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Content And Calorific Value Of Fermentation Of Bioethanol From Pineapple Waste With Variation Of Manufacturing Time

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A B S T R A C T

To solve this increasing energy need, it is proposed to use bioenergy as an alternative energy source to replace fossil fuels. One form of bioenergy used is bioethanol. Bioethanol is a biochemical liquid from the sugar fermentation process and a source of glucose, cellulose and starch or carbohydrates using the help of microorganisms. Bioethanol can be made from plant products such as sap, tubers and fruit. Based on the description that has been presented, researchers are interested in conducting research on the content and calorific value of bioethanol fermented from pineapple fruit waste with variations in the length of production time. This research is an experiment that utilizes pineapple waste material to be used as bioethanol, through several processes, namely the hydrolysis process, fermentation process and distillation process. The aim of this research was to determine the calorific value and alcohol content. For the materials used, 2 kg of pineapple fruit waste, 10 liters of distilled water, 100 ml of amylase enzyme, 400 grams of yeast and for variations in the fermentation time, namely 7 days and 14 days. The research results obtained the highest alcohol content with a fermentation time of 14 days with an alcohol content of 67%. Fermentation time of 7 days produces an alcohol content of 54%. The highest calorific value with a fermentation time of 14 days is 3393.423 cal/gram, while the calorific value with a fermentation time of 7 days is 2214.873 cal/gram.

Keywords: Bioethanol, Pineapple Waste, Calorific Value, Alcohol Content.

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1. Introduction

In this life we cannot be separated from the need for something called energy. As we know that most of the energy sources utilized by mankind come from non-renewable fossil fuels. We can imagine that at this time when the world's energy needs are increasing if it is not supported by efforts to find new energy sources to support world energy needs, one day these fossil-fuel energy sources will run out and if this happens it will be very fatal for our future life. To face the challenge of increasing energy needs, it is proposed to use bioenergy as an alternative energy source to replace fossil fuels. One form of bioenergy that is used and at the same time we will discuss it is bioethanol [1]

Bioethanol is a biochemical liquid from the fermentation process of sugar and a source of glucose, cellulose, and starch or carbohydrates using the help of microorganisms. The advantages or advantages of using bioethanol are that it can be used continuously, is environmentally friendly and can be used as a raw material for the chemical, cosmetic, pharmaceutical industries, and as a fuel [2]. Bioethanol itself can be made from plant products such as sap, tubers and fruits [3].

Pineapple plants (Ananas Comosus) originate from South America. A suitable area for pineapples is a location that gets enough sunlight up to a height of 500 m above sea level. The leaves are spur-shaped, have spiny edges, and some are thornless and contain lots of fiber for rope or cloth. The fruit is long round and the flesh is light yellow [4]. According to Agustina (2004), the contents of pineapple are water, sugar and acid. With details of 82.86% water, 14.64% sugar, and 2.02% acid.

Previous research, [5] on the process of making bioethanol from red dragon fruit. Research used variations of yeast 1%, 2%, 3%, 4% and 5% for every 300 ml sample of red dragon fruit juice as well as nutrients/NPK as much as 2 gr, 4 gr, 6 gr, 8 gr, and 10 gr. The research results showed that the alcohol content produced was influenced by the amount of yeast and the amount of nutrients/NPK. The highest ethanol content is 26% with the addition of 15 grams of yeast and 10 grams of nutrients. This research [6] examined bioethanol from cherry fruit (Muntingia Calabura) which was carried out by, in this study using the treatment of variations in fermentation time, namely at 3, 5, 7 and 9 days. The ethanol content results obtained by

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varying fermentation times of 3, 5, 7, and 9 days were 4.11%, 4.82%, 4.82%, and 5.19%. (Maidangkay and Dosoputranto, 2021) examined the effect of the duration of fermentation and distillation temperature of palm sap on the quality of bioethanol. In this study using variations of fermentation time 2 days, 3 days, 4 days, 5 days, 6 days, and 7 days and the temperature in the distillation process using 70-80℃, 80-90℃, and 90-100 ℃. The results showed that the fermentation time and temperature of the distillation process affected the quality of bioethanol, the best fermentation time was 5 days while the temperature of the distillation process was 70-80 ºC with 91% bioethanol quality.

From previous research, namely making bioethanol from red dragon fruit, making bioethanol from cherry fruit (Muntingia Calabura) and the influence of fermentation time and palm sap distillation temperature on the quality of bioethanol, the author wants to make a research title about "Content and Calorific Value of Bioethanol Fermented from Pineapple Fruit Waste With Varying Length of Manufacturing Time" The methods used are hydrolysis, fermentation and distillation. The aim of the research was to determine the calorific value and alcohol content. The materials used were 2 kg of pineapple fruit waste, 10 liters of distilled water, 100 ml of amylase enzyme, 400 grams of yeast and for variations the length of fermentation time was 7 days and 14 days. The results of this research are expected to find bioethanol fuel as an alternative to fossil energy.

2. Methods

This research is an experimental research which aims to investigate the possible influence of the independent variable (length of fermentation time) on dependent variations (calorific content and value) in the experimental group. In this research the author wants to use pineapple fruit as an alternative fuel, namely using a distillation process to make bioethanol

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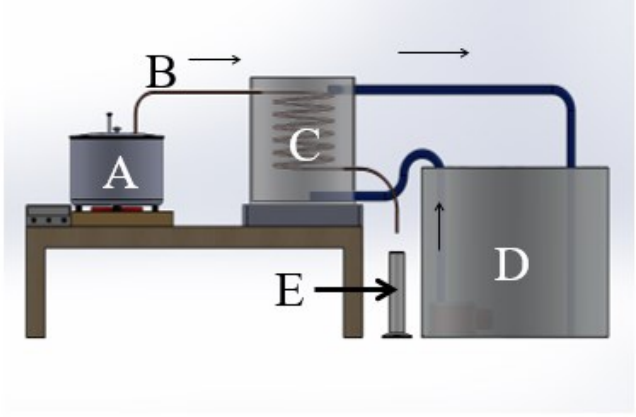

Figure 1 Distillation Process Scheme

Distillation Process Scheme

The distillation process begins with a heating stage in the distillation vessel (A) so that the liquid which has a lower boiling point will evaporate so that it is separated from the substance with a higher boiling point. The steam will move through the copper pipe (B) which is continued to the condenser/cooler (C). The cooling process occurs continuously by circulating water from the reservoir (D) into the condenser tube. The outside of the copper pipe in the condenser becomes cold because it comes into contact with water, so that the steam that passes through the pipe changes state to liquid. The distilled liquid will be collected in a measuring cup (E). (Figure 1)

3. Results and Discussions

To find out the best research results, you have to look for variations in fermentation time to get the highest alcohol content. The following are the best research results:

Fermentation Duration

This research was carried out to obtain the highest alcohol content by finding the length of fermentation time. The variations in fermentation time that are sought are 7 days and 14 days, which can be seen in Figure 2.

Figure 2 Distillation Results

Information :

a) 7 days fermentation produces an alcohol content of 54%.

b) 14 days of fermentation produces an alcohol content of 67%.

From previous research, the production of bioethanol fuel from mulberry fruit with a fermentation time of 7 days produces an alcohol content of 45% and a fermentation time of 14 days produces an alcohol content of 50%. Meanwhile [7]. In this research, fuel was made from pineapple waste with a fermentation time of 7 days producing an alcohol content of 54% and a fermentation time of 14 days producing an alcohol content of 67%.

Multilevel Distillation

Making bioethanol using a multistage distillation method aims to obtain a greater alcohol content. The composition used is as follows: 2 kg of pineapple fruit waste, 10 liters of distilled water, 100 ml of amylase enzyme, 400 gr of yeast. The length of fermentation time required is 7 days and 14 days. (Table 1)

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Table 1 Multilevel Distillation Results

Mass of pineapple fruit waste (kg)	water volume (liter)	Volume of amylase enzyme (ml)	Massa ragi (gram)	Yeast mass (Day)	Distillation	Volume of bioethanol produced (ml)	Alcohol level (%)
2	10	100	400	7	Distillation 1	1480	12
					Distillation 2	530	30
					Distillation 3	210	54
2	10	100	400	14	Distillation 1	1650	20
					Distillation 2	760	44
					Distillation 3	400	67

Based on Table 2, it can be seen that for the fermentation time of 7 days, the first distillation produced 1,480 ml with an alcohol content of 12%, the results of the first distillation were distilled again (second distillation) producing 530 ml with an alcohol content of 30%, the results of the second distillation were distilled again (third distillation) produces 210 ml with an alcohol content of 54%. For a fermentation time of 14 days, the first distillation produces 1,650 ml with a content of 20%, the results of the first distillation are distilled again (second distillation) to produce 760 ml with an alcohol content of 44%, the results of the second distillation are distilled again (third distillation) to produce 400 ml with an alcohol content of 67%.

Test result

Alcohol Level Testing

Testing the alcohol content contained in pineapple waste bioethanol using an alcohol meter. The best results obtained were from the third distillation process with a fermentation time of 14 days with an alcohol content of 67%.

Table 2 Alcohol content testing

No	Fermentation Time (Day)	Alcohol Level (%)								
		Distillation 1			Distillation 2			Distillation 3		
1	7	12	12	12	30	30	30	54	54	54
	Average	12			30			54		
2	14	20	20	20	44	44	44	67	67	67
	Average	20			44			67		

From Figure 2 and Figure 3, with a fermentation time of 7 days, the first distillation produces 1480 ml with an alcohol content of 12%, the second distillation produces 530 ml with an alcohol content of 30%, the third distillation produces 210 ml with an alcohol content of 54%, as for the fermentation time 14 days, the first distillation produces 1650 ml with an alcohol content of 20%, the second distillation produces 760 ml with an alcohol content of 44%, the third distillation produces 400 ml with an alcohol content of 67%. From testing the alcohol content, the alcohol content increased following variations in the length of fermentation time for each sample. The longer the fermentation time, the more alcohol content is produced. In this test, a fermentation time of 14 days was chosen

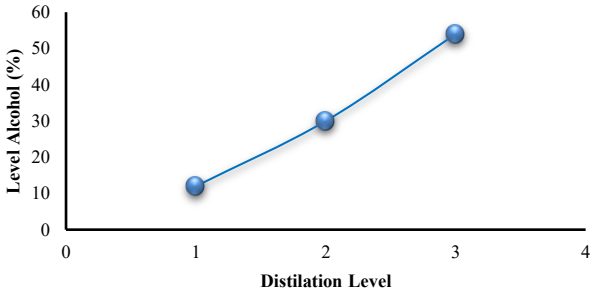

Figure 2 Graph of alcohol content testing with a fermentation time of 7 days

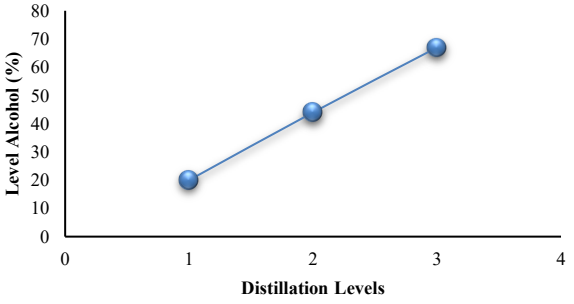

Figure 3 Graph of alcohol content testing with a fermentation time of 4 days

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Calorific Value Testing

Testing the calorific value using a bomb calorimeter with the following results:

Table 2 Calorific value testing

No	Level Alcohol (%)	Calorific Value (Cal/Gram)			Average (Cal/Gram)
		Test 1	Test 2	Test 3	
1	54	2795,26	1727,97	2121,38	2214,87
2	67	3280,49	4201,64	2698,13	3393,42

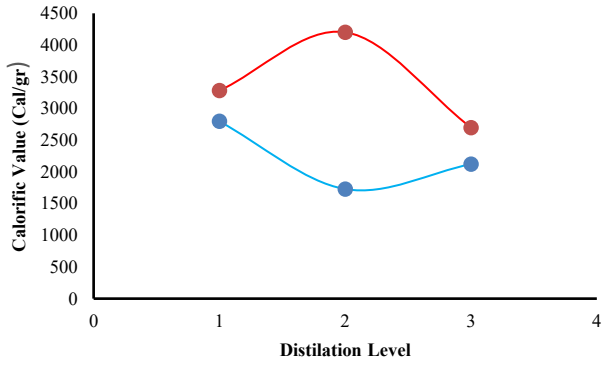

Figure 4 Calorific value test graph

The results of the calorific value test 3 times were then taken as an average, at a fermentation time of 7 days with an alcohol content of 54% the first test produced 2795.26 cal/gr, the second test produced 1727.97 cal/gram, the third test produced 2121.38 cal/gr, the average of the three tests is 2214.87 cal/gr. Meanwhile, at a fermentation time of 14 days with an alcohol content of 67%, the first test produced 3280.49 cal/gr, the second test produced 4201.64 cal/gram, the third test produced 2698.13 cal/gr, so the average of the three tests was equal to 3393.42 cal/gr.

Based on research that was conducted by [7] reported the highest calorific value 29679,47 J/gr or 7088.82 Cal/gr. So compared to the research of Sutanto et al, the calorific value in this panel is still below that.

4. Conclusion

The conclusion of this research is that fermentation times tend to have higher alcohol content. High alcohol content tends to have a high calorific value

REFERENCES

[1] Agustina, L. (2004). Dasar Nutrisi Tanaman (2.). Jakarta: PT.Rineka Cipta

[2] Fadly Khaira, Z., Yenie, E. and Rezeki Muria, S. (2015) 'Pembuatan Bioetanol Dari Limbah Tongkol Jagung Menggunakan Proses Simultaneous Sacharificatian and Fermentation (SSF) Dengan Variasi Konsentrasi Enzim Dan Waktu Fermentasi', *Jom Fteknik*, 2(2), p. 1.

[3] Maidangkay, A. and Dosoputranto, E. (2021) 'Pengaruh Lamanya Fermentasi dan Temperatur Destilasi Nira Aren (Saguer) Terhadap Kualitas Bioetanol', *Jurnal Masina Nipake*, 1(1), pp. 47–56. Available at: http://p3m.polimdo.ac.id/jurnal/index.php/MASINA-NIPAKE/article/view/67.

[4] Melia Akrinisa, SP .MP,. Muhammad Arpah. M.Si, J.A. (1970) 'Keragaman Morfologi Tanaman Nanas(Ananas Comosus (L) Merr) Di Kabupaten Indragiri Hilir', *Jurnal Agro Indragiri*, 4(1), pp. 34–38. Available at: https://doi.org/10.32520/jai.v4i1.1052.

[5] Ramadhani, R.T. *et al.* (2020) 'Proses Pembuatan Bioetanol dari Buah Naga Merah', *ChemPro*, 1(02), pp. 53–57. Available at: https://doi.org/10.33005/chempro.v1i2.51.

[6] Sitoresmi, S. *et al.* (2017) 'Bioetanol Dari Buah Kersen (Muntingia Calabura) Menggunakan Saccharomyces Cerevisiae', *Jurnal Teknik Kimia*, 12(1), pp. 19–23. Available at: https://doi.org/10.33005/tekkim.v12i1.840.

[7] Sutanto, R., Jaya, H. and Mulyanto, A. (2013) 'Analisa Pengaruh Lama Fermentasi Dan Temperatur Distilasi Terhadap Sifat Fisik (Specific Gravity Dan Nilai Kalor) Bioetanol Berbahan Baku Nanas (Ananas Comosus)', *Dinamika Teknik Mesin*, 3(2), pp. 91–100. Available at: https://doi.org/10.29303/d.v3i2.74.