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Development of Bio Batteries Utilizing Coconut Dregs and Pineapple Extract as Alternative Energy Sources

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Abstract

Coconut and pineapple dregs contain ions that can be effectively used as energy sources. This study aims to evaluate the electricity generated from varying compositions of coconut dregs and pineapple juice in bio-batteries. The bio-battery paste is created using different ratios of coconut dregs and pineapple juice, along with electrodes (aluminum and graphite). An experimental method was employed. The results indicated that the highest voltage of 0.54 V and a current of 0.71 mA were achieved with 40 ml of pineapple juice added to the coconut dregs, whereas the lowest voltage of 0.40 V and a current of 0.01 mA were observed without adding pineapple juice. For the pineapple juice concentration, the highest voltage of 0.51 V and a current of 0.91 mA were obtained with 10 grams of coconut dregs, while the lowest voltage of 0.44 V and a current of 0.31 mA occurred with 40 grams of coconut dregs. The concentration of coconut dregs and pineapple juice significantly affects the voltage produced, while the current is significantly influenced by the concentration of coconut dregs but not by the concentration of pineapple juice.

Keywords*: Alternative Energy, Coconut Dregs, Pineapple, Bio-battery*

Abstrak

Ampas kelapa dan nanas yang mempunyai kandungan ion yang dapat dimanfaatkan secara optimal sebagai sumber energy. Penelitian ini bertujuan untuk menganalisis kelistrikan yang dihasilkan dari pengaruh perbandingan komposisi ampas kelapa dan sari buah nanas terhadap bio-baterai. Pasta bio-baterai dibuat dari ampas kelapa dan sari buah nanas dengan perbandingan konsentrasi dan variasi, serta elektroda (aluminium dan grafit). Metode yang digunakan adalah metode eksperimen. Hasil penelitian menunjukkan bahwa pada konsentrasi ampas kelapa menghasilkan tegangan tertinggi sebesar 0,54 V dan arus 0,71 mA pada variasi 40 ml sari buah nanas, sedangkan tegangan terendah sebesar 0,40 V dan arus sebesar 0,01 mA tanpa penambahan variasi sari buah nanas. Pada konsentrasi sari buah nanas menghasilkan tegangan tertinggi sebesar 0,51 V dan arus 0,91 mA pada variasi 10 gr ampas kelapa, sedangkan tegangan terendah sebesar 0,44 V dan arus 0,31 mA pada variasi 40 gr ampas kelapa. ampas kelapa dan konsentrasi sari buah nanas berpengaruh nyata terhadap tegangan listrik yang dihasilkan, sedangkan untuk arus berpengaruh nyata pada konsentrasi ampas kelapa akan tetapi berpengaruh tidak nyata terhadap arus pada konsentrasi sari buah nanas.

Kata Kunci: *Energi Alternatif, Ampas Kelapa, Nanas, Bio-baterai*

Introduction

Energy is one of the most crucial needs in the world, including in Indonesia, which currently relies heavily on non-renewable energy sources such as coal and petroleum. Consequently, the reserves of fossil fuels are depleting over time, necessitating the transition to renewable energy sources, which serve as alternative energy [1]. An alternative energy source widely recognized as biomass is derived from the photosynthesis process involving both organic and inorganic materials. Biomass energy sources have the benefit of being renewable, thereby offering sustainable energy solutions [2]. According to [3], biomass is one of the renewable energy sources derived from agriculture, plantations, and forestry, such as flowers, seeds, stems, roots, leaves, and branches. One such biomass source is pineapple fruit and coconut dregs.

In 100 grams of pineapple, the content includes 12.63 grams of carbohydrates, 9.26 grams of sugar, 1.4 grams of fiber, 0.12 grams of fat, 0.54 grams of protein, thiamine (Vit. B1) 0.079 mg (6%), riboflavin (Vit.B2) 0.031 mg (2%), niacin (Vit. B3) 0.489 mg (3%), pantothenic acid (B5) 0.205 mg (4%), vitamin B6 0.110 mg8%, folate (Vit. B9) 15 µg (4%), vitamin C 36.2 mg (60%), calcium 13 mg (1%), iron 0.28 mg (2%), magnesium 12 mg (3%), phosphorus 8 mg (1%), potassium 115 mg (2%), zinc 0.10 mg (1%) [4]. Thus, these acids and ions can be utilized as electrolytes in bio-battery materials to generate electrical energy. The acidic content within pineapple fruit can serve as an electrolyte material, influencing the voltage and electric current produced [5].

Coconut dregs are household waste resulting from coconut milk processing, with limited utilization [6]. Interestingly, coconut dregs still contain oil that can be used to generate energy [7]. Coconut dregs contain organic compounds such as lignin and cellulose, which bacteria can break down into simpler organic compounds, making them suitable as electrolyte base materials. Conventional batteries, commonly used as alternative energy sources, can lead to environmental pollution if not professionally processed, as they are difficult to decompose and pose hazards [8]. To address this issue, environmentally friendly bio-batteries can be utilized.

Method

This research employs an experimental and quantitative approach with coconut husk juice ratios (5 g:0 ml, 5 g:10 ml, 5 g:20 ml, 5 g:30 ml, 5 g:40 ml) and pineapple extract husk ratios (80 ml:10 g, 80 ml:20 g, 80 ml:30 g, 80 ml:40 g). The variables tested include electric voltage and electric current.

a. Preparation Phase

Coconut dregs and pineapple fruit were purchased from vendors at Plaju Palembang market. The collected coconut dregs were sun-dried for three days until dry to facilitate the grinding process.

b. Bio-Battery Production Phase

The sun-dried coconut dregs were finely ground using a blender and then sieved through a 10-mesh screen. Pineapple extract was prepared by blending the fruit with a

small amount of water and then filtering it. The mixture of ground coconut dregs and pineapple extract was then combined and placed into the bio-battery assembly, which used graphite and zinc as the anode and cathode. The bio-battery's current and voltage were tested using a digital multimeter.

c. Experimental setup

The experimental setup can be seen as depicted in Figure 1.

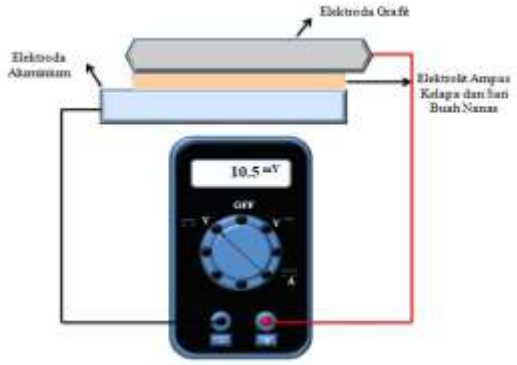

Figure 1. Electrical Testing Setup
(Source: private)

d. Instruments and Materials

The equipment utilized includes a multimeter (Sanwa CD 800a) for measuring electric current, a test sieve (size 10 mesh), a blender (Miyako Type 102 GS) for grinding materials, a digital scale (KPRO2 500 g - 0.01 g) for weighing samples, a stainless steel bowl for mixing materials, plastic sieves for filtering pineapple extract, a measuring glass (Pyrex 100 ml), and alligator clips for connecting the multimeter with graphite and zinc as electrodes.

Results and Discussion

The study on producing bio-batteries using natural materials, specifically coconut dregs and pineapple extract, followed the established procedure. This involved maintaining the concentration of coconut dregs and pineapple extract in the bio-battery production while varying the electrolyte mixtures. The electrons in the pineapple extract flow, carried by ions, thus enabling the conduction of electricity. Based on the results of voltage and electric current measurements obtained with pineapple juice variations, they can be seen in Table 1.

Table 1. Results of Current and Voltage Measurements at Coconut Dregs and Pineapple Extract Concentrations

Variation		Voltage	Current
Coconut dregs	Pineapple extract	(Volt)	(mA)
5 gr	0 ml	0,40	0,01
5 gr	10 ml	0,41	0,17
5 gr	20 ml	0,43	0,25
5 gr	30 ml	0,47	0,67
5 gr	40 ml	0,54	0,71

Table 1 shows that the combination of coconut dregs with pineapple extract produces the highest voltage of 0.54 V and a current of 0.71 mA at a 40 ml variation. In contrast, the lowest voltage is 0.40 V and a current of 0.01 mA without adding pineapple extract. These results indicate that increasing the mixture of pineapple extract leads to higher electric voltage and current, suggesting that as the volume of pineapple extract increases, the electrical output improves. The voltage and current intensity increase proportionally, thus indicating a direct relationship between current (I) and voltage (V) in accordance with Ohm's law. The voltage and electric current produced with variations of pineapple extract are presented in Figure 1.

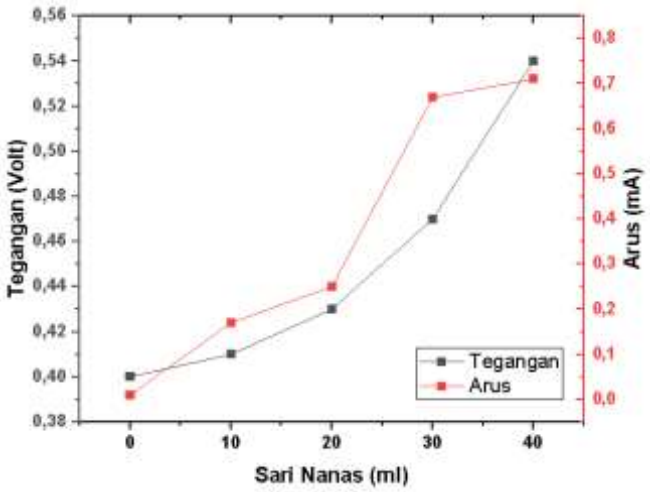

Figure 2. Voltage and Current Graph with Variations in Pineapple Extract

Figure 2 illustrates the concentration of coconut dregs towards the voltage and electric current generated with varying mixtures of pineapple extract, which increases as obtained. Research by [9] regarding the influence of varying volumes of pineapple extract solution on the voltage and current produced by the bio-battery yielded a pineapple extract solution pH value of 3.7, voltage ranging from 1.94 volts to 4.96 volts, current ranging from 1.21 mA to 16.75 mA, and electrical power ranging from 2.34 mW to 83.08 mW.

Table 2. Results of F-Test Analysis on Pineapple Extract Variations Against Electric Voltage

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,012	1	,012	24,083	,016[b]
	Residual	,001	3	,000		
	Total	,013	4			

a. Dependent Variable: Volt
b. Predictors: (Constant), ml

The results of the F-test analysis on the concentration of coconut dregs with variations in pineapple extract against electric voltage yield an $F_{Measure}$ of 24.083, which is greater than the F_{Table} value of 6.94 with a significance level of less than 5%, as shown in Table 2. It can be concluded that there is a significant effect of the relationship between the concentration of coconut dregs and pineapple extract on electric voltage. The results of the F-test analysis on pineapple extract variations against electric current can be seen in Table 3.

Table 3. Results of the F-Test Analysis on Pineapple Extract Variations Against Electric Current

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,361	1	,361	38,296	,008[b]
	Residual	,028	3	,009		
	Total	,389	4			

a. Dependent Variable: mA
b. Predictors: (Constant), ml

Table 3 shows the results of the F-test analysis on the concentration of coconut dregs with variations in pineapple extract against electric current, with an F measure of 38.296, which is greater than the F table value of 6.94 with a significance level of less than 5%. Therefore, it can be concluded that there is a significant effect of the relationship between the concentration of coconut dregs and pineapple extract on electric current. Based on the results of the voltage and electric current measurements obtained from coconut dregs variations, they can be seen in Table 4.

Table 4. Results Of Current and Voltage Measurements at Pineapple Extract Concentrations with Coconut Dregs Variations

Variation		Voltage	Current
Pineapple extract	Coconut dregs	(Volt)	(mA)
80 ml	10 gr	0,51	0,91
80 ml	20 gr	0,50	0,61
80 ml	30 gr	0,48	0,53
80 ml	40 gr	0,44	0,31

Table 4 displays that the voltage and electric current of pineapple extract, varied with coconut dregs, exhibit the highest voltage of 0.51 V and a current of 0.91 mA at the 10 g variation, while the lowest voltage is 0.44 V with a current of 0.31 mA at the 40 g variation. This shows that as the volume of coconut dregs increases, the voltage and current intensity also increase proportionally, confirming a direct relationship between current (I) and voltage (V) according to Ohm's law. The voltage and electric current produced with variations in coconut dregs are illustrated in Figure 3.

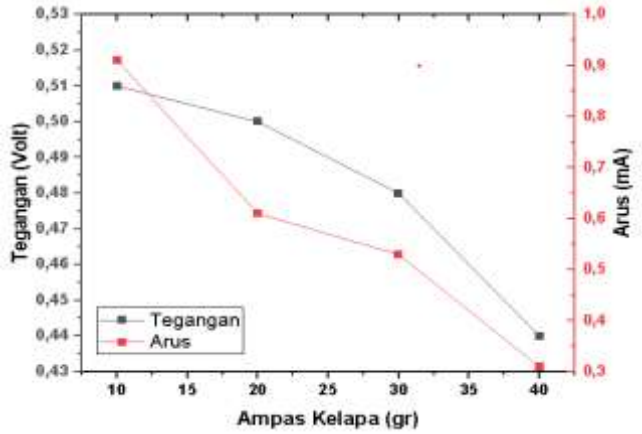

Figure 3. Voltage and Current with Coconut Dregs Variations

Based on Figure 3, the concentration of pineapple extract against the voltage and electric current generated with varying mixtures of coconut dregs decreases. Research by [10] on the mixture of coconut dregs and rotten tomatoes yielded a battery with optimal potential and current strength of 1.46 V and 2.1 mA, respectively, with a

concentration of 10% coconut dregs and 90% rotten tomatoes. Meanwhile, research conducted by [11] found that the optimum condition for the battery was achieved with a concentration of 25% coconut dregs compared to rotten tomatoes, resulting in a power output of 1.56 milliwatts.

Table 5. Results of F-Test Analysis on Coconut Dregs Variations Against Electric Voltage

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,003	1	,003	23,000	,041[b]
	Residual	,000	2	,000		
	Total	,003	3			

a. Dependent Variable: Volt
b. Predictors: (Constant), gr

Table 5 presents the results of the F-test analysis on the concentration of pineapple extract with variations in coconut dregs against electric voltage, with an F Measure of 23.000, which is greater than the F-table value of 6.94 with a significance level of less than 5%. Hence, it can be inferred that the concentration of pineapple extract and the variations in coconut dregs significantly affect the electric voltage. The results of the F-test analysis on coconut dregs variations against electric current can be seen in Table 6.

Table 6. Results of F-test Analysis on Coconut Dregs Variations against Electric Current

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,006	1	,006	,038	,858[b]
	Residual	,458	3	,153		
	Total	,463	4			

a. Dependent Variable: mA
b. Predictors: (Constant), gr

Table 6 shows the results of the F-test analysis on the concentration of pineapple extract with variations in coconut dregs against electric current, with an F-measure of 0.038, which is smaller than the F-table value of 6.94 with a significance level of less than 5%. Therefore, it can be concluded that there is no significant effect of the relationship between the concentration of pineapple extract and variations in coconut dregs on electric current.

Conclusion

The electric voltage produced at coconut dregs concentrations reached its highest value at 0.54 volts with an electric current of 0.71 mA when varied with 40 ml of pineapple extract, while the lowest voltage was 0.40 volts with an electric current of 0.01 mA without the addition of pineapple extract. Regarding pineapple extract concentrations, the highest voltage recorded was 0.51 volts with an electric current of 0.91 mA at the 10 g variation, whereas the lowest voltage was 0.44 volts with an electric current of 0.31 mA at the 40 g variation of coconut dregs. Based on the F-test results, both coconut dregs and pineapple extract concentrations significantly influenced the electric voltage produced. However, while coconut dregs concentration had a

significant effect on electric current, pineapple extract concentration did not significantly affect electric current.

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