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The Effectiveness of Biogas From Chicken Manure as Alternative Fuels

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Abstract

Chicken manure with large populations actually has a negative impact on the environment because of the odor caused by ammonia gas. Producing biogas by using chicken manure as raw materials would provide solutions to environmental pollution because it was able to reduce the smell of ammonia gas. These problems can be overcome simultaneously by making it into biogas that can be used by the communities, especially those who live in rural areas. The economic value and effectiveness of biogas were tested in this study by analyzing the price of raw materials, time last of biogas, and the price of 3 kg Liquid Petroleum Gas (LPG), and the duration of use. The biogas process used simple technology (Digester) containing 6 main components in the form of a mixing bath, the main storage tank, a biogas storage tank, a bio-slurry storage tank (unused biogas waste), pipes of various sizes, opening valves or gas pressure cover and gauge. Additional components include a gas stove, gas tap, gas hose, and pipe glue. The raw material (chicken manure) that has been prepared was mixed with water with a comparison (1:1), stirred evenly then put into the main tub. This process was left for some time (7-10 hours). The analysis results showed that biogas, which was made with basic ingredients of chicken manure was still effective, compared to using gas from a 3 kg tube with a market price of IDR 35,000. The effectiveness of biogas can be seen from the price of basic ingredients, which was only IDR 10,000 per 20 kg. If it was processed to be biogas, it could produce biogas with an average usage time of 1.6 hours, while the average usage time was 3.8 hours for 3 kg LPG tubes. For four treatments (20, 40, 60, and 80 kg), the overall price was IDR 100,000, with the usage time was 12.5 hours, while the gas tube was 3 kg (3x4 treatments), resulting in the price of IDR 140,000 for the same usage time. Based on the data above showed that the use of chicken manure as a raw material for biogas can still be relatively more effective compared to 3 kg LPG.

Keywords: *Chicken Manure, Biogas, Alternative Energy.*

1.Introduction

Fuel is a very important household need, as is kerosene, which is currently scarce in the market. 3 kg LPG for the poor is one of the government's efforts to overcome this scarcity. A price of Rp 21,000 of 3 kg LPG is expected to be easy to obtain in the market, but the facts on the field that besides the price are high (because it reaches IDR 35,000/tube) also was still difficult to find because it was usually often bought up by people who want to seek more profits.

The use of biogas as fuel for cooking is still relatively rare among rural communities in the Central Kalimantan region. Oktavitri (2019) said that biogas is a fuel that can be used as an alternative option because it is a renewable energy source [1]. There have been many biogas fuels currently developed from cow, buffalo, and pig droppings, but the development of biogas from chicken manure (broiler chickens) was still relatively small. The potential of broiler chicken manure is quite big to be processed into biogas. Farms always leave problems for the surrounding environment. The smell caused by ammonia gas is very disturbing to the people who live in the environment. Ammonia gas (NH_3) generated from chicken manure reaches 1.88 ppm at source [2], which means it has exceeded the permitted threshold of 0.54 ppm [3]. Every 1,000 chicken nursery harvest can produce 1,200 kg of manure or around 1.2 kg/chicken. Febrina (2008) research showed that broiler chickens would produce 1.3 kg of droppings, and this waste can be used either as organic fertilizer or as an energy source [4]. This amount of stool is quite the potential to be processed and developed as biogas fuel, while the population distribution per cage is 1,000-5,000 [5].

Producing biogas using chicken manure is not as popular as making using cow dung, buffalo, or other livestock, which consumes more grass, while chicken consumes food that has been prepared by the factory. This does not mean that chicken manure cannot be processed into biogas, but it was predicted to have an impact on the quality of gas and the effectiveness of the materials used.

2.Literature Review

2.1. Potential Productivity of Poultry

The development of broiler chicken farms in Central Kalimantan, especially in the city of Palangka Raya and its surroundings, has reached a population of 15,500 chickens/day, or about 70% of the 21,000 chickens per day [5]. The needs of broiler chickens are only supplied from two regions, Central Kalimantan and South Kalimantan. This amount, if predicted, will produce 27.3 tons of impurities or around 27,300 kg/day. This much waste has the potential to pollute the environment surrounding the settlement. In 2020, it is estimated that chicken meat needs will increase by 15% in line with the development of the population in Central Kalimantan as well as improving economic growth in the community.
The development of chicken meat production, along with the increase of droppings or waste produced if not managed properly, it can lead to new problems such as environmental pollution. People who live around the farm because of the appearance of odor caused by ammonia gas from Chicken Manure are not a few people who protest the presence of farmers, especially those close to residential areas.
Lingga (in Wahyuni, 2011) said that Chicken Manure (broiler chickens) is one of the organic materials that affect the physical, chemical, and plant growth. Chicken droppings, in addition to having high levels of nutrients and organic matter, also save huge energy in the form of methane gas contained in ammonia gas (NH_3) [6]. The content of chicken droppings consists of 57% water content, 29% organic matter, 1.5% Nitrogen, P_2O_5 1.3%, CaO_4.0%, while the C/N ratio reaches 9-11% [7].
Chicken droppings, which are the basic ingredient of biogas, is produced by methanogenic bacteria from materials that can decompose naturally. Biogas, which has the main content (CH_4) and carbon dioxide (CO_2), in general, the production process of biogas (digester), is designed airtight so that the decomposition process by microorganisms can run optimally. According to Indri (Harabab, 1978) and Arianto et al. (2019), it is said that livestock waste, which includes solid and liquid waste, feces, urine as a whole if decomposed with microorganisms can be a source of energy in the form of biogas. This is caused because a nitrogen-rich protein in animal feed that is not fully converted into animal products. Furthermore, it is said that droppings and humans have the potential to produce gas [8], [9].
Handayani (2006), from the results of her study it was explained that every 20 kg of chicken manure could produce 2.04 m^3 of biogas, which means that for 1 kg of droppings can be obtained 0.102 m^3/kg of biogas. The potential for energy is huge [10].

2.2. Biogas Technology

Methane gas is formed due to anaerobic fermentation process (without air) by methane bacteria or also called anaerobic bacteria that reduce the waste that contains a lot of organic matter (biomass) so that methane gas (CH_4) when burned can produce thermal energy. This process occurs scientifically in certain places as a gas explosion event formed under a pile of rubbish in Leuwigajah Final Waste Disposal Site (TPA), Bandung Regency, West Java [11]. Methane gas is the same as liquid petroleum gas (LPG). The difference is that methane has one C atom, while LPG has more.

3. Research Methods

3.1 Place and Time of Research

This research was carried out in Palangka Raya City, and biogas raw materials in the form of livestock waste (chicken droppings) were taken from chicken farms in Kereng Bangkirai Village, Palangka Raya City. The research period was eight months, starting from preparation, data collection, field trials, data analysis, data processing, and final report preparation.

3.2 Theoretical Approach

The quality of biogas is largely determined by the basic ingredients of the gas production, the basic material referred to broiler chickens manure, which was actually very rich in ammonia gas content (NH_3). Ammonia gas has the potential to pollute the environment so that it can disrupt the activities of the surrounding community. Chicken manure that is under the cage within 24 hours will occur fermentation with the emergence of a population of microorganisms that can decompose it completely. Taiganides ((1977) in Pribadi, 2008) states that the work process of these microorganisms needs to be given sufficient and enclosed space or space to accommodate the gas caused by the process [12]. (Afra (2010) in Sanjaya, 2015) this gas collection has become part of the process of producing biogas that can be utilized by the community [13].

3.3 Research Step

This research is experimental research. The treatment is given in the form of :
1. Biodigester consisted of 6 main parts: making mixing tanks, making main storage tanks with a capacity of 1000-1200 liters, gas reservoirs (biogas), processing dung delivery tubs (process waste) which then can be used for agricultural purposes (fertilizer), manufacture of gas delivery valves and the manufacture of gas distribution installations resulting from the process towards the gas stove.
2. The mixing tank was sufficient, with a capacity of 40-50 liters. The function was to mix the raw material of chicken manure with water in the ratio (1:1). The results of this mixing were then entered into the main tub (the tub of fermentation), here it takes 7-10 hours to perfect the process of fermentation. The results of this process in the form of biogas were channeled to a gas reservoir, while the processed waste (bio-slurry) results of the process will be distributed in the waste collection basin for farmers to use as fertilizer.
3. The biogas contained in the gas storage has then flowed through the installation pipe to the gas stove that was prepared beforehand. This channeled gas must first pass through an opening/closing valve and pass through a pressure detector (manometer) in order to maintain safety before use.
4. The effectiveness test of the production of biogas can be done by analyzing the raw materials used in the form of biogas that was used (the time of use), the conversion of raw material prices, and the duration of the flame in a single process. As a comparison to get better data, a comparison calculated using the length of time of use a 3 kg LPG tube at a standard price.
5. Data results obtained from this process and found the value of effectiveness in economic terms by comparing the price of raw materials used, the length of use of biogas, and the comparison with the price and duration of use of 3 kg LPG tube.

3.4 Research Design

The main tank (digester) served to collect impurities that will be used as a basis for biogas. The main tank was also required mixing tank, where the mixing tank was made next to the main tank. The mixing tank was positioned with the main tank to facilitate the flow of entry of raw materials that have been mixed with water into the digester. Furthermore, preparing a gas tube or a place to hold gas that has formed from the previous process can flow into this place. Gas tubes are used in the form of thick plastic with a size that adjusts the amount of dirt processed into gas. Furthermore,

it was channeled to a gas stove that has been prepared in the house. The gas that was formed will be able to light a gas stove that has been installed.

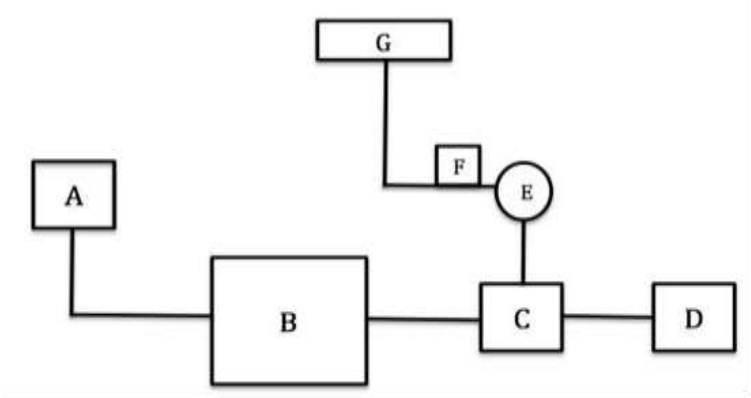

Figure 1. Research Design

A : Mixing Tub
B : Main cross-section
C : Gas tank
D : Waste Tub (unused slurry)
E : Closing/opening valve
F : Pressure gauge
G : Gas stove

3.5 Research Flow Chart

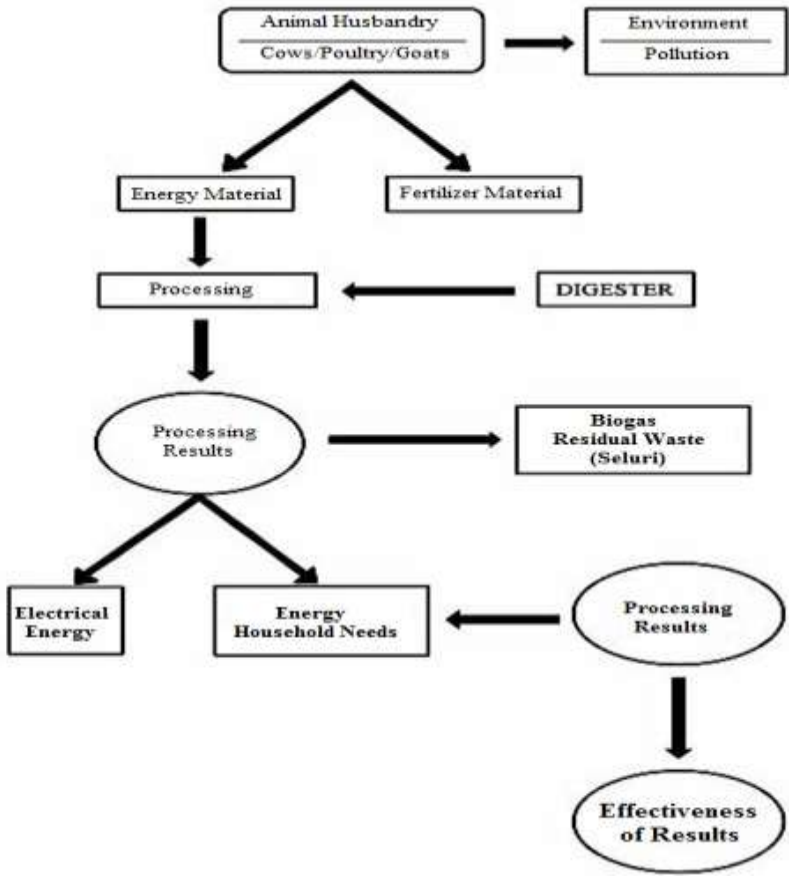

Figure 2. Research Flow Chart

4. Results and Discussion

4.1 Result

The results of research conducted with various variations or composition of the weight of raw materials used ranging from 20 kg, 40 kg, 60 kg, and 80 kg all of these were recorded at how long the flame produced from each of these compositions. While as a comparison, 3 kg LPG tubes were bought in the market to measure the level of efficiency and effectiveness of chicken manure biogas. All data obtained while conducting research can be seen in the results of the study of table 1, table 2, and table 3.

4.2 Research Result

Table 1. Comparison of Usage Time

	Chicken Manure	Usage Time (N_1)		LPG Tube 3 Kg	Usage Time (N_2)
	20 Kg	1,6 Hour		3 Kg	3,8 Hour
	40 Kg	2,5 Hour		3 Kg	4,2 Hour

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	60 Kg	3,7 Hour		3 Kg	3,9 Hour
	80 Kg	4,7 Hour		3 Kg	4,3 Hour
Total		**12,5 Hour**	**Total**		**15,2 Hour**

Based on table 1, it can be seen that there was an increase in the time of use of biogas in each addition of raw materials. The first treatment with 20 kg of chicken manure produced biogas with a usage time of about 1.6 hours. The second treatment with 40 kg of obtained a usage time of about 2.5 hours. The third treatment with 60 kg obtained usage time of about 3.7 hours. The fourth treatment with 80 kg obtained usage time of about 4.7 hours. Looking at the movement of data both from the addition of biogas raw materials and the length of time the use of biogas produced, there was an increase of 0.9-1.2 hours. This figure shows that when the initial calculation basis of 20 kg, the biogas production can be used for 1.6 hours. This meant that if the raw material for biogas was added up to 100% (become 40 kg), there would be an increase in usage time of 0.9 hours to a total of 2.5 hours. Addition to 60 kg of biogas raw material will also increase the usage time by 1.2 hours to 3.7 hours usage time.

While in the use of 3 kg gas tubes as a comparison, it can be seen in the table above, the length of time used varies depending on the figure (3.8-4.3) hours or an average of around 4.05 hours/tube. Given the efficiency factor, which was the main objective in this study, the next step was to compare the price of biogas raw materials with the price of LPG gas contents in a 3 kg tube. The use of raw materials, as in table 1, it will be easier to confirm the price of raw materials used. The following is in table 2 the comparison of the price of raw materials (poultry drop per 20 kg, 40 kg, 60 kg, and 80 kg) with the price of 3 kg LPG :

Table 2. Comparison of Fuel Purchase Prices

	Chicken Manure	**Price (X_1)**		**LPG Tube 3 Kg**	**Price (X_2)**
	20 Kg	IDR 10.000		3 kg	IDR 35.000
	40 Kg	IDR 20.000		3 kg	IDR 35.000
	60 Kg	IDR 30.000		3 kg	IDR 35.000
	80 Kg	IDR 40.000		3 kg	IDR 35.000
Total		**IDR 100.000**	**Total**		**IDR 140.000**

Table 2 showed that the price of raw materials for every 20 kg is IDR 10,000 or IDR 500/kg. While the price of 3 kg LPG gas in the market, especially in Kereng Bangkirai Kelurahan, reached IDR 35,000/tube (this price was obtained on November 12, 2019). Based on the data above, by purchasing chicken manure raw materials as much as IDR 100,000 after passing through the process of producing biogas has a usage time of 12.5 hours. Meanwhile, if using 3 kg of LPG gas reached IDR 140,000 (4 times the purchase), the usage time reaches 16.2 hours. Data was made on average so that a household can spend as much as Rp 100,000 to buy chicken manure biogas with a usage time of 12.5 hours. Meanwhile, if you buy 3 kg of LPG gas on the market at a price as above, the household can use it for cooking with a usage time of around 16.2 hours. The difference in expenditure between buying LPG gas and buying chicken manure for 4 treatments is IDR 40,000,- and the difference in usage time between biogas and LPG gas was around 3.7 hours. The calculation of its effectiveness can be seen in Table 3 below.

Table 3. Comparison of the Economic Value of Biogas Fuels with 3 Kg LPG Gas Tubes

	Raw Material	**Price (X_1)**	**Usage Time (N_1)**		**Raw Material**	**Price (X_2)**	**Usage Time (N_2)**
	Chicken Manure 100 Kg	IDR 100.000	12,5 Hour		LPG Tube 3 Kg	IDR 140.000	15,2 Hour
	Chicken Manure 200 Kg	IDR 200.000	25 Hour		LPG Tube 3 Kg	IDR 280.000	32,4 Hour
Total		**IDR 300.000**	**37,5 Hour**	**Total**		**IDR 420.000**	**48,6 Hour**

The raw material, which amounts to 100 kg at a price of IDR 100,000, can produce biogas around 12.5 hours. While for 3 kg, LPG gas by buying 4 tubes at the price of IDR 140,000 produced a time duration of use of 16.2 hours. If the raw material for chicken manure, which amounts to 200 kg at a price of IDR 200,000, can produce a duration of use of 25 hours (as for LPG gas for 3 kg size with a 32.4hour-long usage), it meant that for every purchase of raw material for chicken manure as much as IDR 100,000, the household could enjoy the results of biogas with a usage time of 12.5 hours or only about IDR 8,000/hour. Meanwhile, if you use 3 kg LPG gas tubes, the average value was Rp 8,600/hour. Based on the above data, it can be concluded that the use of biogas was cheaper at around IDR 600- every hour. But if the price of 3 kg LPG was around IDR 30,000/tube, it would still be more effective to use LPG tubes than chicken manure biogas.

5. Conclusion

Based on the results of the study, it can be concluded, namely as follows:

a. Effectively used and developed as a basis for producing biogas, especially for household classes. This effectiveness was based on intensive research results with a variety of standard composition used.

b. Effectiveness can be measured from the time of using biogas after undergoing a process in the digester, gas levels produced from chicken manure, and then compared with the use of 3 kg LPG.

c. Biogas produced based on the average time of use reached 3.1 hours per 20 kg of chicken manure, while the use of LPG tubes reached 3.8 hours/tube

d. In terms of economic aspects, the use of biogas from chicken manure was only IDR 8,000/hour, while the use of LPG tubes reached IDR 8,6800/hour.

6. Suggestion

The chicken manure that is used should be processed directly. It means that good manure falls not directly to the ground, but are given a base to prevent them from being mixed with the soil. There needs to be an appropriate measure to determine the right ratio between chicken manure with the amount of water used as a mixer, and it needs to be evenly mixed, so that chicken manure is no longer found in lumps. Probiotics used should be from the intestines of cows because by using the intestine from this, it can more quickly form methane gas in the digester. Gas pressure measuring devices formed from digesters should be provided with a gauge (barometer) so that it can be known how much gas pressure is formed from chicken manure biogas. A neat and strong gluing system contributes greatly to the rapid process of methane gas formation because under such conditions, it is certain that there is no circulation of air in and out of the digester except in the production and exhaust holes.

References

[1] N. I. Oktavitri, W. B. Pratiwi, I. Purnamasari, M. Hayati, M. R. Fitrianingtyas, and S. Hadinnata, "Anaerobic Digestion of Slaughterhouse Wastewater: CO 2 Capture of Biogas Using Chlorella vulgaris," Indones. J. Chem., vol. 19, no. 1, **(2018)**, pp. 1–8.
[2] P. Abustan, "Reducing the intensity of Ammonia Gas Chicken Manure by Using Lime and Soybean Plants at Bangkeng Bangkeng Ranch Farms," J. Sustain. Environ. Manag. **(2018)**.
[3] "Government Regulation (Permen) Environment" **(2008)**.
[4] N. Febrina, "Central Kalimantan Poultry Farmers Association, Animal Productivity, and Broiler Poultry Distribution in Palangka Raya and surrounding areas," Distanak of Central Kalimantan Province, **(2018)**.
[5] Kalimantan, Agriculture and Animal husbandry Departemen of Central. **(2008)**.
[6] W. S, Producing Biogas from Various Wastes. Jakarta: PT. Library Media Agro., **(2011)**.
[7] H. Indri, "Test Difference in the Composition of Cattle Droppings Mixtures with Some Agricultural Waste Products on Biogas Produced," University of North Sumatra (USU), **(2009)**.
[8] A. and G. S. Harahap F M, "Biogas Technology," Development Technology Center of the Bandung Institute of Technology., **(1978)**.
[9] P. Arianto, A. R. Tualeka, D. Andarini, P. Rahmawati, S. S. Russeng, and A. Wahyu, "Determination of Ammonia Gas Safe concentration in chicken Farm Workers in Lembak Village, South Sumatra Indonesia," Indian J. Public Heal. Res. Dev., vol. 10, no. 9, **(2019)**, pp. 745–750.
[10] T. Handayani, "Biogas from Animal Husbandry Waste as Alternative Energy Sources," J. News, vol. 16, no. 3, **(2006)**.
[11] Compass, "A Gas Blast That Occurred Under a Pile of Garbage at a TPA in Leuwigajah caused by Biogas Formation," Bandung Regency, West Java, 17-Mar-**(2005)**.
[12] A. Pribadi, "Utilization of Biogas as Alternative Energy," Surakarta University: Solo., **(2008)**.
[13] D. Sanjaya, "Production of Bogas from Mixed Droppings with Chicken Droppings," J. Agric. Eng. Lampung, vol. 4, no. 2, **(2015),** pp. 127–136.