The effect of bioactivator addition to the quality of bio gas slurry

N Ginting*, Hasnudi and Yunilas

Animal Production Program Study, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *nurzainah@usu.ac.id

Abstract. The results of biomethanization process are biogas and slurry. The process of forming conventional biogas with cow feces input has a hydraulic retention time (HRT) of 30 days. In this study, an innovation was carried out by adding new bioactivator with the aim decomposition on input occur optimally and quickly. HRT of one week was showed good and stable gas production than controls. It is assumed that if the gas has stabilized, the slurry has undergone decomposition in which the slurry is a liquid fertilizer ready to use. The study design was a completely randomized design with three treatments as follows: (1) T1: control without an additional bioactivator; (2) T2: addition of biactivator 1%; and (3) T3: addition of bioactivator 2%. Bioactivator was made from waste bananas, papayas and pineapples with an additional of chicken intestines. Addition of chicken intestine was done because the bacteria in the chicken intestine are known very effective at work. The parameters measured were pH, C-Organic, N-Total, P2O5 and K2O. The results showed that T3 had characteristics as slurries which are better than T2 or T1. This means that an additional of bioactivators cause good slurry quality even though HRT is only 1 week.

1. Introduction

At this time, rural communities need two main things, that mentioned as follows: energy; needed for cooking. On average, every household with a total of 5 people needs 3 kg LPG cylinder every 3 weeks and fertilizer; needed by farmers in the process of farming. Study to address the farming community needs has been pioneered at the University of North Sumatra, especially the Faculty of Agriculture since 2010. [1] has carried out biomethanization technology research by utilizing beef cattle waste where the results were bio gas accompanied by bio gas slurry which was an organic fertilizer liquid ready to use.

In India, China and Vietnam the use of biomethanization technology is so intensive and it impacts on household savings to buy fuel and fertilizer. Utilization of slurry which is an organic fertilizer is commonly done by farmers who have bio gas units. Study results have shown that bio gas slurry is very well applied to substitute some of fertilizer needs [2]. Slurry contains not only macro elements but also micro elements that are not present in chemical fertilizers [3][4] found that every 250 ml of slurry was equal to 2.5g NPK. The bio gas unit with 50 kg daily input of cattle feces produces gas for daily needs of one household and slurry around 150 litres / day [5]. The excess of slurry can quickly treat nutrient deficiencies and able to provide nutrients quickly. Slurries as liquid organic fertilizer generally will not damage the soil and plants, and contain binding agents so that fertilizer solutions...
given to the soil surface can be directly used by plants, loosen soil, then increase binding between particles. [6] stated that the material as a liquid organic fertilizer is able to increase the cation exchange capacity (CEC), increase the availability of nutrients and improve the weathering process of mineral matter (N).

The current population of the Province of North Sumatra is around 14.5 million [7], which 60% live in villages and have livestock so that it is possible to utilize bio-gas technology. The types of livestock that are commonly used by their feces are cows, buffaloes, goats, sheep and pigs. The livestock population in 2018 were; cow/buffalo: 846,019, pigs: 1,228,951, goat: 705,559 and sheep: 908,880 [8] and if the feces is utilized through bio-gas technology, a significant amount of energy and fertilizer will be produced to help the community.

This research aims to produce bio-slurry and gas faster through the addition of bioactivators. In this paper the discussion was focused on the quality of the resulting slurry. [9] found that in the bio gas unit with brick construction and filled daily with cattle rumen, the production of slurry and bio gas was stable on day 27 while [10] in another study found that the bio gas unit from the fibre was completely filled from the start, the production of slurry and bio-gas was stable after 2 weeks. This addition of bioactivator research was assumed to cause the decomposition process on the input substrate run better so that the resulting slurry for ready application is also faster.

1.1. Process on biomethanization technology
The are 3 stages of process that takes place in biomethanization technology where digestion of organic waste occurs into bio gas, namely hydrolysis, acidification and methanization [11]. The hydrolysis stage is the initial processing stage. Inputs entered into biodigesters usually come from livestock waste. This waste generally contains cellulose, carbohydrates, lipids and protein. Complex shaped waste will be destroyed into simpler forms with the help of enzymes released by microorganisms. The result was simple sugars, amino acids, and most are in the form of Volatile Fatty Acid, ethanol, water and CO2.

In this initial anaerobic process, the one that plays a role is the bacteria forming organic acids. The main species of bacteria that digest cellulose are Ruminococcus albus, R. Flavefasiens, Bacteroides succinogenes, Butyribrio fibrosolvens, Clostridium lockheadii. The main digestive species for hemicellulose are Eubacterium ruminantium Bacteroides ruminicola. The main species of starch digesters include Streptococcus bovis, Bacteroides amylophylus and Bacteroides ruminicola. The main protein digesting species originate from protozoa, namely Entodinium and Ophryscolex and Isotricha [12].

Besides bacteria and protozoa, there are also fungi such as Neocallimastic frontalis and Sphaeromonas communis. The role of fungi is beneficial for the digestion of fibre fractions. Fungi form colonies in lignocellulosic tissue, rhizoid fungi can grow far through the cell wall of fibres thereby creating access for bacteria and cellulose enzymes to digest fibre [13].

The next step is acidification where a simple molecule undergoes a process of continued digestion into organic acids / acetate, CO2, H2S and Ammonia. Then, there was the next advanced stage called methanization where methane, CO2 and water are formed. This process is carried out by secondary bacteria where its growth is very slow and sensitive to environmental changes both physically and chemically. These secondary bacteria are several types but generally form methane gas. Methanisasi stage is the last stage of the entire process stage [14]. Various strains of methane bacteria that play a role in the formation of methane gas. The most widely used source of methane gas is carbon derived from CO2.

The deadline for the process that lasts for the above 3 stages is called Hydraulic retention Time, which is around 20-30 days. The input is filled every day and the input that filled on the first day will come out as a slurry after passing the HRT.
1.2. Bioactivator

Bioactivator is biologically active ingredient used to increase the activity of a process, for example the process in a bio gas unit. The material which is input to the bio gas unit such as cow’s feces contains fibre while in the bioactivator there are a variety of microbials which are expected to accelerate the process of breaking down the material in the bio gas unit.

In this research, microbials that develop in bioactivators are microbial origin of chicken intestine and microbials which are adaptive to the fruit waste environment, including banana, papaya and pineapple. These so-called fruits are the most wasted fruit on local market.

Bioactivator contain effective microorganisms that can actively help decompose organic matter. It is known that fruit waste contains simple sugar / sucrose needed by microbes in metabolism as an energy source [15]. Bioactivators from fruit waste also contain microbes that will assist in the process of overhauling biogas inputs such as cow dung. [16] stated that in the fruit waste bioactivator 4 types of bacteria are found, namely Clavibacter, Agrobacterium, Clostridium and Pseudomonas fluorescens. [17] stated that in research on bioactivators, several bacteria were found including Enterobacter sp and Bacillus sp.

2. Materials and methods

The study was carried out in the Animal Production laboratory, Faculty of Agriculture, University of North Sumatra in May until August 2019.

The main research material were cow feces and bioactivators. The main tool was an assembled biodigester made of plastic material with a thickness of 40 microns of 500 litre capacity. Biodigester material from plastic will facilitate the monitoring of gas formation.

The study used a statistical design that was RAL (Completely Randomized Design) with the aim of differentiating the data taken from biodigesters that have the same characteristics. Feces were mixed with water where the feces balance with water was 1:2. According to [10] dilution of 1:1 cow feces with water, but in this study it was found that a 1:1 dilution caused the substrate become too thick which could inhibit the growth of microorganism so that a 1:2 dilution was took placed with water until its consistency was like watery slurry. Then filtered so that the dilution free from grass. After that, bioactivators was inserted. There were four replications in this research. 3 treatments with biodigester fruit were as follows:

- T1 : Feces 100%
- T2 : Feces 100%+ Bioactivator 1%
- T3 : Feces 100%+ Bioactivator 2%

The research parameters are pH, C-Organic, N-Total, P2O5 and K2O

3. Result and discussion

3.1. pH

| No | Treatments   | pH   |
|----|--------------|------|
| 1  | T0           | 7.13 |
| 2  | T1           | 7.11 |
| 3  | T2           | 6.89 |

To maintain the working process of microorganisms, it is necessary to maintain an ideal pH value of pH 6-7. At the initial processing stage by microorganisms organic, acids were produced as a result of the work of acid-forming bacteria so that the pH in the reactor dropped to below 5. Next nitrogen overhaul occurred where NH4 were produced so that the pH raised. When methane production was stable, the pH remained alkaline, i.e between 7.2 - 8.2 [18].
In this study, pH of T0 was 7.13. The pH of cow’s feces was 6.6 and after it was diluted with water with a pH of 7 and a hydrolysis, acidification and methanization process were occured which caused the pH increased and became 7.13.

In T1 treatment with the addition of 1% bioactivator, a slurry pH of 7.11 was obtained. pH of T1 was lower than T0 was caused by the addition of bioactivator. Bioactivator was made from rotten fruits, palm sugar and chicken intestines with a pH of 4.2. In the T2 treatment, 2% bioactivator was added and the slurry pH was lower than the other treatments, 6.89.

The pH of the entire treatments were the ideal pH as a liquid fertilizer. A good soil pH is 6.5 to 7-5, so the pH of fertilized fertilizer should be in the soil pH range so that it does not have a negative effect, among others, on soil microbes.

3.2. C-organic (%)

Table 2. C-organic of slurry with cattle feces input and bioactivator addition

| No | Treatments | C-organic |
|----|------------|-----------|
| 1  | T0         | 0.20<sup>A</sup> |
| 2  | T1         | 0.38<sup>A</sup> |
| 3  | T2         | 1.60<sup>B</sup> |

Note: Different superscripts in the same column show a very significant different effect (P <0.01).

C-organic is a material needed to control soil physical, chemical and biological fertility [19] therefore the provision of organic material is one way to improve soil quality. In this study, the higher the percentage of bioactivators given, the higher the C-organic content. This was related to the higher microbial population in the T2 treatment so that more material was decomposed with qualifications as liquid fertilizer.

Organic C in slurry was smaller than SNI standard organic C. This can be understood because the slurry came from the feces of cattle that have experienced dilution, in this study up to 2 times. However, slurry has advantages because the condition is liquid so that the roots of the plant absorb quickly. Besides that according to [20] slurry contained with live microorganisms and was proved to be able to support the growth of Turi (Sesbania grandiflora) plants better than without the addition of slurry. Microorganism populations found in soil in Turi (Sesbania grandiflora) roots increased with increasing doses of slurry application.

3.3. N-total (%)

Table 3. N-total of slurry with cattle feces input and bioactivator addition

| No | Treatments | N-total |
|----|------------|---------|
| 1  | T0         | 0.01<sup>A</sup> |
| 2  | T1         | 0.02<sup>A</sup> |
| 3  | T2         | 0.15<sup>B</sup> |

Note: Different superscripts in the same column show a very significant different effect (P <0.01).

Nitrogen is an essential element for plants because it influences the synthesis of acids, proteins, nucleic acids and coenzymes. The N element is very influential in plant vegetative cell growth and also regulating metabolism. The supply of N elements through fertilization is preferred for plants because N is the most missing element from agricultural land.
In this study the highest N content was due to T2 treatment. This was because the population of microorganisms on T2 was highest. Microbial in bioactivator was fast developing and fast in degeneration. Microorganism itself is an amino acid so that the higher the population, the higher the element N is formed. In addition, the fruit itself contains protein so that T2 affects the N content of T2.

3.4. $P_2O_5$ (%)
Phosphorus is the main food ingredient used by all organisms for energy and growth. Phosphorus is the main element in photosynthesis. Generally, the phosphorus used comes from artificial fertilizers in the form of phosphorus oxide ($P_2O_5$). Phosphorus will be more available when applied to soils that have an ideal pH. The use of phosphorus will be better if there is a community of microorganisms in the fertilizer. Therefore, the application of slurries containing microorganisms with high populations, will greatly help the availability of phosphorus in the field.

In this study, the T2 treatment contained the phosphorus element better than the other treatments. This was related to a higher population of microorganisms. Phosphorus is mostly derived from weathering organic matter. In this study, organic matter came from cow feces and from bioactivators.

| No | Treatments | $P_2O_5$ (%) |
|----|------------|--------------|
| 1  | T0         | 0.04a        |
| 2  | T1         | 0.04a        |
| 3  | T2         | 0.08b        |

Note: Different superscripts in the same column show a significant different effect ($P <0.05$).

3.5. $K_2O$ (%)

| No | Treatments | $K_2O$ (%) |
|----|------------|------------|
| 1  | T0         | 0.22a      |
| 2  | T1         | 0.74h      |
| 3  | T2         | 0.64h      |

Note: Different superscripts in the same column show a very significant different effect ($P <0.01$).

Potassium is one of the three nutrients needed by plants in addition to nitrogen and phosphorus. Potassium helps increase plant resistance to disease. Additionally, Potassium increases the size and quality of fruit, granules, and vegetables. Potassium is quite abundant in the soil and Potassium in the soil is very easy to experience release (leaching). Potassium is needed most by plants, besides nitrogen.

In this study, the potassium content between T2 and T3 was not significantly different. This was probably because the amount of feces used in each treatment was the same that distinguishes only the percentage of bioactivators even though the element of potassium in this study mainly came from cattle feces.

4. Conclusions
Eventhough HRT only one week, the pH parameter of the slurry was in the SNI standard. The pH of the slurry from this study indicated that the slurry could be applied as fertilizer. While for other parameters, namely C-Organic, N-Total, P2O5 and K2O in the slurry were smaller than the SNI
standard. This can be understood because the slurry originated from cattle feces that have experienced dilution, in this study up to 2 times.

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