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Biogas Productivity Using Cow Feces Input and Palm Oil Empty Affluent Soaking Water

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Abstract. Soaking water of empty palm oil fruit bunches is a waste that is usually disposed of in straw mushroom cultivation. It turns out that this soaking water still contains nutrients, so it is suitable as input for biogas along with cow faeces. Therefore a study was carried out while the treatments used were P0 (cow faeces + empty palm oil bunches soaking water) and P1 (cow faeces + empty palm oil bunches soaking water + 5% bioactivator). All biogas input was fermented for 28 days, and the fermentation parameters were gas pH, gas pressure, gas volume, flame test and colour. The results showed that adding 5% bio activator significantly affected the gas produced. Maximum production in both treatments occurred on day 28, i.e. cow feces + empty palm oil bunches soaking water with a pH of 7.61, resulting in a gas pressure of 416.925 pa and a gas volume of 20 L. Meanwhile, cow faeces + empty palm oil bunches soaking water + 5% bioactivator cause a pH of 7.91, produces a gas pressure of 588.6 pa and a gas volume of 30 L.

Keyword: Biogas, Bioactivator, Cow faeces, Empty palm fruit bunches, Gas pressure

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1 Introduction

1. Utilization of animal manure can realize efforts to reduce environmental pollution. For example, cow manure can be used as biogas. The influential factor when biogas is formed in order to get maximum production is the carbon-nitrogen ratio (C/N). The C/N ratio is between 25-30, the optimum for anaerobic decomposition processes [1].

Apart from cow dung, other materials in the field can be used as a biogas mixture, such as empty palm oil fruit bunches (EPOFB). EPOFB is also used as a mushroom culture medium, and before being used as a medium, EPOFB is soaked in water for one day and one night, and the residue of soaking is usually discarded [2]; this time, it is used as a component of the mixture to produce biogas. According to [3], biogas is a renewable energy. The biogas process has 2 essential components, namely starter and substrate.

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Biogas has been used for various activities such as cooking pig food [4], as replacement energy for heaters (brooder) in chicken farming businesses [5], and as alternative energy in cafes in tourist areas [6].

2 Material and methods

This research was conducted in Tadukan Raga Village, STM Hilir District, Deli Serdang Regency, North Sumatra Province, from August to October 2022. The tools used in the study were Polyvinyl chloride (PVC) pipes for gas flow ¾ and 4 inches for substrate flow, Polyethylene (PE) plastic with a size of 4 meters and a diameter of 110 cm for the reactor, and 110 cm in diameter of 50 cm for gas containers, 1-litre mineral water bottles, tarpaulin/plastic, plastic buckets, PVC glue, faucets, sockets, rubber tires, Ph meters, biogas stoves, simple U manometers, simple gas metre ,and stationery. The materials used are cow faeces, soaking water from empty palm oil bunches, and bioactivator.

This study used 6 treatments with observational parameters, including:

(1) pH

According to [7], pH of a material is measured when a material has been mixed according to a treatment, then stirred and measured using a pH meter. This study measured the pH using a pH meter by taking 5 ml of slurry from the biogas digester.

(2) Gas Pressure

Biogas pressure measurement is done by making a simple manometer made of a hose, also known as a U manometer. After measurements using a U manometer, the water level (h) difference is obtained.

(3) Gas Volume

Biogas volume was measured by a simple gas metre which assembled using PVC pipe with a pressure of 1 bar.

(4) Flame Test

flame test was observed by flowing biogas contained in a biogas container to a fire used as a cooking medium and then measuring the length of time the flame burned. By opening the biogas channel faucet, turning it on fire, and then cooking 150 ml of water over the biogas flame, calculate how long it takes for water to boil.

(5) The Color of Fire

The colour of biogas flame is conducted by directly observing colour produced by biogas when the fire is lit.

3 Results and Discussion

3.1 Biogas Digesters

The biodigester used is a continuous feeding type biodigester with a capacity of 300 litres where the organic matter is filled every day with daily filling for P0 (3,750 kg of faeces and 3,750 litres of empty bunch soaking water) to P1 (3,562 kg of faeces, 3,562 litres of empty bunches soaking water and 375 ml of bioactivation.

3.2 Biogas Producing Materials

The EPOFB-soaked water chemical' content result is showed on Table 1. The soaked water test was conducted in the Testing Laboratory of the North Sumatra Agricultural Technology Assessment Center (BPTP).

Table 1. Analysis of the EPOFB-soaked water chemical contents

Chemical contents	Percentage (%)
C-Organik	0,03
N-Total	0,03
P2O5	0,12
K2O	0,12

Cow feces on this study was tested in order to know its chemical contents. Test was conducted at Research & Technology Laboratory, Faculty of Agriculture, University of North Sumatra. The result is showed on Table 2.

Table 2. Analysis of chemical contents of cow feces

Chemical analysis	Percentage (%)
C-Organik	32,12
N-Total	1,47
P_2O_5	0,12
C/N	21,8

3.3 pH

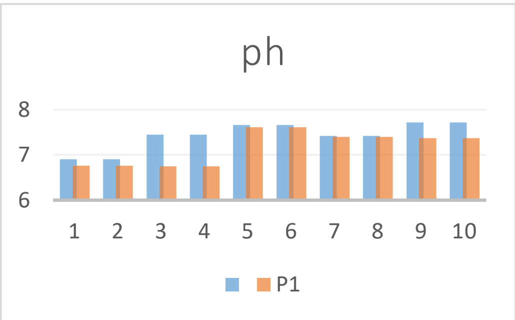

Figure 1. ph

The observation of reactor contents pH showed that there was a difference on pH between the two treatments, with a reading of a significant value smaller than 0.05 (P> 0.05). This indicates the addition of bioactivators where the lowest pH of the material in each treatment are on day 0 which is 6.90 for P0 and for P1 on day 2 which is 6 .75. In contrast, the highest initial pH of the material occurred on day 28 for P0 which was 7.72 and on day 14 for P1 which was 7.61.

3.4 Gas Pressure

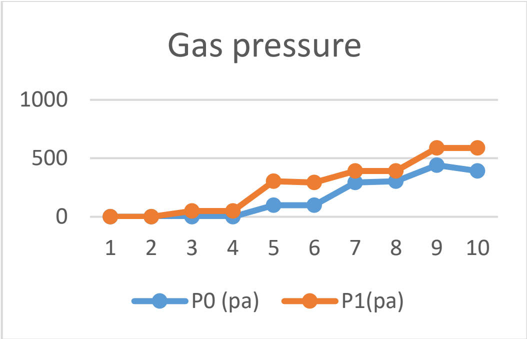

Figure 2. Gas pressure

The data above shows that the pressure on biogas production varies considerably from each treatment. Based on the Paired T-test statistical test, the gas production pressure showed a difference in the two treatments with a significance value reading of less than 0.05 (P <0.05). This indicates that the addition of bioactivator to biogas has a significant effect on the performance of increasing biogas pressure. The gas pressure at P0 on the 14th day with a pH of 7.52 produced 98.1 pa of gas; on the 21st day with a pH of 7.59, it increased to 299.205 pa and peaked on the 28th day with a pH of 7.61, the gas produced of 416.925 pa. In treatment P1 with the addition of 5% bioactivator, gas was formed starting on the 7th day with a reactor pH of 6.60 which was 49.05 pa; it increased on day 14 with a reactor pH of 7.70, producing gas of 299.204 pa, on day 21 it increased with a reactor pH of 7.75 to 392.4 pa and peak biogas production on the 28th day with a ph of 7.91 the gas produced was 588.6 pa.

3.5 Gas Volumes

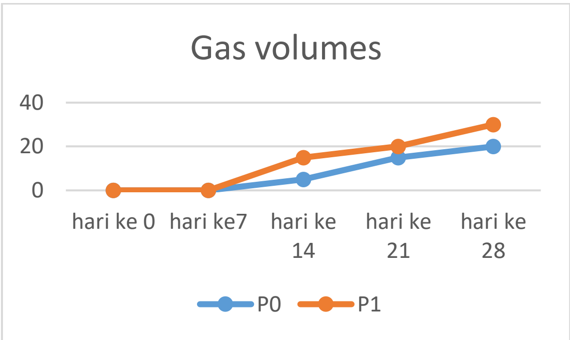

Figure 3. Gas Volumes

Based on the statistical test Paired T-test (attachment), the volume produced shows a difference in the two treatments with a reading of a significance value of less than 0.05 ($P < 0.05$). This indicates that the addition of bioactivators to biogas has a significant effect on the the volume of biogas. Where at P0, the gas volume was formed on day 14, which was around 5 L, then increased on day 21 to 15 L, and on day 28, it produced a volume of 20 L. At P1, gas volume was formed 5 L on day 7, increased on day 14 to 15 L, on day 21 to 20 L and the highest volume on day 28 was 30L.

3.6 Flame Test

The flame test was carried out at intervals of 7 days, from the 14th day to the 28th day. The flame test was conducted to determine whether gas was produced during the biogas fermentation. This aligns with [9], which states that the biogas obtained can be burned if it contains 45% methane gas (CH_4). To boil 150 ml of water in each treatment takes various times; in treatment P0, the flame test on day 14 takes 7.16 minutes to boil 150 ml of water. In the P1 treatment on day 14, it took 8.16 minutes. While the fastest time to boil water for treatment P0 occurred on day 28, the time needed was 6.12 minutes, and P1 also occurred on day 28, which required 6.01 minutes.

3.7 Fire Color

The color of the fire in the study was seen by observing the color of the fire that burned when the burning was carried out from the 14th to the 28th day with an interval of 7 days. For the P0 treatment from day 14 to day 28, the color of the fire produced was blue. The P1 treatment also produces a blue flame from day 14 to day 28; this indicates that the gas produced in biogas fermentation is of good quality. This is following research by [10]; the color of the fire produced during combustion is affected by the methane content. If the gas burns quickly and the color of the flame is blue, then the quality of the gas produced is good.

4 Conclusion

The results showed that adding 5% bioactivator significantly affected the biogas pressure, with a pH of 7.91, produced 588.6 pa of gas and a volume of 30L. At the same time without adding 5% bioactivator, the pH of 7.61, produced 416.925 pa of gas and a volume of 20L.

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