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Processing Cow Manure Waste into Biogas as an Effort to Control Livestock Waste

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ABSTRACT: Livestock waste consists of two types of waste, namely liquid and solid. Solid waste consists of animal manure and leftover animal feed, while liquid waste consists of livestock sanitation wastewater, animal urine, and barn wash water. One example of a renewable energy source that has not yet been fully utilized is organic materials, one of which is cow dung. Cow manure can be used as a basic material in the production of biogas through an anaerobic fermentation process to generate energy. The aim of this research is to use cow dung as organic waste as an alternative energy source for biogas and simultaneously reduce the environmental pollution impact of livestock waste. The research methods used were observation and experimentation to determine how to produce biogas from cow dung waste. The research results indicate that there is a high possibility that cow dung can be used as an organic raw material to produce biogas. Methane gas can be produced during the production process starting from the 16th day after fermentation and continuing until the 25th day. A longer fermentation process results in a larger gas volume, as indicated by the daily increase in digester volume.

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INTRODUCTION

The majority of the Indonesian population can invest in cattle farming because there is plenty of agricultural land and profit available in the tropical regions. Additionally, since cattle farming significantly contributes to the livelihoods of a large number of people, economic factors also play an important role. According to Putri et al. (2019), farmers must have at least three to four cows in rural areas of Indonesia.

The number of cattle farmers in the Indonesian region has both positive and negative effects. Cattle are a livestock commodity that is economically profitable. The demand for beef in Indonesia continues to increase every year along with the rise in import rates. (Ploransia et al., 2022). Cattle farming also has negative impacts, especially on the environment, but this trend encourages people in rural areas with vast lands to develop cattle farming businesses.

Livestock waste consists of two types of waste, namely liquid and solid. Solid waste consists of animal manure and leftover animal feed, while liquid waste consists of livestock sanitation wastewater, animal urine, and barn washing. The level of environmental cleanliness will be directly affected by the livestock waste produced by this cattle farm. According to Saputro et al. (2014), three types of livestock waste can cause hygiene problems, including the production of noxious gases, soil contamination due to excessive livestock manure, and water pollution. This is why it is important for farmers to pay attention to livestock waste management.

Biogas is a flammable gas that comes from animals and humans. Utilizing anaerobic microorganisms to ferment manure is the process of its production (Wahyuni, 2013). Nutrients are a source of energy for anaerobic bacteria to carry out anaerobic reactions.

There is a possibility that these nutrients consist of amino acids and essential vitamins, which can be added to the media to provide certain nutrients for growth and metabolism. In addition, magnesium, calcium, sodium, barium, selenium, cobalt, and iron. Effendi (2018) the problem of cow dung waste is often overlooked by many cattle farmers. Generally, cattle farm waste is not well managed; some farmers even dispose of their waste directly into public waters.

One example of a renewable energy source that has not yet been fully utilized is organic material, one of which is cow dung. Cow dung is often scattered on the streets, even around residential areas, causing air and soil pollution. Therefore,

processing is necessary. cow dung that is properly and beneficially processed, which is converted into biogas through an anaerobic fermentation process to produce renewable energy (Samosir, 2021).

To enhance microbial activity, biogas primarily consists of methane and carbon dioxide. With a high methane (CH4) content in cow dung and a calorific value of 4,800–6,700 kcal/m3, biogas is an excellent energy alternative. In addition, the combustion of methane gas does not have a negative impact on the environment (Wardana et al., 2021).

With the cattle development program, Ngada Regency grew by 4.96% per year from 2016 to 2018 (BPS Ngada, 2019). According to the law, Riung District is one of the districts that must be prioritized for cattle development. Especially in dry and wet regions, cattle farming is considered one of the main commodities, supporting its primary role in local economic growth.

Natural resources, namely land, water, and local livestock farming culture, support it. From a socio-cultural perspective, cattle play an important role in fulfilling the ceremonial events of the Ngada community, including the Riung District. Cattle are significant in several social and cultural needs, such as being a source of meat for feasts, in various traditional ceremonies like weddings, celebrations, and funerals, as well as sacrificial animals for the construction of traditional houses.

However, the processing of cow dung waste in Ngada Regency has not yet been implemented, so the researchers are seeking solutions to the livestock waste problem, particularly the solid waste from cow dung. The aim of this research is to use cow dung as organic waste as an alternative energy source for biogas and simultaneously reduce the environmental pollution impact of livestock waste.

METHOD

This research uses observation and experimentation to determine how to produce biogas from cow manure waste. Cow dung biogas was fermented for 25 days, and a flame test was conducted on days 10, 16, and 25 after the biogas fermentation.

DISCUSSION

The amount of cow dung, the concentration of chemicals in cow dung, the ratio of the mixture of water, probiotics, and cow dung, the size of the biogas installation, the biogas model, and the temperature are some factors that can affect the process of processing cow dung into fertilizer and biogas. This is because the amount of gas produced from the fermentation of cow dung is proportional to the duration of the fermentation process.

Among other ruminant livestock products, cattle produce the highest CH4. In Indonesia, the cattle farming subsector generates the largest CH4 emissions, accounting for 65.12% of ruminant emissions or 58.84% of CH4 emissions from all livestock products. As a result, livestock growth will increase CH4 emissions in Indonesia. To reduce the gas emission effects from livestock manure, the manure must be processed to contain more CH4, which pollutes the environment. Because cow dung already contains methanogenic bacteria found in the stomachs of ruminants, it is an ideal substrate for biogas production. The bacteria in the large intestines of ruminant livestock assist in the fermentation process and enable faster biogas formation in the biodigester (Irawan et al., 2020).

Cow dung is a wet waste from farms that is often mixed with urine and livestock bath water when disposed of. The nutrient content in cow dung varies depending on the productivity state of the cows (dairy cows, beef cattle, etc.), the type of feed, and the amount of feed, but the highest nutrient is cellulose (Sugiono et al., 2023). Considered an ideal source of bio gas, cow dung contains methane-producing bacteria found in the stomachs of ruminant animals.

Because cow dung contains these three organic materials, the conversion of methane gas is easier to carry out. One method to determine suitable organic materials for use as additives in biogas systems is by knowing the carbon (C) to nitrogen (N) ratio, also known as the C/N ratio (Naufal, 2022).

For organic materials, the researchers added straw and rice bran in this study. In this experiment, the researchers added straw and rice bran as organic materials. The ratio used for the amount of manure, water, straw, and bran is 3:2:1:1. The methane content in biogas can be increased by adding straw.

This is in line with the research conducted by Elyza (2020), which found that the addition of straw to cow dung can increase average daily production, shorten production time, and increase the methane content in biogas. The moisture content of fresh rice straw ranges from 20 to 26 percent, and when cooked, the moisture content usually decreases to 12–14 percent (wet). The amount of volatile matter in rice straw ranges from 60.5% to 69.70%, distinguishing it from other biomass resources (Pal et al., 2022).

Biogas is produced from the fermentation of anaerobic bacteria in several stages. At the beginning of fermentation, anaerobic bacteria break down the chemical structure of organic materials such as cow dung and straw into simpler molecules, such as converting polysaccharides into monosaccharides and proteins into peptides and amino acids.

Anaerobic bacteria produce acetic acid from simple compounds that have been hydrolyzed into acetic acid, hydrogen, and carbon dioxide. To produce acetic acid, anaerobic bacteria require oxygen and carbon dioxide, which are obtained from dissolved oxygen in the solution. Therefore, the water composition must be abundant to meet the needs of anaerobic bacteria. (Irfan et al., 2023).

The experimental results show that the production of biogas from cow dung has been observed since day 16, as the flame burst from the pilot flame indicates that gas is being released from the biogas digester. On the 25th day, a biogas production test was also conducted, which produced more biogas and a stronger odor than the previous test. A test was also conducted on the 10th day, but the results did not show a flame, indicating that not much gas was produced during fermentation. The results varied in each test at different times, showing that anaerobic bacteria can ferment the digester well every day. These results indicate that the longer the biogas ferments, the more gas is produced.

CONCLUTION

The research results indicate that there is a high possibility that cow dung can be used as an organic raw material for producing biogas. Methane gas can be produced during the production process from the 16th day after fermentation and continues until the 25th day. A longer fermentation process results in a larger gas volume, as indicated by the daily increase in digester volume.

At the stage of mixing the composition of water and animal manure, more water should be used because water is the fermentation medium for anaerobic bacteria, which will decompose organic matter and affect the volume of gas produced. Temperature, acidity level, organic material composition, and manure quality are all factors that affect the quality of gas produced during the biogas production process.

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