VOL. 05 NO. 9,
FEBRUARY, 2025
E-ISSN 3026-958X
P-ISSN 3027-1169

African Scholar Publications & Research International
www.africanscholarpub.com

Journal of Science Innovation & Technology Research (JSITR)

The Impact of Proximate Composition of Cow Dung on the Rate of Methane Production in Akwanga Local Government Area of Nasarawa State

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DOI: https://doi.org/10.70382/ajsitr.v7i9.023

Abstract

Organic loading influences the effectiveness of producing biogas through anaerobic digestion. This study set out to evaluate the proximate composition of cow dung used for methane production in Akwanga Local Government Area of Nasarawa State. The cow dung being the raw material for the production of biogas was obtained from Lafia Abattoir, Lafia Local Government Area of Nasarawa State and transported to the Biochemistry Division of the National Veterinary Research Institute (NVRI), Vom, for processing and proximate composition analysis. The result of the proximate analysis revealed that the moisture content of the cow dung was 66.55, the crude protein and crude fibre was 9.50 and 6.23 respectively. Nitrogen was 0.58 while carbon and NFE was 19.88 and 59.66. Calcium and Phosphorus had 0.16 and 0.07. In conclusion, the amount of proximate composition that is found in the cow dung substrate revealed a significant impact on the amount of methane that will be produced from the cow manure through anaerobic digestion. Also, in order to attain high and steady yield of gas production a number of factors like moisture content, crude protein, crude fat, Nitrogen, Carbon, Calcium and Phosphorus must be present in the waste materials used. The study recommends that More attention should be given to animal dung (Cow dung) as feedstock for anaerobic digestion plants that aids in biogas production, more studies be carried out at a larger scale in order to

understand the effect of factors studied and other variables so as to determine the most effective environments for carrying out anaerobic digestion from cow dung and food waste.

Keywords: Methane production, Cow dung, Proximate composition, Anaerobic digestion

Introduction

Most developing countries, poor urban and rural population has been very dependent on firewood and cow dung as a source of fuel (Emmanuel *et al*., 2023). The continued reliance on such sources contributes negatively to the environment because deforestation exposes the ground to soil erosion, inability to trap nutrients and increases the carbon dioxide levels in the atmosphere since trees help to trap carbon dioxide in turn reducing the risk of global warming (Greenwood, 2021). The use of such sources also leads to poor health especially smoke coming from cow dung causes air pollution, therefore there is need for better, cleaner alternative sources of energy for such communities Traditionally, the production of liquid fuels, organic chemicals and energy, has relied heavily on the gasification of coal, distillation of crude oil and hydro-electric power. As natural resources continue to deplete due to the exponential growth of population and lifestyle improvement, the need to look for alternative sources of raw materials and processes is imperative (Emmanuel *et al*., 2023). The population of cows is estimated to be 1.5 billion worldwide and the global demand is predicted to increase to 74 million tons by 2023 (Adila *et al.,* 2023). Apart from the production of milk and meat, dairy cows are the primary producer of livestock manure, cow dung is obtained from a cow, where about 50 liters of methane can be generated from a single cow after chewing the cud, accounting for most of the greenhouse gas (GHG) emissions (Afolalu *et al.,* 2021). In addition, the improper waste management techniques of cow dung have resulted in the escape of dangerous pathogens, GHG, and airborne ammonia, thereby leading to environmental issues (Hamzah *et al*., 2021). Cow dung is toxic to the environment and causes nutrient imbalance and contamination because of its high nitrogen and phosphorus content, as well as traces of harmful elements Due to the fossil fuel depletion, a readily available, inexpensive, and environmentally friendly renewable energy source is necessary (Elumalai *et al.,* 2021). This has created a lot of pressure on the already degraded arid environment. This phenomenon informs

us that cow dung must be seriously looked into as a valuable alternative source of domestic energy for the rural poor community (Yerima *et al.*, 2019).

The main energy requirement in the ecological zone includes domestic cooking, heating, warming during the cold harmattan period, small scale food processing industries and lighting in rare cases (Gupta *et al.*, 2021). Domestic homes in the urban areas have been using firewood, kerosene or electricity for their fuel requirement in homes and industries, while in the rural areas, particularly in the extreme northern arid zone of the region, these fuel materials are not accessible or completely not available due to acute aridity, loss of vegetation and where available they are expensive. Due to domestic pressure and necessity, the alternative fuel is necessary (Okwu *et al*., 2020). This research, therefore intends to use the impact of proximate composition of cow dung as an alternative source of energy to produce biogas (methane) as a source of fuel for use in the rural areas of Nigeria particularly in the dry land zones in the northern part of the country. The gas has a number of advantages to the economy of a nation like Nigeria, which include reduction of dependence on imported or using petroleum gas, protecting the environment by minimizing greenhouse gas emissions, reduction the effect of deforestation and production of organic fertilizer called bio-fertilizer or slurry to improves the nutrient status of the soil (Tan *et al*., 2021).

MATERIALS AND METHODS

Sample Collection and Preparation

The fresh cow dung being the raw material for the production of biogas was obtained from Lafia Abattoir, Lafia Local Government Area of Nasarawa State and transported to the Biochemistry Division of the National Veterinary Research Institute (NVRI), Vom, for processing and proximate composition analysis. Impurities were excluded by using 1 mm screens (Retsch, Germany) to screen the cow dung after it had been combined with equal portions of tap water. The substrate was then kept in an airtight container and plastic bottles, and chilled at 4 ^{o}C until use. The inoculum was collected from fresh manure that had been kept for over a month in an anaerobic environment. Before the anaerobic digestion process, the inoculums were stored in a mesophilic condition inside a water to allow the bacteria to acclimatise. The inoculums were kept in the same condition as the substrates.

Plate 1: The cow dung being ready for proximate composition analysis

Proximate analysis: The nutritional composition analyses (Moisture content, protein, Crude fibre, Lipids, Ash, NFE, Phosphorus and Calcium) in the sample were determined using the method described by AOAC (2010). Crude fat was determined using the Soxlet system (Soxtecavante 2050), Crude protein and NFE were determine by Kjeldahl method using Kjeltec TM Model 2300 principle: The Soxlet equipment was used to defat the sample as in crude fat determination, Moisture content determination by the air oven drying method, the Nitrogen, Calcium, Phosphorus and the Carbon content were determined using different methods.

RESULTS AND DISCUSSION

Proximate Analyses of the Cow Dung

Proximate analyses of cow dung that were used for the study was carried out in order to ascertain the possibility of obtaining gas from the substrate. Table 1 below shows the values of the parameters tested.

Table 1. Proximate Analyses of the Cow Dung

SAMPLE	MOISTURE	CRUDE PROTEIN	CRUDE FIBRE	NITROGRN	CARBON	NFE	CALCIUM	PHOSPHORUS
COW DUNG	66.55	9.50	6.23	0.58	19.88	59.66	0.16	0.07

The results of the proximate composition of the cow dung used for methane production are presented in Table 1 accordingly. Available literature on composition of cow dung showed different percentages of protein, fat, fibre, moisture, ash and carbohydrate

contents in comparison which revealed that the moisture content of the cow dung was 66.55, the crude protein and crude fibre was 9.50 and 6.23 respectively. Nitrogen was 0.58 while carbon and NFE was 19.88 and 59.66. Calcium and Phosphorus had 0.16 and 0.07 respectively. The possible reason for such a difference could be attributed to varietal and regional/soil differences, the nature of processing (Kalsum *et al.*, 2020).
The moisture content of the cow dung was 66.55. This revealed that the substrates contain significant moistures for methane to be produce from the cow dung. Hence, it will have more and longer storability and a high shelf life (Emmanuel *et al*., 2023). The Crude protein of the cow dung was 9.50. This finding means that the biofuel can serve as good source of domestic fuel (Adila *et al.,* 2023).
Crude fiber value of the cow dung was 6.23. This affects the biogas production and the process stability (Yerima *et al*., 2019). The Nitrogen was 0.58 while carbon and NFE was 19.88 and 59.66 respectively. This indicated that cow dung contains high nitrogen with high carbon content. The Carbon/Nitrogen of cow dung was reported between 16 and 25 (Adila *et al.,* 2023). Cow dung's Carbon/Nitrogen ratio is suitable for anaerobic digestion, as the literature suggests a Carbon/Nitrogen ratio of 15–30 for anaerobic digestion (Kainthola *et al.,* 2020). Calcium and Phosphorus had 0.16 and 0.07 respectively. This might be attributed to the available nutrient in the substrate which is suitable for anaerobic digestion responsible for methane production (Emmanuel *et al*., 2023).

Conclusion

The cow dung substrate in the study was found to have significant nutritional composition. Hence, the amount of proximate composition that is found in the cow dung substrate revealed a significant impact on the amount of methane that will be produced from the cow manure through anaerobic digestion. Also, in order to attain high and steady yield of gas production a number of factors like moisture content, crude protein, crude fat, Nitrogen, Carbon, Calcium and Phosphorus must be present in the waste materials used.

Recommendations

1. More attention should be given to animal dung (Cow dung) as feedstock for anaerobic digestion plants that aids in biogas production.
2. More studies be carried out at a larger scale in order to understand the effect of factors studied and other variables so as to determine the most effective environments for carrying out anaerobic digestion from cow dung and food waste.

3. Production of biogas from cow dung is not a dream anymore but a reality, other researchers should focus on using the gas for generation of electricity and source of domestic energy.

Contribution To Knowledge

This study has established the use of cow dung as suitable feedstocks for biogas production, waste management and cost-saving enterprise.

Conflicts of Interest: The authors declare no conflict of interest

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