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EFFECTS OF YEAST WEIGHT AND STARTER VOLUME ON THE PERCENTAGE KEPOK BANANA BASED BIOETHANOL

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Abstract.

The low availability of energy resources is in line with the increasing human need for these resources, such as fossil fuels which are increasingly expensive because they are difficult to obtain right. Bioethanol is an environmentally friendly liquid produced from the glucose fermentation process from carbohydrate sources of natural raw materials with the help of microorganisms in baker's yeast. The focus of the research is on the waste of kepok banana peels because it has a high starch content of 18.5%. In addition, kepok banana peel waste is easy to obtain and has not been widely used by the community. This study aims to determine the effect of yeast weight and starter volume in the manufacture of bioethanol and the quality of the bioethanol produced by comparing the levels with the reference levels of bioethanol as alternative fuel. The bioethanol obtained from the starch of the kepok banana peel has gone through a fermentation process with Saccharomyces cerevisiae and refined into pure bioethanol. Based on the related literature review, it shows that the greater the weight of yeast and the volume of starter used in the manufacture of kepok banana peel bioethanol influences the yield of bioethanol content which also increases so that it affects the quality of the bioethanol produced. However, the level of bioethanol which is obtained has not reached the standard range of SNI 7390:2012 with a minimum level of bioethanol as a substitute for fuel is 94.0-95.5%. Thus, bioethanol cannot be used as a substitute for fossil fuels and further research is needed with the use of the optimum amount of yeast and starter volume and re-purification.

Keywords: bioethanol; kepok banana; fermentation; starter volume; Saccharomyces cerevisiae.

1. INTRODUCTION

The imbalance between human needs for commodities results in a scarcity of energy resources. Scarcity is a condition in which the number of commodities used to satisfy needs is not balanced with the needs that must be met [1]. The cause of the scarcity of energy sources is due to the increasing human needs. Reporting from the results of the Population Census in September 2020 on the [2] website, it was recorded that Indonesia's population was 270.20 million people, with an average population growth rate per year during 2010-2020 of 1.25%. This figure continues to increase along with the needs of the Indonesian population for energy sources so that dependence on fossil fuels must be reduced by using other energy sources as alternative materials [3].

Apart from the fact that fuel oil is a non-renewable resource, the use of low-quality fuel oil has also been shown to be the largest contributor to carbon dioxide (CO2) gas, nitrogen oxides (NO), sulfur oxides (SO) and heavy metals in the air [4]. According to a [5], more than 90% of greenhouse gases were produced by burning fossil fuels. These conditions indicate a great danger to life if society continues to depend on fossil fuels. Based on 2020 reserve data and it is assumed that there are no new oil and gas reserves, there are 4.17 billion barrels of national oil reserves with proven reserves of 2.44 billion barrels and unproven reserves of 2.44 billion barrels. Oil reserves in Indonesia are predicted to be available for the next 9.5 years [6]. This requires Indonesia to use alternative energy as a substitute for fossil energy which continues to run out. One of these alternative energies is bioethanol with kepok banana as raw material.

Bananas are native to Southeast Asia, especially Indonesia [7]. The country as the center of banana diversity, distribution and production has identified more than 300 cultivars (varieties cultivated by farmers in Indonesia), while it is predicted that there will be more than 1000 banana cultivars in Indonesia [8]. Bananas that exist today are believed to have come from natural crosses between wild bananas and domestic bananas. Bananas are very suitable and widely cultivated in Indonesia because of the tropical climate and high humus content of the soil. Currently, most of Indonesia's territory consists of banana tree planting areas. Banana planting areas in Java are West Java, namely Sukabumi, Cianjur, Bogor, and others. West Java Province is the center area with the largest banana production.

There are various types of bananas, one of which is the kepok banana. The kepok banana has the Latin name Musa paradisiaca L. The kepok banana is an annual herbaceous banana plant that has an underground root and stem system where this plant only bears fruit once (monocarpic), and then dies [9]. Kepok bananas are the most common type of fruit found, not only in urban areas but also

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in remote villages. Banana kepok grows at the optimum temperature for its growth around 27ºC-38ºC. The shape of the kepok banana is rather flat and faceted. The size of the kepok banana is not too big, the length of the fruit is 10-12 cm with 80-120 grams as the weight of the kepok banana. Kepok banana flesh is white and yellow [10]. Kepok bananas are bananas with various benefits for humans and can be consumed at any time by all ages. In addition, banana kepok can also be used as an alternative to staple food because it has a high carbohydrate content which is sufficient for the human body. The position of the kepok banana plant in the systematics (taxonomy) of plants can be seen in Table 1.

Table 1. Kepok Banana Plant Taxonomy [11]

Kingdom	*Plantae* (Plant)
Division	*Magnoliophyta* (Flowering Plant)
Classis	*Liliopsida* (Monocotyl)
Order	*Zingiberales*
Famili	*Musaceae* (Banana Tribe)
Genus	*Musa Species* : *Musa paradisiaca*

Kepok Banana has a very thick skin with a greenish yellow color and sometimes brown spots. Kepok banana peels are usually just thrown away by people and become a waste problem in nature because it increases soil acidity and pollutes the environment [12].

Bioethanol has been used by humans since prehistoric times as an ingredient in alcoholic beverages and was first made synthetically by Henry Hennel and SG Serulas in France [13]. Bioethanol is the result of ethanol production by fermenting vegetable raw materials containing carbohydrates, sugars, or cellulose that have gone through a process of reshuffling into glucose. Ethanol (ethyl alcohol) is a colorless liquid, volatile, flammable, easily soluble in water, non-carcinogenic, and has no significant impact on the environment in the event of pollution.

In the research entitled "Effects of Yeast Weight and Starter Volume on The Percentage Kepok Banana Based Bioethanol," this research specifically uses the raw material of kepok banana peel waste. Since the emergence of the problem that the supply of fossil fuels is shrinking, the use of bioethanol as a substitute for fossil fuels (fuel oil) has become a concern for various countries, especially Indonesia. Efforts to utilize renewable fuels in the form of bioethanol developed rapidly after the world oil crisis in the early 1970s [14]. In a study conducted by [15], it is explained that the use of bioethanol as an alternative fuel has a positive impact on engine performance and reduces exhaust emissions. The use of bioethanol as fuel is based on bioethanol which has an octane number, oxygen content, calorific value, volatility, and latent heat are higher than gasoline [16]. However, the use of bioethanol as fuel is still in the development stage due to several reasons such as the high cost of producing bioethanol and various rejections from local entrepreneurs [17].

At first the term fermentation was used to describe the process of converting glucose into ethanol which took place anaerobically, but now the term fermentation has developed to describe the entire overhaul of organic compounds carried out by microorganisms [18]. The fermentation process generally produces alcohol with a content of 7–15%. To increase the level of bioethanol, a distillation process is needed which will produce bioethanol with a maximum concentration of 95% and cannot be increased because of the azeotropic nature of the bioethanol-water solution [19]. Thus, the use of bioethanol can be mixed with gasoline with a certain composition, the result is known as gasohol [20]. Gasohol is an abbreviation of gasoline (gasoline) and alcohol (bioethanol), with this mixing the use of gasoline can be saved more. Gasohol stands for gasoline (gasoline) and alcohol (bioethanol), this mixing of gasoline can be further saved [21].

Based on this statement, the kepok banana peel with High carbohydrate content can be fermented with the help of microorganisms into bioethanol liquid [22]. Making bioethanol from kepok banana peels is done by mixing many ingredients and going through a long process, one of which is by adding different amounts of yeast weight and starter volume. The yeast used is baker's yeast with its microorganism, namely Saccharomyces cerevisiae because it is stable, can tolerate high alcohol levels, is resistant to high amounts of sugar so that it can produce large amounts of alcohol [23]. As for the nutrition of these microorganisms, a starter is used which is a mixture of sugar solution, urea fertilizer, Nitrogen Phosphate Potassium (NPK) fertilizer, and baker's yeast with a certain ratio, then tightly closed and stored in a dark room for 24 hours at room temperature [24]. In a study reviewed by [25] regarding the effect of the type of yeast used on the levels of bioethanol produced, it was stated that the use of baker's yeast in the bioethanol fermentation process resulted in better bioethanol levels from kepok banana peels, namely 6.1277% compared to tape yeast which only produces bioethanol content of 5.2897%.

This is because tape yeast not only contains the same yeast as bread yeast, namely Saccharomyces cerevisiae but other microorganisms so that the bioethanol yield obtained using tape yeast is not too good compared to using baker's yeast. Based on this statement, a study was conducted to analyze whether yeast weight and starter volume could affect the bioethanol content of the kepok banana peel produced or not. The final step is to determine the quality of the bioethanol by comparing the bioethanol content of the kepok banana peel to the SNI 7390:2012 standard on Denatured Bioethanol for Gasohol.

2. METHODS

The research method used is the literature study method from 40 scientific literature. Literature study is part of a research to collect research references in accordance with the research field so that it helps in identifying research theory and analyzing and interpreting data [26]. The research

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was conducted by searching various related literature published on the internet using search engines such as bioethanol synthesis, raw material for kepok bananas for bioethanol production, addition of yeast concentration and starter volume, and SNI 7390:2012. Narrative reviews are made using journals, scientific articles, and similar publications derived from databases on the network. Secondary data in the form of yeast weight, starter volume, and the bioethanol content of the kepok banana peel with the relevant method was used to analyze whether there was a difference with the change in the addition of yeast weight and the volume of starter added to the fermentation process, so that the bioethanol content of the kepok banana peel was compared with the SNI 7390:2012 standard and concluded whether the production Bioethanol from kepok banana peels can be used as a substitute for fossil fuels or not. By using 34 national journals and 6 international journals that are relevant to the keywords used, several appropriate journal articles are obtained that are needed to answer the questions that underlie the making of this narrative review.

3. RESULTS AND DISCUSSION

3.1. Raw Materials of Kepok Banana

Bananas are a fruit that grows a lot in Indonesia so that Indonesia is known as the world's banana producer, to be precise, it has produced 6.20% of total world production, 50% of Asian banana production comes from Indonesia [27]. Bananas are very easy to get and have affordable prices, so they are popular in Indonesia [28]. In general, bananas serve as a quick energy provider to increase endurance and prevent muscle fatigue [29]. One type of banana is the kepok banana (Musa sapientum).

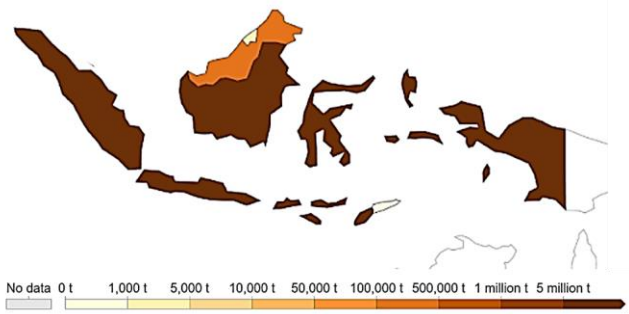

Figure 1. Map of Indonesia Production of Banana in 2018 in Tons [30].

Figure 1 shows a map of banana production in Indonesia in 2018. It can be seen in the figure that Indonesia produced 1,000-5,000,000 tons of bananas in 2018. Kepok bananas, which are a type of banana, are very easy to find anywhere, both in urban areas. as well as in remote villages. The kepok banana itself is the most consumed type of banana and is used as a basic ingredient for making fried bananas, banana chips, banana sale, fruit juice, and so on [31]. Consumption of kepok bananas consumed more flesh. But unfortunately, banana peels, especially kepok bananas, have not been widely used so that they are simply wasted after the kepok banana flesh is used even though the nutritional content of kepok banana peels is quite complete as an energy source for humans [32]. Based on the total production of bananas in Indonesia, banana peels that are just thrown away will become a worrying waste. Therefore, research is needed on how to convert banana peels into other useful products such as bioethanol.

Table 2. Kepok Banana Peel Nutritional Content [33]

Element	Composition
Water	69,80 %
Carbohydrates	18,50 %
Fat	2,11 %
Protein	0,32 %
Calcium	715 mg/100 g
Phosphor	117 mg/100 g
Iron	0,6 mg/100 g
Vitamin B	0,12 mg/100 g
Vitamin C	17,5 mg/100 g

Based on Table 2, the kepok banana peel has a high carbohydrate content of 18.50%, where the carbohydrate content is the second highest composition in the kepok banana after water. The carbohydrate content of the kepok banana peel is high enough so that the kepok banana peel can be used as bioethanol. This carbohydrate content is then broken down into glucose through a hydrolysis process, then fermented with Saccharomyces cerevisiae or yeast to produce bioethanol which can be processed as one of the raw materials for making bioethanol [12]. In addition to the nine ingredients above, the kepok banana peel also has an ash content of 1.1% [34]. Banana peel extract contains quite high antioxidants with 95.14% activity which is beneficial for the body [27].

3.2. Saccharomyces cerevisiae As Fermentation Yeast

Saccharomyces cerevisiae is a yeast or yeast that morphologically only forms round, oval, cylindrical, oval or egg-shaped blastospores which are influenced by the strain as shown in Figure 2 [35]. The addition of microorganisms in baker's yeast is used to complete the banana peel fermentation process by breaking down carbohydrates into their constituent components, namely glucose.

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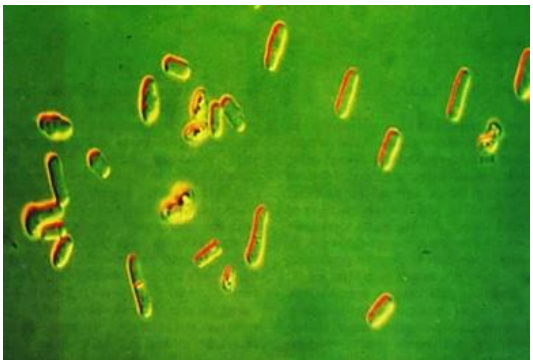

Figure 2. Saccharomyces cerevisiae Magnification 10 × 40 on a Microscope [36]

3.3. The Effect of Yeast Weight on Bioethanol Content

The comparison of yeast weight to bioethanol content is in Table 3.

Table 3. The comparison of yeast weight to bioethanol content

No	Reference	Weight Yeast	Bioethanol Content	[37]	Results
1	[2]	2,8 grams	40%	94,0 - 95,5%	Not meeting the quality standards
2	[31]	100 grams	57%		Not meeting the quality standards

Based on Table 3, literature 1 has a yeast weight of 2.8 grams with a bioethanol content of 40%, while literature 2 has a yeast weight of 100 grams with a higher bioethanol content than literature 1, which is 57%. The existence of disparities or significant differences in yeast weight in the process of making bioethanol causes an impact on the levels of bioethanol produced. This happened because the microorganisms Saccharomyces cerevisiae grew rapidly and the supply of nutrients that supported the growth of Saccharomyces cerevisiae was still accompanied by the addition of a larger number of starters. As a result, the microbes that convert glucose into bioethanol are getting bigger. This process will stop if the microbes cannot tolerate the alcohol content [38]. This is also evidenced by research on the effect of the concentration of Xylanase and Saccharomyces cerevisiae enzymes in the manufacture of bioethanol by simultaneous saccharification and fermentation processes.

The results showed that the administration of 10% Saccharomyces cerevisiae yeast produced higher bioethanol levels than 5% yeast, with the fermentation process for 96 hours and enough nutrients during the fermentation process [39].

3.4 The Effect of Starter Volume on Bioethanol Content

The effect of starter volume on bioethanol content is in Table 4.

Table 4. Comparison of Starter Volume to Bioethanol Content

No.	Reference	Volume Starter	Bioethanol Content	[37]	Results
1	[31]	100 mL	34%	94,0 - 95,5%	Not meeting the quality standards
2	[2]	350 mL	37%		Not meeting the quality standards

Based on Table 4, literature 1 with a starter volume of 100 mL produced bioethanol with a content of 34%, while in literature two a higher bioethanol content was produced, namely 37% with a starter volume of 350 mL. It can be stated that the addition of a high volume of starter produces high levels of bioethanol. This can happen because the higher the volume of starter mixed into the substrate, the greater the amount of yeast (*Saccharomyces cerevisiae)* so that more yeast converts glucose into ethanol. A higher percentage of ethanol content was obtained [40].

The results of the analysis in Tables 4 and 5 are both showed an increase in bioethanol content along with the addition of the tested variations, both in yeast weight and starter volume. The second analysis proves the initial hypothesis on the object of research that bioethanol levels can be increased by increasing the amount of yeast and starter volume. The use of this bioethanol can be mixed with gasoline in any composition to form a gasohol mixture [20]. However, the level of bioethanol to be used must comply with applicable standards, namely SNI 7390:2012 concerning Denatured Bioethanol for Gasohol. Based on the results of research based on two literature sources, either using yeast weight or a larger starter volume, the bioethanol content of banana kepok produced has not entered the standard range of SNI 7390:2012 with a minimum level as a fuel substitute of 94.0-95.5% .

4. CONCLUSION

The conclusion is that yeast weight and starter volume affect the bioethanol content produced. The greater the weight of the yeast or the more volume of starter used, the higher the bioethanol content produced, reaching 57% for 100 gram yeast and 37% for 350 ml starter. However, the

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levels of bioethanol produced have not yet entered the standard range of SNI 7390:2012 concerning Denatured Bioethanol for Gasohol with a minimum level as a fuel substitute of 94.0-95.5% so that the bioethanol cannot be used as a substitute for fossil fuels because not good quality. Therefore, further research is needed using the optimum amount of yeast and starter volume so that the bioethanol content increases so that it can meet SNI 7390: 2012 on Denatured Bioethanol for Gasohol. Repurification is also an important point for the yield of bioethanol content that meets the standard as an alternative fuel to overcome the problem of depletion of fossil energy for society, transportation, and industry.

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