Global Scientific JOURNALS

GSJ: Volume 13, Issue 8, August 2025, Online: ISSN 2320-9186

www.globalscientificjournal.com

Comparative analysis of Bio-gas produced from Cow dung and Poultry dung.

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Abstract

This study compares biogas production from cow dung and poultry dung, aiming to evaluate the efficiency and yield of biogas generation from these two organic substrates. Biogas, primarily composed of methane and carbon dioxide, is a valuable renewable energy source, and understanding the potential of different feedstock is crucial for optimizing biogas production processes. The research involved anaerobic digestion of both cow dung and poultry dung under controlled conditions, measuring biogas yield, methane content, and digestion efficiency over a specified retention time. Results showed that poultry dung produced significantly higher biogas yields compared to cow dung, attributed to its higher organic matter content and nitrogen levels, which enhance microbial activity during digestion. The study also explored the impact of various operational parameters, such as pH, on biogas production efficiency. These findings suggest that while both substrates are viable for biogas production, poultry dung presents a more effective option for maximizing methane output. This comparative analysis highlights the potential of utilizing poultry dung as a superior feedstock for biogas production, providing insights that could inform strategies for sustainable waste management and renewable energy generation in agricultural systems.

Key Words: Cow dung, Poultry dung, Substrates, Bio-gas and yield

Introduction

Biogas production from organic waste has gained significant attention as a sustainable energy solution, particularly in the context of agricultural residues such as cow dung and poultry dung. Both types of manure are rich in organic matter and possess the potential for anaerobic digestion, a process that converts organic materials into biogas, primarily composed of methane and carbon dioxide. Previous studies have shown that the composition and microbial community in these manures can influence biogas yield and quality (Amani et al., 2018). Cow dung is often characterized by its higher fiber content, while poultry dung is richer in nitrogen and phosphorus, leading to differences in the efficiency of biogas production (Rao, 2020). This comparative analysis aims to explore the biogas production potential of cow dung and poultry dung, evaluating factors such as substrate composition, digestion efficiency, and environmental impact, thereby contributing to the understanding of how to optimize biogas production in agricultural practices.

Because of its potential as a sustainable energy source, the production of biogas from agricultural waste has attracted a lot of attention recently (Chandra et al., 2012). One of the most popular agricultural waste products used to produce biogas is cow and poultry manure (Kumar et al., 2018). Growing interest in producing biogas from organic substrates is a result of the search for sustainable energy options. Particularly for the production of biogas, animal manure presents a viable feedstock. Cow dung and poultry dung are the most common types of animal excrement because of their accessibility and nutrient-rich makeup. The creation of biogas from these substrates solves waste management and environmental issues in addition to offering a renewable energy source. This study compares the creation of biogas from cow and poultry manure, looking at variables including biogas yield and composition, production and quality of methane, retention duration and digestion efficiency, analysis of nutrients, and the possibility for fertilizer environmental impact and economic feasibility.

By looking into these factors, the study hopes to determine which animal dung substrate is best for producing biogas, which will aid in the creation of waste management plans and sustainable energy sources. One crucial element that improves the production of biogas is seeding. It has been demonstrated that it takes a few days for the digester to begin producing gas after being fed freshly made slurry. However, gas production begins instantly after seeding (Stephen, et al., 2013).

This study intends to: identify the best substrate for biogas production based on energy yield, quality, and production efficiency; examine the impact of digestion parameters on biogas production and quality; and explore the potential of cow dung and poultry dung as biogas substrates. Assess the sustainability of the environment and the economic feasibility of producing biogas from these substrates. Make suggestions for the use of biogas, substrate selection, and digestion optimization.

2. Methodology

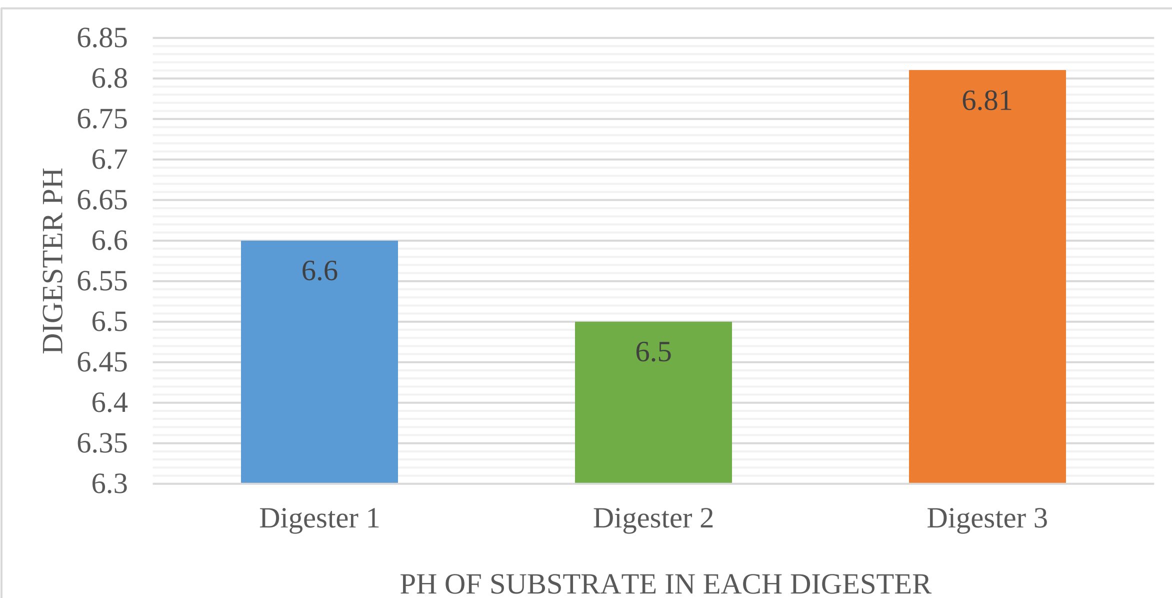
Fresh cow dung and Poultry dung were sourced from the animal farm located at The Federal Polytechnic Ado-Ekiti, The project utilized two plastic drums Three mercury-in-glass thermometers were used to measure temperature. A gas detector was part of the equipment utilized. A weighing balance with a capacity of 50 kg was obtained. Three pressure gauges were incorporated into the system and a gas valve was included in the design and proximate analysis were carried out. The digester was assembled using a 30-liter (0.03 m^3) plastic drum, which was fitted with a lid, as shown in Plate 1. On the lid, a mercury-in-glass thermometer was installed to continuously monitor the substrate temperature inside the digester. Additionally, a pressure gauge was included to measure the internal pressure, and a gas valve with a burner was installed for the collection and testing of the produced gas. All joints were carefully sealed with adhesive to eliminate any potential gas leaks. The plastic drums ensured that all components were accurately installed on the lid, creating an airtight seal essential for the anaerobic digestion process for the substrate within. This setup is referred to as an anaerobic digester.

Plate 1. Installation of pressure gauges, gas valves and thermometers on the digester's cover

The cow dung and poultry droppings utilized in this study were freshly sourced from the animal farm. The experimental procedure was conducted as follows. In Digester 1, 10 kg of cow dung was combined with 5 kg of water, maintaining a ratio of 1:2. For Digester 2, a mixture of 10 kg of poultry dung and 5 kg of water was prepared, also in a 1:2 ratio. Digester 3 contained an equal blend of 5 kg each of cow dung and poultry dung, mixed with water. Each digester's contents were thoroughly stirred for a duration of 10 minutes to ensure a uniform consistency. The pH of the slurry in all digesters was measured using a digital pH meter. Each digester was tightly sealed with a lid to maintain a gas-tight environment and digesters were positioned in an open area. To promote effective mixing and maintain close contact between the microorganisms and the substrate, the contents of each digester were shaken every three days, which also helped prevent sludge formation. During this period, the combustion time of the gas produced in each digester was tracked through the gas valve. At the end of the retention period, the pH of the substrate in each digester was measured again.

3. Result and discussion

Figure 1. PH of the substrates before digestion



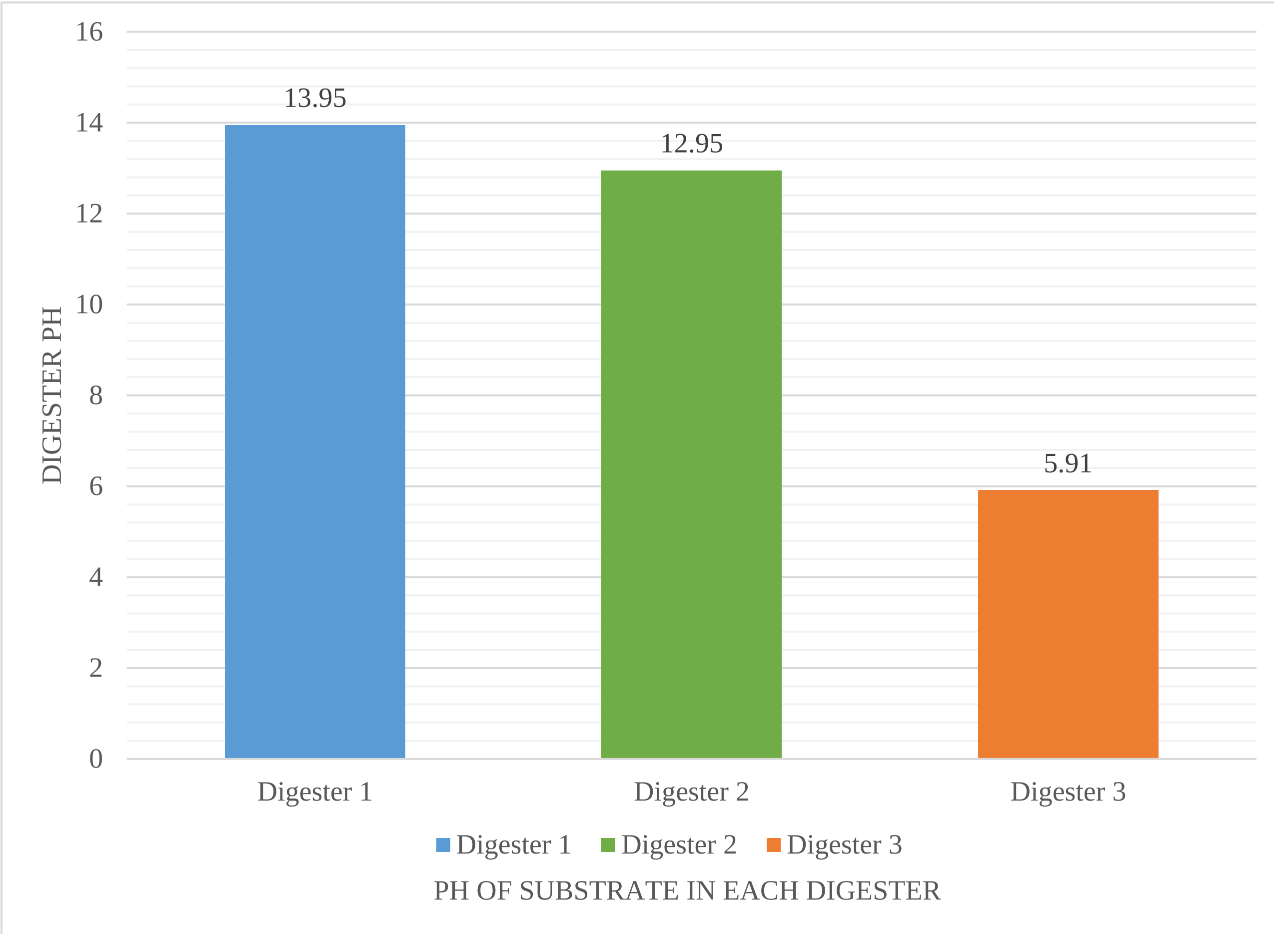


Figure 2. pH of the substrates after digestion

The results from figure 1. showed that digester (3) has the highest pH value substrate before digestion which was 6.81, while digester (2) has the lowest pH value substrate in between the digester before digestion which was 6.5. From figure.2, the result shows that digester (1) has the highest pH value substrate in between the digester after digestion which was 13.95, while digester (3) has the lowest pH value substrate in between the digester before digestion which was 5.91.

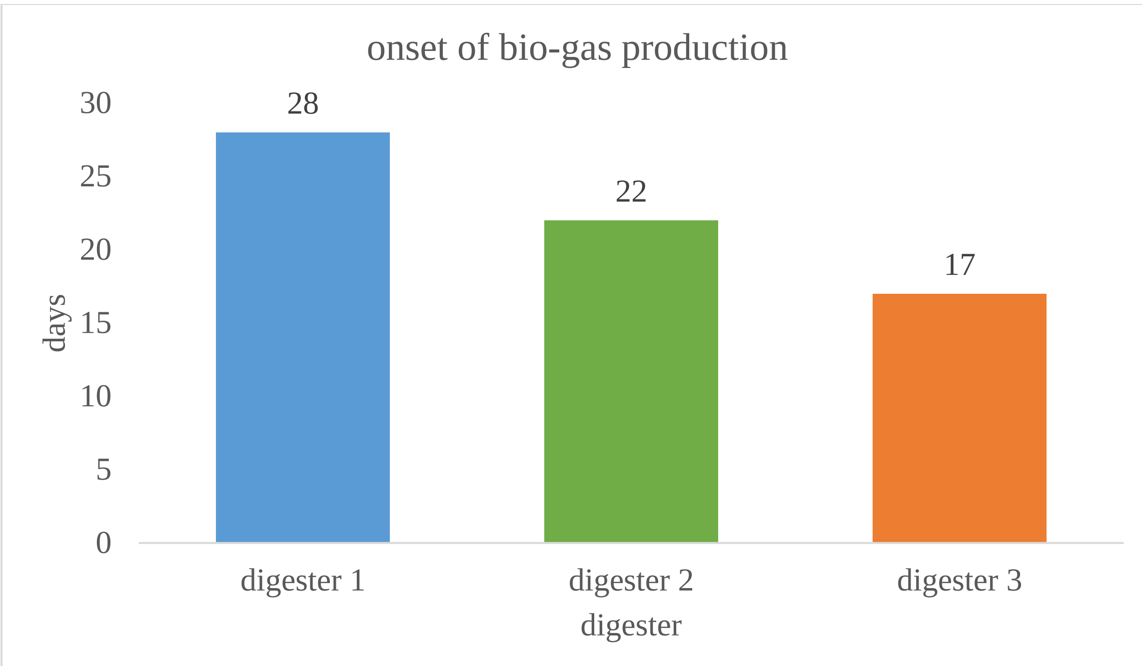


Figure 3. Bio-gas production from the substrate in the three digesters

The result shows from figure 3 the biogas yield from cow dung was estimated to be approximately 0.30 to 0.35 m³/kg of dry matter. This variability can be attributed to the composition of the dung, moisture content, and anaerobic digestion conditions. In contrast, poultry dung produced a significantly higher biogas yield, averaging between 0.45 to 0.55 m³/kg of dry matter. This increase can be linked to the higher nitrogen content and more favorable microbial activity in poultry waste. The methane content in biogas derived from cow dung ranged from 50% to 60%. In poultry dung, the methane content was notably higher, reaching 60% to 70%. This indicates that poultry dung not only produces more gas but also yields a higher percentage of methane, which is a more energy-rich component.

The digestate produced from cow dung exhibited a higher carbon-to-nitrogen (C) ratio, making it suitable as a slow-release fertilizer. The digestate from poultry dung, while also rich in nutrients, had a lower ratio, indicating a faster nutrient release, which may benefit crop growth in the short term.

4. Proximate analysis of substrates

Proximate analysis was conducted to assess the key components of cow dung and poultry dung, providing insight into their suitability for biogas production. The analysis typically includes measurements of moisture content, volatile solids, fixed solids, and ash content. .Proximate analysis highlights the differences in composition between cow dung and poultry dung, indicating that poultry dung has a higher potential for biogas production due to its lower moisture content and higher volatile solids.

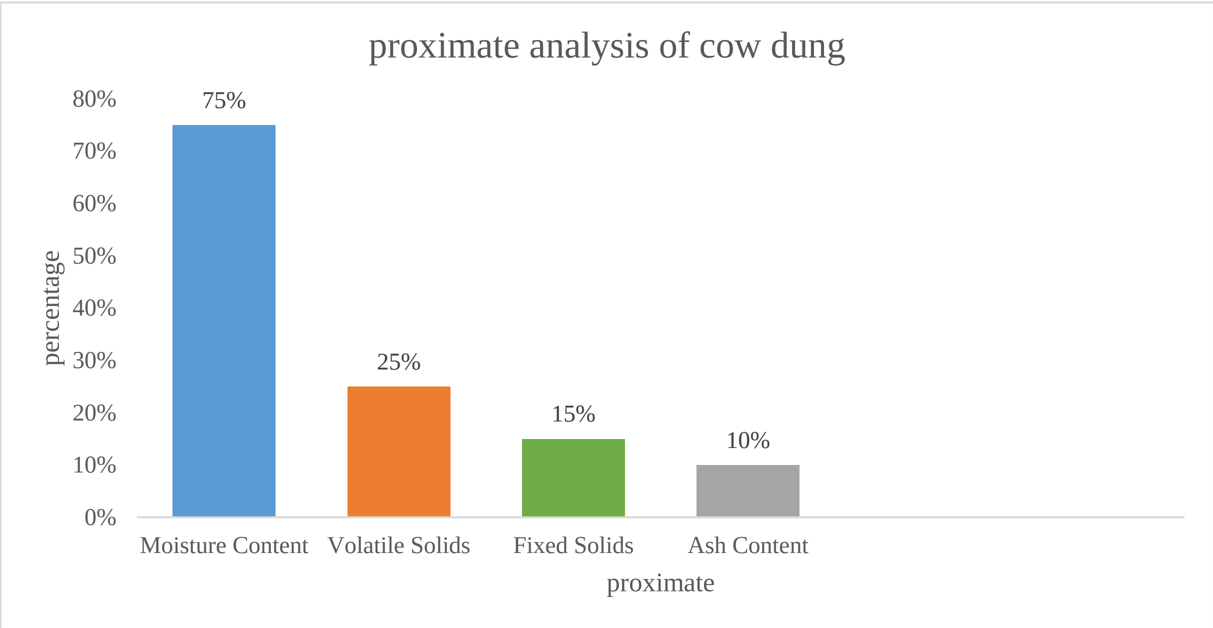


Figure 4. Proximate analysis of Cow dung

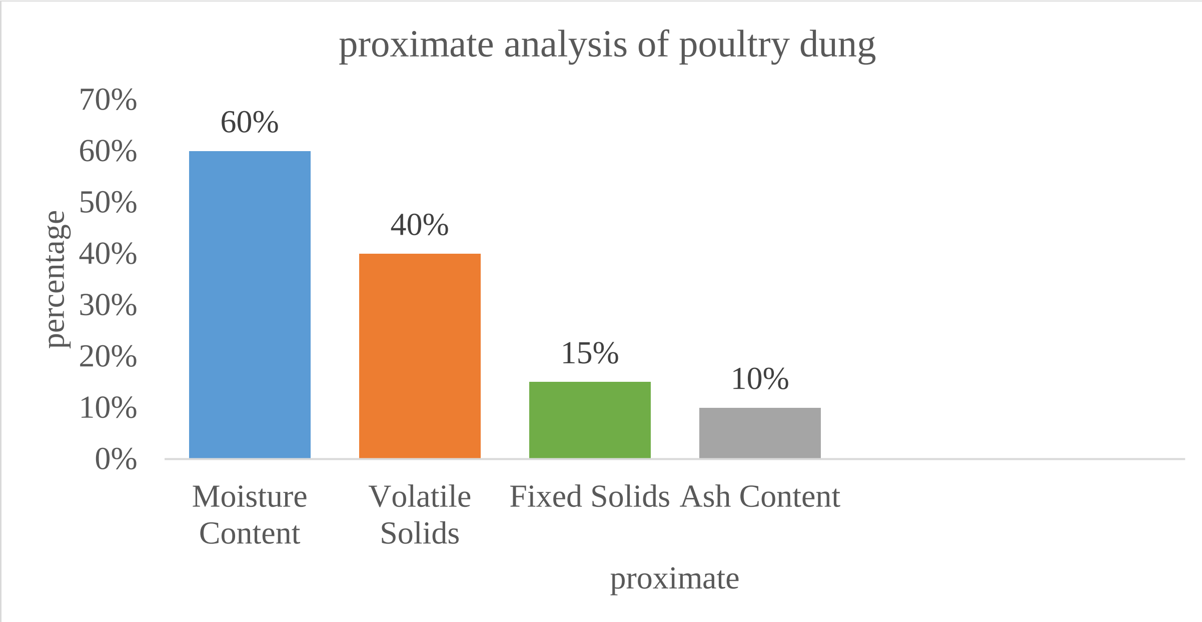


Figure 5. Proximate analysis of Poultry dung

From the results shown in figure 4 and figure 5 that Cow dung has a higher moisture content (75%) compared to poultry dung (60%). This high moisture level can affect the anaerobic digestion process, potentially leading to longer retention times and lower biogas yields. The volatile solids content is higher in poultry dung (40%) than in cow dung (25%). Higher volatile solids indicate greater potential for biogas production, as they represent the fraction of organic matter that can be converted into biogas. Both substrates have similar ash content (around 10%), which is a non-biodegradable fraction. The fixed solids content in poultry dung (30%) is higher than in cow dung (15%), suggesting that poultry dung may contribute more nutrients to the digestion process. The results of this comparison underscore the importance of feedstock selection in biogas production processes. The higher biogas yield and methane composition from poultry dung highlight its potential as a more efficient substrate for biogas production compared to cow dung. Several factors contribute to this difference; Poultry dung generally has a higher concentration of nitrogen and organic matter, which promotes enhanced microbial activity during anaerobic digestion. The presence of more readily biodegradable compounds in poultry waste leads to increased biogas production. The microbial community in poultry dung is often more diverse and robust, leading to faster degradation of organic material and improved gas yield. This can be particularly advantageous in optimizing biogas production processes. Given the higher biogas yields from poultry dung, it may offer better economic returns in biogas production facilities, making it a more attractive option for farmers and investors. This could lead to increased interest in poultry waste management and utilization for energy production. Utilizing poultry dung for biogas production can mitigate environmental issues associated with poultry farming, such as waste accumulation and nutrient runoff. Additionally, the process can contribute to renewable energy generation and reduce reliance on fossil fuels. While both cow dung and poultry dung are valuable feedstocks for biogas production, poultry dung clearly offers superior yield and methane content. These findings can guide future biogas production strategies and waste management practices, promoting sustainable energy solutions in agricultural contexts.

5. Conclusion

This work was successfully characterized and informing individuals about the usefulness of their household waste in the generation of biogas, Show that plant and animal wastes can serve as an alternative source of energy, and also reducing of pollution in the environment. High calorific cow dung substrate had a better biogas yield; therefore, the calorific content of substrate affects biogas production. Also the cow dung was alkaline which showed that pH of the substrate would determine the effectiveness of biogas production. In addition, the presence of traces of heavy metals in large amounts in poultry droppings acts as inhibitor to anaerobic digestion of the substrate thus reduced the volume of biogas likely to be produced from the substrate.

The comparison of biogas production between cow dung and poultry dung reveals significant differences in both yield and quality. Poultry dung consistently produced higher biogas yields and a greater percentage of methane compared to cow dung. This is attributed to the superior nutritional composition and microbial activity in poultry waste, making it a more effective substrate for anaerobic digestion. Additionally, the digestate from both sources offers distinct advantages for agricultural applications, with poultry dung providing quicker nutrient release and cow dung serving as a slower-release fertilizer. Overall, these findings highlight the potential of poultry dung as a more efficient feedstock for biogas production, contributing to renewable energy generation and improved waste management in agricultural practices.

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Fig 4.1: The pH of substrate in each of the digester before digestion.

Fig 4.3: Plots of digester's temperatures against time (days) for digester 2 (10 kg of poultry dungs)

Fig 4.4: Plots of digester's temperatures against time (days) for digester(3kg of cow dung and 5kg poultry dungs)

Fig 4.5 onset of bio-gas production

Fig 4.6 proximate analysis of cow dung

Fig 4.7 proximate analysis of poultry dung

DISCUSSION