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Analysis of Potential Bioethanol Production from Pineapple (Ananas Comosus L.Merr) Peel Waste Belik District - Pemalang - Central Java

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Abstract. Belik Subdistrict - Pemalang District, which produces honey pineapple with a contribution of around 27,162 tons per year in Central Java, is a superior product, which has great and reliable potential to develop the regional economy. It several small and medium-sized businesses that produce processed pineapple honey that is made into pineapple juice products, pineapple chips, pineapple meal, and some small and medium businesses that sell pineapples peel. This activity produces a lot of honey pineapples peel waste; utilization of pineapple peel waste into bioethanol is expected to be potential energy for household needs. Pineapple skin waste containing carbohydrates and reducing sugars is high enough so that it has the potential to become bioethanol by carrying out the process of fermentation and distillation. One kilogram of pineapple fruit can produce 250 grams of pineapple peel waste, or 1 ton can produce about 250 kg of peel waste. This study uses raw materials for pineapple skin waste with LSF (liquid state fermentation) fermentation method and the distillation process. Using 2.5 kg of peel can produce 1 liter of bioethanol with 27% content. In Belik District, produces pineapple peel waste around 4,125 tons (4,125 kg) per day, bioethanol can be produced around 1.650 liters per day.

INTRODUCTION

The Regional Energy General Plan (RUED) of Central Java Province has a combined energy projection in 2016; bioethanol contributes around 2.23% of the 8.83% new renewable energy [1][3]. Bioethanol is ethanol made from biomass that contains starch or cellulose, such as cassava and sugar cane. In the industrial world, ethanol is generally used as an industrial raw material for alcohol derivatives, mixtures for liquor (such as sake and gin), as well as pharmaceutical and cosmetic raw materials [2]. In 2025, bioethanol is expected to increase to 6.12%. The energy mix table for Central Java Province in 2016 and 2025 can be seen in Figures 1; [2].
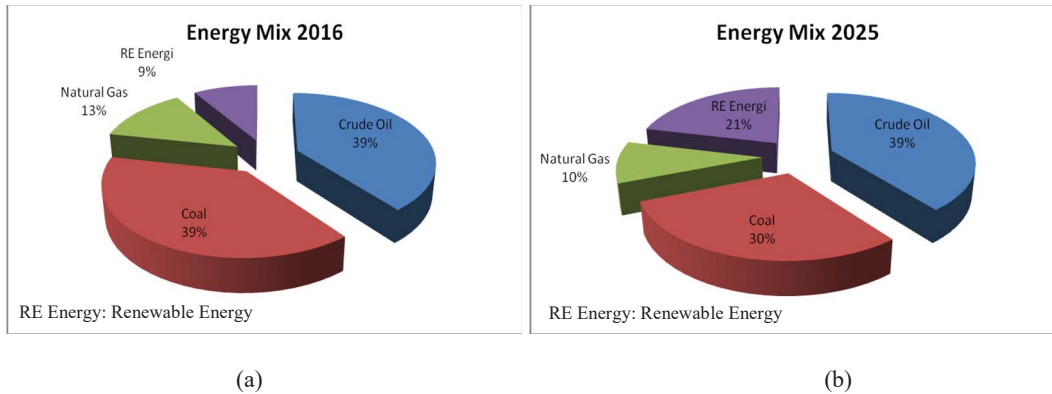
FIGURE 1. Energi Mix Central Java Province 2016 (a) and 2025 (b)

Belik district, located in Pemalang Regency, Central Java Province, is one of the biggest honey pineapple producers in Java. Honey Pineapple is biomass that can produce bioethanol because it has a carbohydrate content of 17.53% and reducing sugar 13.65% [4]. Belik District can produce honey pineapple around 27,162 tons per year [5].

FIGURE 2. Honey pineapple plantation area in Belik District, Pemalang, Central Java.

Potential waste of honey pineapple peel comes from direct sales of pineapple and small and medium business activities by making pineapple juice, chips, etc. By doing a simple fermentation and distillation process, the pineapple peel waste honey spread in Belik District can be utilized as bioethanol, by treating continuous distillation (batch), it will get 60% ethanol content so that it can be used as fuel for household needs for cooking activities using bioethanol stoves. [6][7].

FIGURE 3. Direct sales activity (a) and processed honey pineapple (b)

EXPERIMENTAL PROCEDURE

- Analysis of cellulose content by the method Chesson-Datta.
  Chesson-Datta method is to determine the content of cellulose by conducting several stages of the experiment [10].
- Collecting data on the distribution of pineapple peel waste in Belik District and Pemalang City, data taken from direct sales and processed products from small and medium businesses (UKM).
- Considering the results of pineapple peel waste from 1 kg of honey pineapple fruit to find a comparison of the results of pineapple peel waste, the results of 1 kg of pineapple fruit get the results of 250 gr wet pineapple peel waste.
- Prepare 2.5 kg of dried pineapple peel and 5 liters of water.
- Carry out a fermentation process for 6 days with the addition of yeast, urea, NPK, and NaOH
  Distillation process with 5 liters of fermentation results, and adjusts the temperature of 75°C - 85°C, capable of producing 1 liter of bioethanol.

- Procedure I
  Method Chesson-Datta
  1. One g dry sample **(weight a)** is added 150 ml H_2O or alcohol-benzene and refracted at 100°C with a water bath for 1 hour.
  2. The result filtered; the residue washed with 300 ml hot water.
  3. The residue is then dried in an oven until the weight is constant and then weighed **(weight b)**.
  4. The residue was added with 150 mL of H_2SO_4 1 N; then flushed with a water bath for 1 hour at 100°C.
  5. The result is filtered and washed to neutral (300 ml) and the residue is dried to a constant weight, Weight weighed **(weight c)**.
  6. The Dry residue was added to 100 ml 72% $H2SO4$ and soaked at room temperature for 4 hours.
  7. 150 mL of H_2SO_4 1 N was added and refluxed at 100oC with a water bath for 1 hour on the back cooler.
  8. The residue is filtered and washed with H_2O to neutral (400 ml).
  9. The residue is then heated in an oven at 105°C until the weight is constant and weighed **(weight d)**.

FIGURE 4. Procedure I, Analysis of cellulose content using Chesson-Datta method.

Experimented with the Chesson-Datta method using a mixture of water and benzene alcohol with 3 trials and 3 samples

Calculation of cellulose levels using the following formula:

cellulose content = (c-d)/a x 100%

By using the Chesson-Datta method to look for pineapples peel cellulose content, the results obtained can be seen in the following table:

TABLE 1. The results of cellulose analysis of pineapple honey peel waste Belik District - Pemalang, Central Java

Mixing Material	Weight a (gr.)	Weight b (gr.)	Weight c (gr.)	Weight d (gr.)
Water				
Sample 1	1.0023	0.3911	0.2371	0.1510
Sample 2	1.0041	0.4611	0.2896	0.1684
Sample 3	1.0065	0.4091	0.2654	0.1616
Alcohol-Benzene				
Sample 1	1.0020	0.4959	0.2706	0.1432
Sample 2	1.0056	0.5542	0.3735	0.2001
Sample 3	1.0067	0.6729	0.4576	0.2717

Cellulose content - water mixing ingredients

Sample 1

$$= \frac{[c-d]}{a}100\%$$

$$= \frac{[0.2371-0.1510]}{1.0023}100\%$$

$$= 8.59\ \%$$

Sample 2

$$= \frac{[c-d]}{a}100\%$$

$$= \frac{[0.2896-0.1684]}{1.0041}100\%$$

$$= 12.07\ \%$$

Sample 3

$$= \frac{[c-d]}{a}100\%$$

$$= \frac{[0.2654-0.1616]}{1.0065}100\%$$

$$= 10.31\ \%$$

Cellulose content - Alcohol-Benzene mixing ingredients

Sample 1

$$= \frac{[c-d]}{a}100\%$$

$$= \frac{[0.2706-0.1432]}{1.0029}100\%$$

$$= 12.70\ \%$$

Sample 2

$$= \frac{[c-d]}{a}100\%$$

$$= \frac{[0.3735-0.2001]}{1.0056}100\%$$

$$= 12.70\ \%$$

Sample 3

$$= \frac{[c-d]}{a}100\%$$

$$= \frac{[0.4576-0.2717]}{1.0067}100\%$$

$$= 18.46\ \%$$

- Procedure II

Conducting an initial field survey directly by recording the distribution of honey pineapple peel waste that is located in Belik District, there are several distributions in the data that are: 1. Direct sales, 2. Processed honey pineapple fruit made by several micro-businesses, 3. Pineapples peel business. There are about 50 direct sellers, 3 locations for micro-businesses, and 3 peel business places.

TABLE 2. Data on the number of sales of pineapples every day.

Day	Direct Selling (100 sales) (Kg)	UKM 1 (Kg)	UKM 2 (Kg)	UKM 3 (Kg)	UKM 4 (Kg)	Amount (Kg)
1	5000	2000	2000	2500	5000	16,500
2	6000	2000	2000	2500	5000	17,500
3	4500	2000	2000	2500	5000	16.000

FIGURE 5; Procedure II, pineapple peel waste distribution data collection.

- Procedure III

Weigh 1 kg of pineapple, and then peel the skin to get how much weight the pineapple peel yields.
Pineapple peels that weigh 1 kg or 2 medium-sized pineapples produce about 250 grams of pineapples peel.

TABLE 3. Results weighing pineapple peel waste

Weight of Fruite (Kg)	Weight of Pineapple Peel (gr.)
1	250
4	1000
10	2500

FIGURE 6. Procedure III: Measuring the weight of a pineapple peel 1 kg.

- Procedure IV

The process of fermentation and distillation is the main process in producing bioethanol, in this process using the liquid-state fermentation (LSF) method [8]. Pineapples peel raw material as much as 2.5 kg added 5 liters of water, the addition of yeast, urea, NPK and NaOH, fermentation time is 6 days, and the temperature for distillation is 75°C and 85°C. The results of this process are obtained 1 liter of bioethanol with 27% content.

FIGURE 7. Procedure IV: Fermentation process for 6 days and Distillation at Temp. 75°C - 85°C

RESULT AND DISCUSSION

In the first batch of Distillation, 1,650 liters of bioethanol is produced from 4,125 Kg of pineapple peel waste every day. The distribution of 4,125 Kg of pineapple peel waste is about 22% of 74 tons of honey pineapple per day sold directly and processed by local micro-businnes. In the fermentation process (LSF method) and the first batch, distillation [9], produced from 2.5 kg of pineapple waste produces about 1 liter of bioethanol with levels of 27%. To get a liter of bioethanol can be seen through the equation:

2.5 kg of pineapple peel waste produces 1 liter of bioethanol

$$2.5\ a = b$$

$$a = \frac{[b]}{2.5}$$

a = volume of bioethanol (liters)
b = weight of pineapple peel waste (kg)

$$a = \frac{[b]}{2.5}$$

$$a = \frac{[4,125]}{2.5}$$

$$a = 1,650 \text{ liters}$$

To get 60% -70% bioethanol content, one more distillation is needed; generally, the volume reduction from the first distillation is around 27%. Bioethanol production in Belik Pemalang District, Central Java can be increased by processing more pineapples in small and medium business activities, so that the pineapple peel waste percentage exceeds 22%. From the initial survey and local government information, the main constraints were the marketing of products and the production of processed pineapple, which were not yet optimal.

CONCLUSION

The amount of honey pineapple skin waste around 4,125 kg in Belik District, Pemalang, Central Java has the potential to be bioethanol with a production of 1,650 liters per day, with 27% alcohol content in the first distillation and 12% cellulose content. Bioethanol production can be increased by processing more pineapple honey by increasing the shipping of pineapple honey in the form of peel. Increasing the production of processed pineapple honey into superior products such as honey pineapple juice syrup, pineapple chips, pineapple meal, and others so that pineapples peel waste honey in the district of Belik Pemalang is also available quite a lot.

Nomenclature	
UKM	Usaha kecil menengah (Micro Businnes)
RUED	Rencana Umum Energi Daerah (General Plan of Regional Energy)
RUEN	Rencana Umum Energi Nasional (General Plan of National Energy)
BPS	Badan Pusat Statistik (Statistics Centre Council)

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