



Fermentation of Cassava Skin as Additional Octan Value of Fuel

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The lack of fossil energy sources requires us to look for alternative energy sources. This study uses cassava peel as a renewable energy source. The experimental method of the fermentation process shows that the smaller the density produced, the greater the percentage of ethanol content. Bioethanol from cassava peel initially still contains water, and the fermentation process improves the quality of the fuel mix. The highest percentage of alcohol occurred on the fourth day of fermentation, which was 60%, each variation of ethanol can be seen as the highest ethanol content with fermentation time. Gasoline has a low octane rating and will produce pollutants such as CO, CO₂, SO₂, NO_x, and Pb. These chemicals can be reduced by increasing the octane rating using ethanol. Fermented cassava peel may be an alternative to bioethanol.

Keywords: Bioethanol; ethanol; fermentation; cassava peel; cassava.

1. INTRODUCTION

The increase in non-renewable energy products encourages growth and improves environmental

quality [1]. Increasing the number of workers to supply raw materials and transportation to support the production process is an advantage that exists and can be enjoyed by the

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community. We increased agricultural productivity and improved conditions for rural populations. It also indirectly supports peace and stability because the economic process can produce better results [2]. Alternatively, the exploitation of energy sources such as premiums through a process that has a broad impact on the environment can even invite natural disasters.

Premium as a natural energy source has a low quality as seen from its octane rating. Meanwhile, the lower the octane rating, the greater the pollution caused. Air pollution is one of the most troubling problems in society. Air is a mixture of several gases, and some gases are harmful to humans and the environment. These damaging gases are caused by air pollution from industry and transportation, such as factory smokestacks or vehicle fumes. The most significant contributor to air pollution is motor vehicle fumes. Rising morbidity is a source of severe health and environmental disasters, most severe in cities. Health will be improved by reducing vehicle emissions using natural energy sources.

Pilar Morales ' research (2015) explained that ethanol production by fermenting wine could be reduced by characterizing the strain *Metschnikowia pulcherrima*. During the first 48 h, using a mixture of *M. pulcherrima/Saccharomyces cerevisiae* under controlled oxygenation conditions can affect the survival rate during the anaerobic stage on the physiological composition of yeast [3]. To optimize the performance of yeast in industrial fermentation, it is necessary which affects the oxygen response in yeast cells [4] . Microbial functionality dramatically improves the quality of nutrition and flavouring. The public does unscientifically know the process of microorganisms in fermented foods, for it is essential that much research on the fermentation process. It is carried out by the community [5].

Energy scarcity is a problem that makes it possible to conduct much research on food raw materials. Indeed, most of the raw materials contain sugar and starch. Through lignocellulosic biomass in biofuel production, it has become a fascinating object of study from various interdisciplinary fields to find alternative energy sources [6]. Through the distillation process, bioethanol is usually obtained from the most economical and reliable fermentation broth [7].

South Africa uses sugar cane as a feedstock to increase ethanol production as a biofuel. There

are three commercially developed biorefineries; coproducing sugar ethanol, chemicals and electricity—ingredients for sugar cane, green harvest residue, bagasse and molasses [8]. One of the better power grid improvements is the Microgrid, and Microgrid working techniques for applications and research are the core elements [9].

Efforts to find alternative energy sources are increasing. However, we are faced with environmental pollution due to the energy process. Diesel is considered the most significant contributor to exhaust emissions. Gas produced from vehicles is one of the major air pollutants or sources of air pollution [10]. Air pollution contains toxins harmful to human health, threatening the respiratory tract, especially carbon monoxide (CO) gas. Carbon monoxide (CO) gas is one of the most common causes of poisoning to human health. Exhaust emission standards are often measured by the content of certain gases, namely, hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO₂), oxygen (O₂), and nitrogen dioxide (NO₂) [4].

Additionally, the use of fuel with a low octane rating further supports the occurrence of air pollution that can endanger the health of living things. This is increasingly felt and results in threats to the environment. This makes people think of ways to minimize air pollution by using fuel oil with a high octane rating of [12].

In Indonesia, the high octane fuel known as Pertamax is quite expensive. The researchers innovated the material as an octane enhancer. The ingredients that I made myself came from cassava peel waste. The problem in this research is to convert cassava peel into bioethanol. Erna et al.'s research stated that cassava peel fermentation produced glucose levels of 9.9%, with the highest ethanol being 6.00% in eight days of fermentation [6]. Cassava peel has an excellent octane value of 88, and if added by fermentation using the fungus *Saccharomyces cerevisiae*, the octane value of cassava peel bioethanol becomes 117. Bioethanol from cassava peel can be used as a fuel mixture with a low octane value to increase the octane value of the fuel [14].

2. RESEARCH METHOD

This research was experimental. Experimental design is essential for building essential and powerful research [15]. Researchers want to

prove the relationship between the fermentation process and days with the percentage of ethanol produced by counting numbers. Researchers use tools, materials, procedures, and treatment groups that are of concern as follows;

2.1 Tools

- a. Digital balance
- b. Blender
- c. Pot
- d. Measuring cup
- e. Bottle
- f. Filter cloth
- g. Simple distillation tool

2.2 Ingredients

Cassava peels are considered useless waste by some industries that use cassava as a base material. Therefore, this material is still not widely used and is just thrown away and is usually only used as animal feed. Cassava peel can be a product with high economic value, and it can be processed into flour. The percentage of cassava peel is approximately 20% of the tuber, so per kg of cassava yields 0.2 kg of cassava peel. Cassava peel contains a lot of blue acid poison than the tuber flesh, which is 3–4 times more depending on the sweet or bitter taste. If it tastes sweet, the blue acid content is more than if it tastes bitter. The blue acid content was higher. Cassava peel contains a high HCN substance, which is about 18.0 ppm per 100 g of cassava peel. The amount of cyanide acid (HCN) varies widely from harmless (<50 ppm) to lethal (> 250 ppm). The cyanide content in cassava bread skin was successfully reduced by 98.9%, from 472.8 mg/kg (Dian Nila Sari & Astili, 2018).

Then it is expected that Bioethanol (C₂H₅OH) is a biochemical liquid in the process of fermenting sugar from carbohydrate sources using the help of microorganisms. Most of the production of alcohol-used fermentation and distillation methods in its development. Bioethanol is ethanol fermented from glucose (sugar) followed by a distillation process. The distillation process produces ethanol with a volume level of 95% so that it can be used as fuel (biofuel) and needs to be purified again to reach 99%, which is commonly referred to as Fuel Grade Ethanol (FGE). The purification process with the dehydration principle is usually performed out using the Molecular Sieve method to separate water from ethanol compounds [16].

Ethanol is categorized into two main groups, namely:

1. Ethanol that has a percentage of 95%-96%, is called "hydrated ethanol", divided by in:
 - a. Technical/raw spirit grade, used for fuel
 - b. Spirits, beverages, disinfectants, and solvents.
 - c. Industrial grade, used for industrial raw materials and
 - d. solvent.
 - e. Drinking class for high-quality drinks.
2. Ethanol > 99.5%, used for fuel. If purified

Furthermore, this ethanol can be used for pharmaceutical purposes and as a solvent in analytical laboratories. Ethanol with a percentage content of 99.5% is called Fuel Grade Ethanol (FGE) or anhydrous ethanol (ethanol anhydrous) or dry ethanol, free from water or contains only a small amount of water. This process requires; Cassava peels itself, yeast (*Saccharomyces cerevisiae*) (15 grams), water, alpha-amylase enzyme, glucoamylase enzyme, and benzene.

2.3 Procedure

2.3.1 Control group

1. Take the cassava peel and cut it into small pieces to make it easier to process.
2. Wash thoroughly, then soak the cassava peel in water for one night.
3. Dry the cassava skin in the sun. Usually, it only takes a day to dry if entirely charred.
4. Steps 1–3 are carried out to remove the cassava peels' HCNs (cyanide acid) content.
5. Dry cassava peel; put it in Blender. Blend until it becomes flour.
6. After turning into flour, the weight of flour is 200 g. Continue the gelatinization process by heating 200-ml flour mixed with water to a temperature of 100°C. The ratio of flour to water was 1:1.
7. The dough will thicken and look like mush. Strain the dough on a cloth and squeeze it until it separates between the water and the dregs. The liquid obtained was 95 ml.
8. Because the liquid from cassava peel still contains starch, a hydrolysis process must be carried out using 5 ml of alpha-amylase enzyme and seven ml 7-ml glucoamylases to convert starch glucose.
9. Stages 4–7 are enzymatic steps to converting starch into glucose so that the *Saccharomyces cerevisiae* fungus can function because the cassava peel itself does not contain glucose.

Table 1. Fermentation Result Data

Days to-	Volume (ml)	Mass (g)	Density (g/ml)	Ethanol percentage (%)
1	95	94.9	0.999	0.00
2	95	93.12	0.9802	15.00
4	95	86.7	0.9128	60.00

2.4 Treatment Group

- After the enzymatic process, the cassava peel liquid was given as much as 15 g in each bottle labelled with the fermentation time of one day, two days, and four days.
- The mass content of each bottle was adjusted according to the length of fermentation time.
- Check the alcohol content of each bottle using the density formula. And choose liquid

3. RESULTS

For the mixture itself, we mixed premium quality gasoline and bioethanol with 3:1. The percentage is 75% premium quality gasoline mixed with 25% bioethanol.

We wanted to produce a 200 ml blend mixed with 150 ml of premium-quality gasoline with 50-ml bioethanol. So the percentage is 100% with the division as described in the previous paragraph.

4. DISCUSSION

Cassava peels in people's lives are nothing more than garbage. The fermentation process can change the composition and chemical structure owned to produce quality alcohol. From the fermentation results, the highest percentage of alcohol was obtained on the fourth day of fermentation, 60%. The smaller the density produced, the greater the ethanol content percentage. This happens because the bioethanol initially from cassava peel still contains water. Although the distillation process has been minimized, the water content in the bioethanol is still there, so pure bioethanol has not been obtained. For the octane rating itself, the premium has an octane rating of 88 with a compression ratio of 7:1 - 9:1. Simultaneously, the octane value of bioethanol is 117, with a compression ratio of >11:1. So, the octane value obtained can be explained as follows:

$$\begin{aligned} \text{Total OV} &= \\ &= (0.V_{\text{fuel}} \times \%v_{\text{fuel}}) + (0.V_{\text{bioethanol}} \times \%v_{\text{bioethanol}}) \\ &= (88 \times 0,75) + (117 \times 0,25) = 95,25 \end{aligned}$$

Information:

OV = Octane Rated

%v = Volume percentage

The mixed gasoline and bioethanol steps are still carried out in each layer. Because gasoline and water do not mix and will form separate layers, this is due to the difference in the boiling points of the two liquids. The bioethanol layer, which still contains water, is under the gasoline layer. This bioethanol liquid is called hydrated ethanol because it still contains water.

This needs to be overcome by further distillation levels so that the water content is completely drained so that pure bioethanol with 100% ethanol content is obtained. Several literature reviews suggest that dehydration can further distillation, i.e., azeotropic distillation using benzene or cyclohexane in the mixture. When these substances are added, a heterogeneous azeotropic mixture is formed. Anhydrous ethanol does not contain water but a water and benzene vapour mixture. Cassava peel is only a tiny part of the potential of ethanol waste. In 2015, as much as 1,035,889.2 tons can be converted into bioethanol, as much as 72,511.2 kiloliters [13].

5. CONCLUSION

The longer the fermentation process, the lower the mass production and the higher the alcohol content. Cassava peel can be used as a good bioethanol because it contains a high octane value. However, if there is still water in the bioethanol, the gasoline will not mix. The manufacture of pure bioethanol is carried out by distillation and dehydration so that the water content can be drained and pure bioethanol can be obtained, which can be a mixture of gasoline.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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