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Biogas Production from Cow Manure

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ABSTRACT: The production of biogas from livestock waste manure in particular is one of the alternative utilization of organic wastes that can be implemented in Indonesia since there is a huge potential of bio-energy in Indonesia. This study utilizes cow manure as the raw material for making biogas and it is coupled with a cow rumen fluid and water. The objective of this study is to determine the effect of manure, rumen, and water composition in biogas production. The research was conducted in anaerobic for 60 days. The composition of manure, water, and the rumen were vary following the variable and ratio; variable A (manure and water); variable B (manure and rumen). The results indicate that the variable A (manure and water) with a 1:3 ratio, and the variable B (manure and rumen) with a 1:2 ratio produced the highest volume of biogas compared to other ratios. The highest biogas production occurred on average at day 23.

Keywords: biogas; cow manure

1. Introduction

Human high dependency in fossil fuel from time to time, lead to the crude oil price increment and it is surged more rapidly. It is a huge burden for oil importing countries like Indonesia. In Indonesia, oil and gas are still the main energy source. Continuity in consuming fossil fuel will lead to dwindling of oil reserves. Based on that, renewable energy is needed.

One of the renewable energy sources is biogas. These gases derived from a wide range of organic wastes such as biomass waste, human waste, animal waste through the process of anaerobic digestion and it can be used as energy. Production of biogas from animal manure, especially cow is very potential and has an advantages, energy derived from it is very environmentally friendly since in addition to utilizing the waste from livestock, left over from the process (biogas slurry) can be used as organic fertilizer that is rich in the elements required by plants **[1]**. The uses of biogas also can reduce atmospheric greenhouse gases and other emissions. The objective of this research was to study the effect of the composition of manure, rumen, and water in biogas production.

Several factors that affect the production of biogas are the condition of the digester, pH, nutrients, temperature, the ratio C / N, and starter **[2, 3]**. The condition in the anaerobic digester must be kept in equilibrium and dynamic. The degree of acidity is maintained in the range of 6.6 to 7.6 for bacteria metanogenic can only work in above range of pH **[4]**. Adequate levels of nutrients such as nitrogen and phosphorus must be added in the system to ensure the availability of nutrients for bacterial growth **[5]**. The optimum temperature needed microorganisms to break down the material is 30-38°C for mesophilic and 49-57°C for thermophilic. The optimum ratio of C/N used in the process of biogas production is 25-30. Starter is very important part that supporting the production of biogas. It is used to accelerate the reform process of organic materials. Common starter used in biogas production are activated sludge or the content of rumen fluid **[6, 7]**.

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2. Materials and Methods

2.1 Materials

The materials used in this study were cow manure, rumen fluid which taken from RPH Semarang.

2.2 Methods

The cow manure was added into a plastic bottle and mixed with the rumen and or water in accordance with predetermined variables. It is mix briefly until all ingredients are well blended in a bottle. The bottle were covered by rubber that has been hollowed out and given a hose, then clamp the hose clamp using a clip, so in an airtight bottle, and fasten with wire. Then it is stored at temperature of 30°C about 30 days. This study used a wide range of variation in the composition of the mixture (manure and water; manure and rumen), as below:

Table 2
Variation in the composition of the mixture investigated

Run	Ratio		
	Manure	Water	Rumen
1	1	0	0
2	1	0.25	0
3	1	0.5	0
4	1	0.75	0
5	1	1	0
6	1	2	0
7	1	3	0
8	1	0	0
9	1	0	0.25
10	1	0	0.5
11	1	0	0.75
12	1	0	1
13	1	0	2
14	1	0	3
15	0	0	1

Rumen and water in ml x 100 and the study was conducted in anaerobic for 60 days.

Sample was taken every 2 days for analysis. The process of biogas production carried out for 30 days in order to know the significant differences in biogas generated by each variable.

3. Result and Discussion

3.1. Effect of Water Addition of Biogas Production

The effect of adding water to the production of biogas is analyzed by varying the ratio of manure: water respectively.

The total volume of biogas production in variation of water addition can be shown in Fig. 1. and the effect of water addition in biogas production can be shown in Fig. 2. In general the increase of water addition ratio will increase the production of biogas. In the ratio of manure: water 1:3, the system produce the highest volume of biogas. This phenomena can briefly explained since water addition is nessesary to fulfil the need of -

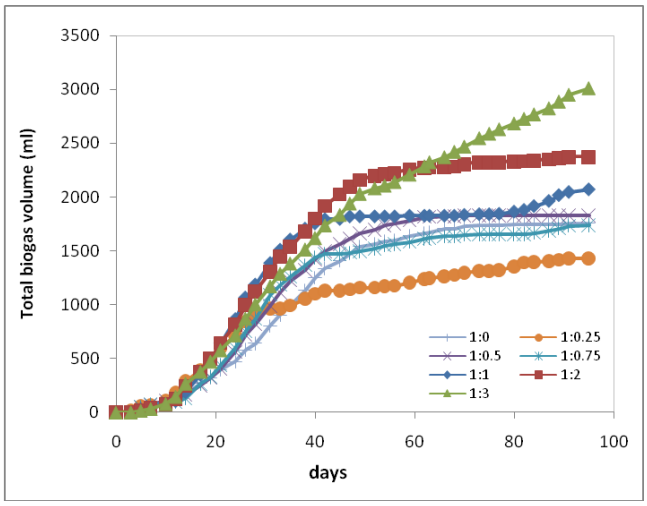

Fig. 1 Total biogas volume in variation ratio of manure: water during observation

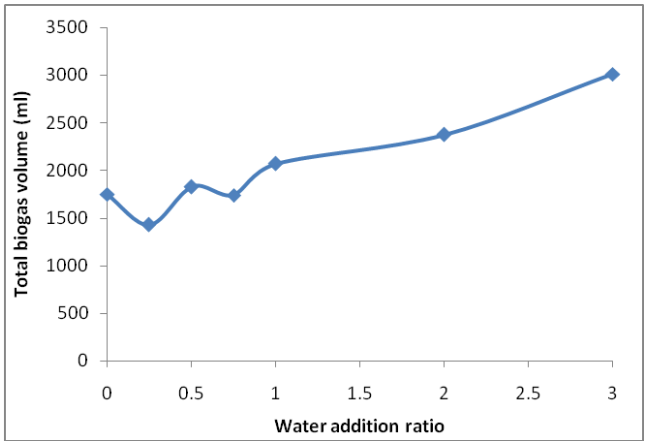

Fig. 2 The effect of water addition ratio in biogas production

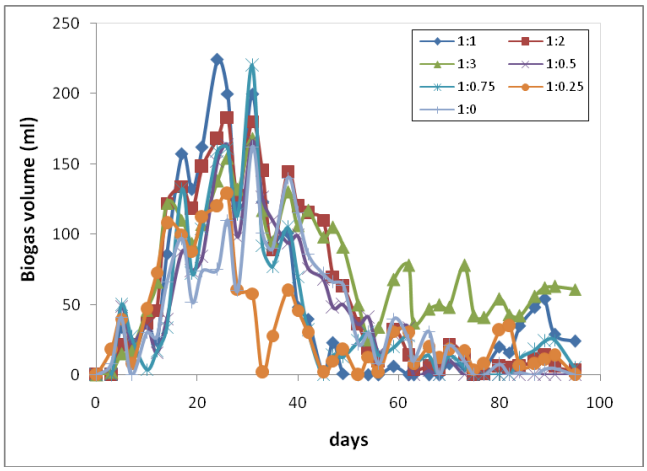

Fig. 3 The effect of water addition ratio in daily biogas production

water molecules to support the hydrolysis reaction and acetogenesis stage. At the stage of hydrolysis, hydrolytic microbes exsist in the system will degrade complex organic compounds in the form of polymers into

monomers which is insoluble compounds and smaller molecular weights.

At the stage of asetogenesis process, ethanol, propionate acid, and butyric acid were converted into acetic acid by the favor of acetogenic bacteria. In the process of converting organic acids into acetic acid molecules, water in excess amount is required so that hydrolisis and acetogenesis process can be done and produce acetic acid. This acetic acid will convert into methane gas in the final stage which called methanogenesis.

The effect of water addition in to the daily biogas production is analyzed by varying the ratio of manure: water respectively. The results of biogas production in general the increase biogas production occurred on day 4 to day 24 and at day 25 had peak biogas production and decreased beyond. Variables obtained at 1:1 increase the biogas production drastically, and gas production in this variable is not constant because water levels are not comparable with the levels of manure in the system. On the other hand, the variable 1:3, where there has been a substantial increase but decrease in gas production is also not much, biogas production can be assumed approximately constant. This is due to the ratio of 1:3 has more water content so it is very supporting the process of hydrolysis and acetogenesis. Observation in daily basis stated that the system does not produce the maximum gas but this variable generates a constant gas.

3.2. Effect of Rumen Addition Of Biogas Production

The effect of rumen addition in biogas production is analyzed by varying the ratio of manure: rumen respectively. The result can be shown in Fig. 4 and 5.

The above figure shown that in general, the increase of levels of rumen addition in the system is increasing the production of biogas. At 1:2 ratio, the total biogas volume reach the maximum point above 3500 ml. This phenomenon stated that the more levels of rumen addition in the system, the more biogas in volume will be produced.

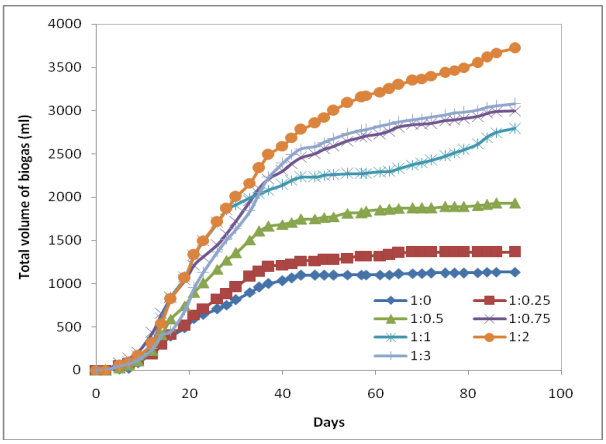

Fig. 4 Total biogas volume in variation ratio of manure: rumen during observation

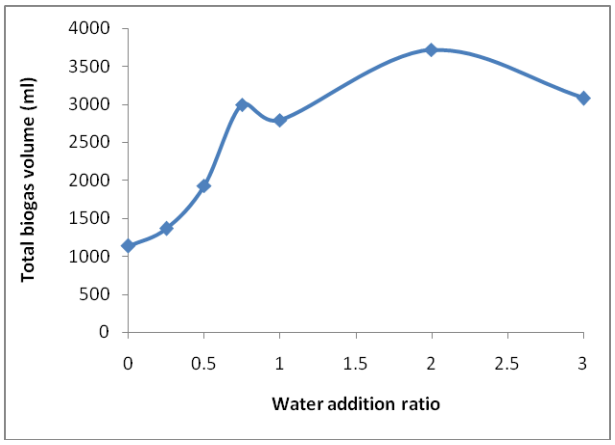

Fig. 5 Total biogas volume in variation ratio of manure: rumen during observation

But at 1:3 ratio, gas production decreased compared with the 1:2 ratio. This observation can be explained as rumen is a source of rumen bacteria (starter) derived from cow's stomach which helps in making the process of anaerobic digestion is biogas. There are posibility in 1:3 ratio, the rumen bacteria was added in huge amount and not fit with the substrate available in the system (limited substrate).

The effect of rumen addition in daily biogas production is analyzed by varying the ratio of manure: rumen respectively. The result can be shown in Fig. 6.

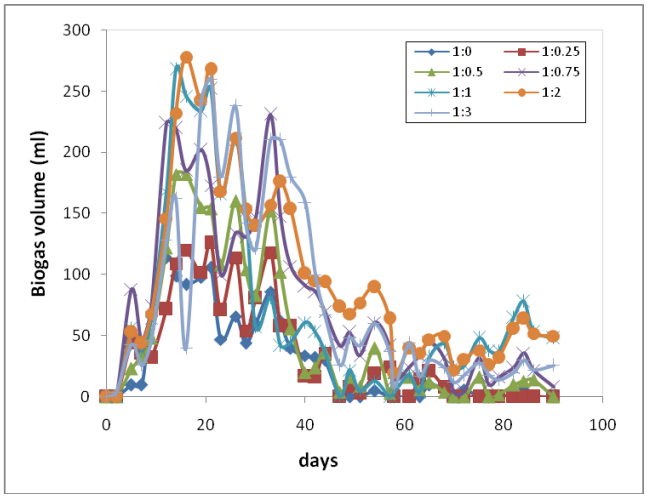

Fig. 6 The effect of rumen addition ratio in daily biogas production

Fig. 6 shows that in general the increase in biogas production occurred on day 3 to day 12, and in the day 13to 23, the biogas production were at the high productivity level. Variable 1:2 shows the highest biogas production compared with other variable. As stated before, the effect of adding rumen in the system is linier with the increased of biogas production and the ratio 1:2 provide the maximum result in biogas production.

4. Conclusion

The results indicate that the variable A (manure and water) 1:3 ratio and the variable B (manure and rumen) with 1:2 ratio produced the highest volume of biogas compared to other ratios. The highest biogas production occurred on average at day 23. Generaly the addition of water and rumen can increase the production of biogas since both raw materials supporting the two important stage in the biogas production (hydrolisis and acetogenesis) in certain level.

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