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Cabbage Waste as Raw Material for Biogas Production with Water and Chicken Manure Activator

Haesti Sembiring^{1*}, Riyanto Suprawihadi²

Departement of Environmental Health, Politeknik Kementerian Kesehatan Medan

Corresponding Author: Haesti Sembiring haestisembiring23@gmail.com

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ABSTRACT

Cabbage is the third largest commodity in North Sumatra after chili and tomatoes. in 2015 which was 70,730 tons, in 2016 the amount of cabbage production was 92,551 tons and in 2017 the amount of cabbage production was 98,325 tons, it can be seen that the trend is increasing every year. Cabbage waste that is wasted and not utilized can cause pollution and environmental pollution

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INTRODUCTION

Biogas is gas produced from the decomposition process of materials organic matter by microorganisms in the absence of oxygen (anaerobic). Materials organic matter that can be broken down by microorganisms in the biogas process can be comes from animal waste such as cow, sheep or goat manure, pig manure and chicken manure, human waste, horse manure and also from kitchen waste and plants.

To produce biogas, a biogas reactor (digester) is needed an airtight installation so that the decomposition process of organic matter can run optimally [1]. In general, all organic materials contain cellulose and lignin which take longer to decompose than livestock manure so that to produce an optimal process, the materials used should be is a mixture of agricultural waste with livestock manure (Wahyuni, 2013)[2].

Manure from livestock and humans has the potential to produce gas. Compared to cow dung, human dung, pig dung, and poultry dung more potential for gas production. Dharma research (1984)[3] explains that from 20 kg of chicken manure which is processed into biogas, biogas is obtained by 2.04 m³.

Biogas is a mixture of several gases with the main components are methane (CH₄) and carbon dioxide (CO₂), with small amounts of water vapor, hydrogen sulfide (H₂S), carbon monoxide (CO), and nitrogen (N₂). Raw materials from plants such as rice stalks, straw, or water hyacinth produce about 55% methane gas.

Water hyacinth can be used in biogas production because it has Hemicellulose content is quite large compared to other organic components. Hemicellulose is a complex polysaccharide that is polymer mixture which, when hydrolyzed, produces a derivative product that can be processed by anaerobic digestion method to produce two a simple mixture of methane and carbon dioxide, commonly known asbiogas (Ghosh et al, 1984)[4]. water hyacinth contains 95% water and make it consist of

a hollow network, has a high energy high, consisting of fermentable materials and very large potential in producing biogas [5][6].

In addition to water hyacinth, one of the plants that contain sufficient fiber high is cabbage or better known as cabbage. Fiber content or Cabbage cellulose reached 18.80% and the C/N ratio of cabbage was 25.02 and the levels of the water reaches 27% (SM Puspita, 2020)[7]. Fiber/cellulose content, ratio C/N and the high water content of this cabbage plant is likely to used as biogas.

Cabbage is an organic material that is very abundant in the Regency Karo this. Cabbage is one of the subtropical horticultural crops. This commodity is widely used as the main commodity by farmers to increase income. The amount of cabbage production in Karo Regency in 2015 was 70,730 tons, in 2016 the total production of cabbage was 92,551 tons and in 2017 the number of cabbage production is 98,325 tons [8].

Cabbage waste that is wasted and not utilized, causes the amount of excessive waste resulting in pollution and environmental pollution.

Aim of this study is to make biogas form cabbage waste with water and chicken manure activator. Cabbage comparison as raw material with water and chicken manure activator in this study was carried out varies, where the concentration ratio between cabbage, water and activator is 1 : 1 : ½ ; 1 : 2 : 1 and 1 : 1 : 1.

METHODS

This type of research is a quasi-experimental research with a post-test design test. The research was conducted to determine the rate of gas formation and how much volume of gas produced during the biogas process. This research using a post test design that is without any control. Measurement is done after research.

RESULTS

Table 1. Results of Observation of Time and Volume of Biogas Formation in the Reactor

Day	Result	Gas Volume Obtained	Gas Test
One	Reactor Material Filling (Test I) Reactor I : Concentration 1 : 1 : 1/2Reactor II : Concentration 1 : 1 : 1 Reactor III : Concentration 1 : 1 : 2		
Three	Gas Collection Tank is lifted up on Reactor II The Gas Collecting Tank has not been lifted up in Reactor I and Reactor III	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$	
Seven	Trial Igniting the gas formed in Reactor II	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not Biogas	Fire Not ignited, Smelly Gas Rotten
Ten	The Gas Collection Tank is lifted up in Reactor I and Reactor III	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$	Fire Not ignited, Smelly Gas Rotten
Eleven	Trial Igniting the gas formed in Reactor I and Reactor III	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not Biogas	Fire Not ignited, Smelly Gas Rotten
Twenty One	Trial Ignition of gas formed in Reactor I, Reactor II and Reactor III	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not Biogas	Fire Not ignited, Smelly Gas Rotten
Thirty two	Reactor Material Filling (Test II) Reactor I : Concentration 1 : 1 : 1/2 Reactor II : Concentration 1 : 1 : 1 Reactor III : Concentration 1 : 1 : 2		

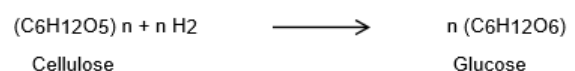
Thirty Eight	Trial Igniting the gas formed in Reactor I	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not all Biogas	Fire ignited (Spark Only)
	Trial Igniting the gas formed in Reactor II	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not all Biogas	Fire ignited: 1 minute 14 seconds
	Trial Igniting the gas formed in Reactor III	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not all Biogas	Fire ignited (Spark Only)
Fourty	Trial Igniting the gas formed in Reactor I	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not all Biogas	Fire ignited (Spark Only)
	Trial Igniting the gas formed in Reactor II	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Not all Biogas	Fire ignited: 1 minute 16 seconds
	Trial Igniting the gas formed in Reactor III	$V = 3,14 \times r \times r \times h$ $= 3,14 \times 0,245 \times 0,245 \times 0,6$ $= 0,113 \text{ m}^3$ Biogas has empty	Fire not ignited

From table 1 above, it can be seen that in reactor II gas has formed but the gas formed is not yet bio gas, this is indicated by the non-flaming of the fire between the gas collection tubes, while in reactors I and III no gas has formed at all. Reactor I and reactor III produced gas on the tenth day marked by the lifting of the 120 liter drum volume in the gas collection tube, but the gas formed was not biogas because it was tried to be ignited and the result was not lit, due to the gas formed from the reactor is not yet bio gas, the researchers refilled the biogas reactor with the innovation of cabbage waste, water and chicken manure activator. Filling is done on the day thirty two, the amount of stuffing for Reactor I is 3 kg of cabbage pieces, 3 liters of clean water and 1.5 kg chicken manure activator; for Reactor II the stuffing material is 3 kg of cabbage waste, 3 liters of clean water, and 3 kg of chicken manure activator and for Reactor III the stuffing material is 3 kg of cabbage knowledge pieces, 3 liters of clean water, and 6 kg of chicken manure activator. On the thirty-eighth day in reactor I and reactor II it was found that

gas had formed, which was indicated by the burning of fire between the gas collection tubes

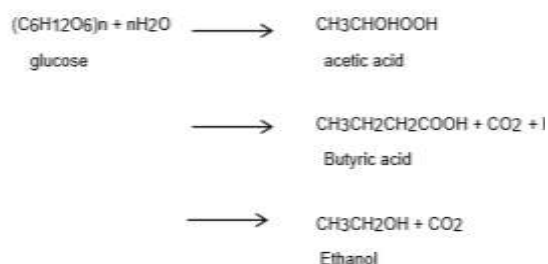
DISCUSSION

According to (Saedi, 2008)[9]. the process that takes place in the formation of biogas consists of three stages, namely the hydrolysis stage, the acidification stage and the methanogenesis stage. The hydrolysis stage is the initial stage in the anaerobic fermentation process, where polymers such as carbohydrates, fats, and proteins are converted into glucose, glycerol and amino acids. Microbes that convert complex compounds into simpler compounds such as *Cellulomonas* sp., *Chytopaga* sp., *Pseudomonas* sp., *Bacillus subtilis*., *Bacillus subtilis*., *Bacillus licheniformis*, and *Lactobacillus plantarum*.



Furthermore, after the hydrolysis stage, the process of forming bio gas in the reactor enters the acidification stage, where bacteria convert simple polymers resulting from hydrolysis into organic

acids such as acetic acid, propionic acid, butyric acid, and lactic acid and produce by-products in the form of hydrogen (H₂), alcohol, ammonia and carbon dioxide (CO₂) (Wahyuni, 2013)[10]. To convert to acetic acid, bacteria need oxygen and carbon obtained from dissolved oxygen in the solution. Acetic acid is very important in the subsequent processes used by microorganisms for the formation of methane. The reaction takes place as below:



Based on the research that has been done, it is known that to grow microbes that can convert complex compounds into simpler compounds in the contents of biogas reactors such as *Cellulomonas* sp., *Chytopaga* sp., *Pseudomonas* sp., *Bacillus subtilis*., *Bacillus subtilis*., *Bacillus licheniformis*, and *Lactobacillus plantarum* (microbes that convert cellulose compounds into glucose) and microbes that can convert simple polymers resulting from hydrolysis into organic acids such as acetic acid, propionic acid, butyric acid, and lactic acid and produce by-products in the form of hydrogen (H₂), alcohol, substances ammonia and carbon dioxide (CO₂) as well as methane-forming microbes such as *Mathanobacterium*, *Mathanobacillus*, *Methanosarcina*, and *Methanococcus* (microbes that convert short-chain fatty acids into H₂, reduce CO₂, then together with H₂ and CO₂ produce the final product, namely methane). CH₄) and carbon dioxide (CO₂) takes quite a long time, namely ± 38 day. This is indicated by the flaming of the hose on the biogas collection tube when it is burned.

In this study, it is also known that the ratio of biogas reactor materials affects the volume of biogas produced. The ratio of the reactor that produces the most biogas is 1: 1: 1 (comparison of cabbage waste, water and chicken manure activator). This is indicated by the long burning fire in the collecting tube hose. In Reactor I and Reactor III the

duration of fire after 38 days and 40 days was only lit, but in Reactor II the duration of fire after 38 days was 1 minute 14 seconds and after 40 days the duration of the fire was 1 16 seconds.

From this study it can be seen that cabbage waste mixed with water and chicken manure activator can produce biogas, this happens because cabbage waste contains 12.5% C/N (Pertwingrum, 2015) and chicken manure also contains a C/N ratio ranging from 18-25%, besides that cabbage plants also contain fiber. Ahmad Roni's research, 2012 states that cabbage waste is a place of life for a bacterium called *Lactobacillus brevis*, *Lactobacillus delbrueckii*, *Lactobacillus fermentum*, *Lactobacillus planetarium* (microbes that convert cellulose compounds into glucose). The mixture of cabbage waste and chicken manure activator is a combination to meet the requirements for the ratio of C/N ratio in biogas production, which is 25-30%. The air requirement for the biogas formation process in this study was compared with cabbage waste and chicken manure. The right ratio is 1 : 1 : 1. From this research experiment it is known that too little air (1 : 1 : ½) makes the biogas formation process imperfect, this is indicated by a flame that is only in form. If there is too much air like the ratio in reactor III (ratio 1: 1: 2), this reactor also produces biogas in the form of only. The use of air that is comparable to other materials in the reactor may occur because cabbage plants do contain a lot of air.

CONCLUSION

From the results of these observations, it can be concluded that the comparison ratio affects the rate of formation of the gas produced, even though bio gas has not yet been formed.

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