Analysis Of Biogas Yield From Organic Waste (Vegetables, Cassava Peels And Banana Leaves)

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ABSTRACT

Until now, waste remains an unresolved issue; however, there is an effort to address the waste problem by utilizing it to produce biogas. Biogas is considered one of the renewable energy sources, as it can be derived from organic waste originating from markets, cooking leftovers, animal manure, and other waste materials. The purpose of this research is to analyze the biogas yield from various types of organic waste as an alternative source of biogas or renewable energy. The waste materials used in biogas production are cooking leftover vegetable waste, banana leaf waste, and cassava peel waste. The biogas production involves anaerobic fermentation over a period of 10 days. Biogas testing is conducted by measuring the mass of the produced biogas using a digital scale and determining the ignition time with a stopwatch. The results of this study reveal the mass of biogas produced and the ignition time for biogas from vegetable waste, banana leaf waste, and cassava peel waste, respectively. The values are 950 grams and 337 seconds, 905 grams and 83 seconds, and 765 grams and 60 seconds. It is found that the highest methane content is produced from cooking leftover vegetable waste mixed with cow dung compared to banana leaf waste and cassava peel waste.

Keywords: *Biogas, vegetables waste, banana leaf, and cassava peel*

ABSTRAK

Sampai saat ini sampah masih menjadi masalah yang belum ditemukan solusinya, namun terdapat salah satu upaya untuk mengatasi masalah sampah, yaitu dengan memanfaatkannya menjadi biogas. Biogas merupakan salah satu dari banyak energi terbarukan, karena biogas dapat diperoleh dari sampah organik yang berasal dari pasar, sisa memasak, kotoran ternak dan limbah buangan lainnya. Adapun tujuan dari penelitian ini adalah untuk menganalisis hasil biogas dari berbagai jenis sampah organik sebagai alternative biogas atau energi terbarukan. Limbah yang digunakan dalam pembuatan biogas ini, yaitu limbah sayuran sisa memasak, limbah daun pisang, dan limbah kulit singkong. Pembuatan biogas ini dilakukan dengan cara fermentasi secara anaerob selama 10 hari. Pengujian biogas dilakukan dengan mengukur jumlah massa hasil biogas dengan menggunakan neraca digital dan waktu biogas dapat menyala dengan menggunakan stopwatch. Dari penelitian ini didapatkan hasil jumlah massa biogas dan waktu biogas dapat menyala pada limbah sayuran, limbah daun pisang, dan limbang kulit dingkong secara berturut-turut sebesar 950 gram dan 337 sekon, 905 gram dan 83 sekon, 765 gram dan 60 sekon. Didapatkan bahwa kandungan metana terbanyak dihasilkan dari limbah sayuran sisa memasak yang dicampur dengan kotoran sapi dibandinganlan dengan limbah daun pisang dan limbah kulit singkong.

Kata kunci: *Biogas, Terbarukan, sampah sayuran, daun pisang, dan Kulit Singkong*

1. INTRODUCTION

Waste is a residual material that lacks economic value. According to its nature, waste is classified into two types: organic and inorganic waste [1]. Up to the present time, waste remains an unresolved issue. However, there is an effort to address the problem of waste, namely by utilizing it to produce biogas [2].

Biogas is one of the many renewable energies, as it can be obtained from organic waste originating from markets, cooking residues, animal manure, and other waste materials [3]. Biogas is produced through anaerobic activities or the fermentation of organic materials (animal manure) and household waste (such as leftover vegetables and kitchen waste). In addition to containing methane and carbon dioxide, biogas also contains carbon monoxide, oxygen, hydrogen sulfide, hydrogen, and propane, albeit in small amounts. However, among the various components found in biogas, only methane can

be utilized as a fuel [4]. The production of biogas is relatively simple, as organic waste can be used as the primary material, utilizing used plastic bottles, such as discarded Aqua bottles, as biogas reactor units [5]. The higher the concentration of organic materials in biogas, the greater the amount of biogas produced. The organic materials used include banana leaf waste, cassava peel waste, and kitchen leftovers, which can be utilized as a source of organic materials for biogas production [6].

The utilization of organic waste for biogas production offers several advantages, including the reduction of greenhouse gas effects, odor mitigation, compost production, and the generation of both electrical and thermal energy [7]. Based on the aforementioned background, there is a need for the processing of organic waste that is beneficial for life, such as transforming it into renewable energy.

2. METHODE

The process of converting organic waste into biogas is carried out through anaerobic or hermetic (airtight) decomposition, facilitated by acetophilic decomposing bacteria in the production of methane and carbon dioxide gases. Organic waste that can serve as an alternative for biogas production includes cow dung, human waste, vegetable residues, and food leftovers. This decomposition occurs through several stages, such as the hydrolysis stage, where basic elements react with water to produce substrates, the acidogenesis stage, where the oxidization process of substrates is carried out anaerobically. The oxidation process involves acetophilic bacteria producing hydrogen. The final stage is the methanogenesis stage, where methane is formed, both through primary and secondary processes [8].

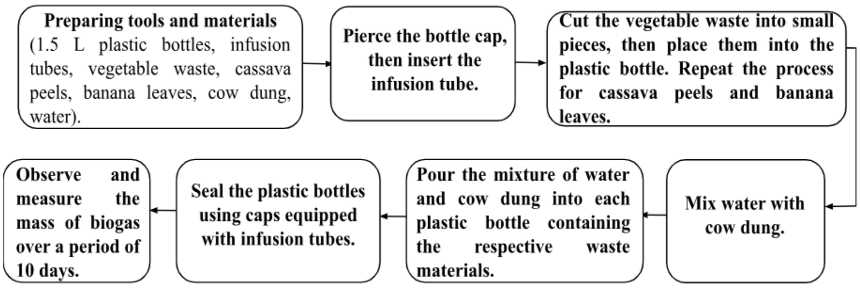

Figure 1. Biogas production proses

The tools and materials utilized in the production of biogas include leftover cooking vegetable waste, banana leaf waste, cassava peel waste, cow dung, water, 1.5 L-sized plastic bottles, and infusion tubing. Figure 1 illustrates the biogas production process. Leftover cooking vegetable waste, banana leaf waste, and cassava peel waste are finely chopped and then placed into 1.5 L-sized plastic bottles. Subsequently, water, mixed with cow dung, is poured into each waste until its mass reaches 500 grams. The bottles are then sealed tightly with infusion tubing to ensure airtightness. Following this, observations and mass measurements are conducted using a balance over a period of 10 days to monitor the biogas generated from the three types of waste.

In the production of biogas from vegetable waste, the addition of cow dung is essential to support the methane content in the vegetable waste, thereby enabling the generation of high-quality biogas. However, if biogas production solely relies

on vegetable waste without incorporating cow dung, the resulting biogas will have minimal methane content, approaching zero or being negligible. Therefore, a specific treatment is necessary for the combination of vegetable waste and cow dung in biogas production [9].

Figure 2. The combustion process of biogas

After allowing the biogas to settle for 10 days, to assess the methane content, a combustion test is conducted with the assistance of a lit candle, as depicted in Figure 2. The combustion process of biogas. If the flame intensifies, it indicates the presence of methane, and the duration of time the biogas can sustain combustion is measured using a stopwatch.

The methodology employed in this study is qualitative descriptive. The independent variable utilized is the type of vegetable waste. The specific types of vegetable waste considered include leftover cooking vegetable waste, banana leaf waste, and cassava peel waste. Meanwhile, the dependent variable is the use of cow dung. Both the independent and dependent variables influence the weight of the biogas produced over the 10-day period.

3. RESULTS AND DISCUSSION

Table 1. Observation results of biogas.

Day-	Amount of Biogas Mass (grams)		
	Cassava Peel	Banana Leaf	Cooking Vegetable Waste
0	500	500	500
1	650	800	750
2	700	800	800
3	750	900	850
4	750	900	880
5	760	900	900
6	760	905	905

7	760	905	910
8	765	905	910
9	765	905	920
10	765	905	950

The biogas production process is carried out through fermentation. This fermentation process utilizes an anaerobic system, requiring airtight conditions to ensure the optimal production of methane gas. Based on Table 1, which presents the observation results of biogas mass, it is found that all three waste types experienced an increase in mass over the course of 10 days. This phenomenon is attributed to the fermentation process and the formation of methane gas. The mass produced by the waste on the 10th day is as follows: cassava peel waste 760 grams, banana leaf waste 905 grams, and cooking vegetable waste 910 grams.

The study reveals that the highest biogas yield is obtained from cooking vegetable waste mixed with cow dung, compared to banana leaf waste and cassava peel waste. In another study (Luthfi, S.A.C., and R. Fitria), this is attributed to the decomposition process of cooking vegetable waste, leading to more optimal fermentation as the substrates from the materials used easily react with microorganisms [14].

After completing the fermentation process, a flame test is conducted on the three biogases to determine the methane content resulting from the biogas production process. This process involves directly igniting the flame at the input needle's end near a flame source (assisted by a candle) and measuring the duration of biogas combustion using a stopwatch.

Figure 3. Sequential flame tests were conducted on cassava peel waste biogas, banana leaf waste biogas, and cooking vegetable waste biogas.

Tabel 1. The duration of biogas combustion

Duration of Biogas Combustion (Seconds)		
Cassava Peel	Banana Leaf	Cooking Vegetable Waste
60 s	83 s	337 s

In Figure 3. Sequential flame tests were conducted on cassava peel waste biogas, banana leaf waste biogas, and cooking vegetable waste biogas, it is evident that the biogas produced generates a flame. However, the flame produced still exhibits a reddish color, indicating a relatively low methane content and a higher presence of other impurity gases. This aligns with findings from a study conducted by Medya Ayunda, Dhaniswara, and Trisna Kumala (2018) [13].

Furthermore, in the flame test, each biogas derived from different waste materials resulted in flames with varying durations. The flame test results indicated durations of 60 seconds for cassava peel waste, 83 seconds for banana leaf waste, and 337 seconds for cooking vegetable waste. The longest flame duration was observed in the biogas derived from cooking vegetable waste, while the shortest flame duration was recorded in the biogas from cassava peel waste.

4. CONCLUSION AND RECOMMENDATIONS

Based on the experimental results and literature review, it can be concluded that the biogas production mechanism occurs through the anaerobic process. The materials utilized include residual cooking vegetable waste, leaf litter, and cassava peel waste mixed with cow dung and water in equal mass ratios. The fermentation process is carried out for a duration of 10 days. The research findings reveal that the highest methane content is produced from the mixture of residual cooking vegetable waste and cow dung compared to banana leaf waste and cassava peel waste.

The utilization of organic waste as raw material for biogas presents a potential solution for renewable energy, simultaneously addressing the issue of accumulating waste. Therefore, we hope that alternative methods or technologies will be developed or researched in the future, utilizing different materials as sources of alternative or renewable energy.

ACKNOWLEDGMENT

As the authors of this journal, we would like to express our gratitude to Ms. Fuji Hernawati Kusumah, M.Si, as our lecturer who has assisted and guided us in completing this journal. We would also like to extend our appreciation to our colleagues who were involved in the writing of this journal, whose names cannot be individually mentioned, both during the experimentation and data collection phases, as well as in the preparation of this journal.

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