 ml  |
|                 | 6 days            | 500 gr        | 114 ml  |
|                 | 9 days            | 500 gr        | 122 ml  |
| Becici          | 3 days            | 500 gr        | 34 ml   |
|                 | 6 days            | 500 gr        | 48 ml   |
|                 | 9 days            | 500 gr        | 61 ml   |
| Uter            | 3 days            | 500 gr        | 5 ml    |
|                 | 6 days            | 500 gr        | 9 ml    |
|                 | 9 days            | 500 gr        | 12 l    |

The banana pseudo stem used was very easy to find and it can be processed very easily. There were nine samples, each has 0.5 kg in weight with three different type of bananas. Banana pseudo stem was cleaned and then cut into small pieces in order to make it easier to blend. Then, the pseudo stem was mashed by using blender to be slurry, and next was cooked for 30 minutes. After in a room temperature, the pseudo stem was weighed for 500 grams for each samples and mixed with yeast S. cereviceae 0.6% concentration or as much as 3 grams. Then, the samples were placed into the fermentation apparatus and closed tightly. The variation of fermentation times were 3 days, 6 days and 9 days.

According to the research that has been done, the percentage of ethanol is very small because of the sample is little as well (Table 1). Ethanol obtained from the fermentation was not clear and then be filtered by using filter paper. Next, the results were entered into the clean and empty bottle and tested in the Laboratory of Mathematics and Science Natural Sciences, Islamic University of Indonesia by using Gas Chromatography. After two days, the concentration of ethanol content from each samples have been known (Table 2). The ethanol obtained in this study is low because using the amount of raw materials is also low. It can be seen from Figure 1 that the longer the fermentation time, will give the better amount of ethanol obtained. The highest result of ethanol present on day 9 is banana uter.
Table 2. Percentage of Ethanol

| Type of Bananas | Fermentation time | Results | Ethanol   |
|-----------------|-------------------|---------|-----------|
| Kepok           | 3 days            | 100 ml  | 0.637%    |
|                 | 6 days            | 114 ml  | 0.920%    |
|                 | 9 days            | 122 ml  | 1.314%    |
| Becici          | 3 days            | 34 ml   | 0.378%    |
|                 | 6 days            | 48 ml   | 0.424%    |
|                 | 9 days            | 61 ml   | 1.071%    |
| Uter            | 3 days            | 5 ml    | 0.074%    |
|                 | 6 days            | 9 ml    | 0.104%    |
|                 | 9 days            | 12 ml   | 1.474%    |

Figure 3. Ethanol Level

4. Conclusions
In Indonesia where population is increasing significantly each year, managing the usage of fuels and searching biofuels alternative is an important thing to research. Banana is abundant every region in which resulted in waste. The fermentation of banana pseudo stem to bioethanol is interesting to proceed in mass production. According to the results and discussion above, it can be concluded that all types of banana can be utilized to bioethanol. Based on three types of banana used in this study, uter banana produces more bioethanol and higher level percentage than becici and kapok bananas. The longer the fermentation process, the higher the bioethanol level.

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