Journal of Science Research and Reviews

PRINT ISSN: 1595-9074
E-ISSN: 1595-8329
DOI: https://doi.org/10.70882/josrar.2024.v1i1.4
Homepage: https://josrar.esrgngr.org

Original Research Article

Generating and Characterizing Biogas from Household Waste through Anaerobic Digestion

***[1,2]Okoh, Ezennia V. C. and [1]Adamu, Samira S.**

[1]Department of Energy and Applied Chemistry, Faculty of Chemical and Life Sciences, Usmanu Danfodiyo University Sokoto, Sokoto State Nigeria
[2]Sokoto Energy Research Centre, Usmanu Danfodiyo University Sokoto, Sokoto State Nigeria
*Corresponding Author's email: ezennia.okoh@udusok.edu.ng

KEYWORDS
Biogas,
Domestic Waste,
Renewable energy.

CITATION
Okoh, E. V. C., & Adamu, S. S. (2024). Generating and Characterizing Biogas from Household Waste through Anaerobic Digestion. *Journal of Science Research and Reviews*, *1*(1), 16-18.
https://doi.org/10.70882/josrar.2024.v1i1.4

ABSTRACT
Utilizing the energy found in biogas presents an intriguing substitute for balancing the production of renewable electricity with environmental cleanliness. Anaerobic digestion is one method of recovering energy from biomass that shows promise in treating solid waste and effluents. This study shows how home garbage can be a rich source of biogas because of its high calorific value and biodegradability, which can help minimize the need for fossil fuels. The results of the home waste's physicochemical examination were established. The findings from the physicochemical examination of the household trash comprise the following percentages: moisture (69.2%), total solids (38.2%), volatile solids (71.7%), and carbon (40.71%). Methane, which has a calorific value of 2420 kcal/kg, is confirmed to be the main element in biogas through characterization.

INTRODUCTION

Any food item, whether raw or cooked, that is thrown away or meant to be thrown away is considered food waste. Food waste is an underutilized energy source that is primarily released into the atmosphere as it decomposes in landfills. Among the main producers of food waste are homes, lodging facilities, restaurants, retail establishments, residential buildings, canteens, and the food processing sector. Vermicomposting, composting, and anaerobic digestion are three methods for recycling food waste (Somashekar *et al.*, 2014). Methane and carbon dioxide make up the majority of the gas known as biogas, which is often produced when organic materials decompose in the absence of oxygen. When biogas is lit, it emits a blue flame similar to that of liquefied petroleum gas and has no particular color (Sathianathan, 1975).

Biogas can be an energy substitute for firewood, agricultural residue and electricity. In addition, it has been observed that air and environmental pollutions are minimized when the wastes are converted to biogas (Lantz *et al.*, 2007). Biogas is an environmentally friendly fuel that serves as an alternative fuel for compressed natural gas. Beside the use of biogas for generation of energy, the residue can serve as an organic fertilizer; this can replace the costly inorganic fertilizer. Removal, treatment and management of wastes using biogas system help to develop clean state of affairs of the environments (Kossmann *et al.*, 1999).

The term "anaerobic digestion" describes how organic wastes break down spontaneously by bacteria in the absence of oxygen to create biogas. It may also be defined as the process of decomposing organic materials and wastes using a variety of microbiological techniques to create digestate that is rich in macro and micronutrients for plant growth and biogas with a high methane content (Ziana and Rajesh, 2015). Temperature, retention time, and input material composition all affect biogas composition.

Methane makes up the majority of the gas, usually between 55% and 80% (Jemmett, 2006). Methane (40–70 vol.%), carbon dioxide (30–60 vol.%), and trace components (1–5% vol.%), such as hydrogen (0–1% vol.%)

and hydrogen sulfide (0–3% vol.%), make up biogas, according to Kossman et al. (1999). But according to Ziana et al. (2015), methane (55–60 vol.%), carbon dioxide (3540 vol.%), hydrogen (0–1% vol.%), water (2–7% vol.%), ammonia (0–0.05 vol.%), oxygen (0–2% vol.%), nitrogen (0–2% vol.%), and hydrogen sulfide (2 vol.%) make up biogas. The aim of this study is to investigate the possibility of biogas production for cooking, electricity generation etc., from household waste.

MATERIALS AND METHODS

Sample Collection and Preparation

The procedure outlined by Dupade and Pawar (2013) was adopted. Samples of domestic waste were collected from different food vendors and eateries located within Sokoto metropolis. Analysis of the wastes shows that they were chiefly composed of rice, beans, yam, tuwo, bread and vegetables among others. The domestic wastes were blended together with the aid of a blender to form paste which was immediately preserved at 4ºC. Fresh sample was diluted with water before being taken for physicochemical analysis (Somashekar *et al.*, 2014).

Physicochemical Analysis

The physicochemical analysis carried out includes percentage moisture content , total solids, volatile solids and carbon.

Preparation of the Inoculum

Inoculum was prepared from cow dung, this is because cow is a ruminant and the paunch serves as the primary site for microbial fermentation of ingested feed (Dupade and Pawar, 2013). A 1 kg of cow dung collected from Kasuwan Daji abattoir in Sokoto metropolis was weighed, put into a container and diluted with 1 L of water making a dilution factor of 1:1.

Loading of Biodigester

The slurry (comprising of 1:1 of the substrate and innoculum and substrate alone) was fed into the fabricated biodigestermade from cylindrical cans. The cans were all sealed with aradite adhesive to prevent leakage before being kept aside for 7-day duration as described by Sharada *et al*. (2016)

Calorific value determination

The bomb calorimeter was used for the determination of the calorific value of the produced biogas

RESULTS AND DISCUSSION

Physicochemical analysis of the domestic waste

Table 1 displays the findings of the physicochemical study of the blended household trash sample in relation to other studies.

Table 1: Results for physicochemical analysis of the analyzed domestic waste

Parameters (%)	Present Study	Muhibbu-din *et al*. (2020).	Maxwell (2011)	Dupade *et al*. (2013)
Moisture	69.20	59.20	65.00	55.00
Total Solid	38.20	40.80	35.00	45.00
Volatile Solid	71.70	77.30	ND	80.00
Carbon	40.71	42.90	ND	ND

Key: ND = Not Determined

Moisture has a major impact on the anaerobic digestion of household wastes, according to Sadaka et al. (2003). This is due to two main factors: first, water's mobility increases microbial growth, which facilitates nutrient breakdown and passage; second, water lessens the restriction of bulk transfer of non-homogenous substrate. Generally speaking, as the amount of volatile solid and total solid reduction rises, so does the amount of water in the digest state. When compared to other researchers, the 69.20% moisture content is not statistically significant. A useful method for estimating the amount of nutrients that will be accessible for bacterial action during digestion is to calculate the total solids of food waste.

Comparing this study to Muhibbu-din et al. (2020), Maxwell (2011), and Dupade et al. (2013), the total solids are the lowest. Because there is enough moisture content in the digester—the highest level—microorganisms may be actively breaking down food waste, which could explain the drop. The percentage of volatile substances in household garbage is considerable (71.70%). This is crucial because the amount of volatile solid—that is, the amount of solids in the waste and their degradability—determines how much methane is created (Ofoefule *et al*., 2010). Given that volatile solids are responsible for the formation of biogas, residential trash has a good chance of being used as raw materials for biogas production (Somashekar *et al*., 2014).

Calorific Value

The heating capability of the household trash was found to be 2420 kcal/kg. This indicates that there is a good chance of producing biogas from the substrates.

CONCLUSION

This study investigated the energy found in biogas for the purpose of renewable electricity generation as well as cooking and spent slurry is good as fertilizer. The findings percentages indicated from the physicochemical examination of the household revealed that: moisture (69.2%), total solids (38.2%), volatile solids (71.7%), and carbon (40.71%). This study demonstrates how domestic waste's high calorific value and biodegradability might reduce the need for fossil fuels by making it a rich source of biogas. The residential waste's physicochemical analysis yielded established results. Characterisation confirms that methane, with a calorific value of 2420 kcal/kg, is the primary component of biogas.

REFERENCES

Dupade, V. and Pawar, S. (2013). Generation of Biogas from Kitchen Waste Experimental Analysis. *International Journal of Engineering Science Invention*, 2(10):15-19.

Jemmett, R. (2006). Methane, biogas, production guide. United Kingdom, (Accessed on 13 August 2020).

Kossmann, W., Pönitz, U., Habermehl, S., Hoerz, T., Krämer, P., Klingler, B., Kellner, C., Wittur, T., Klopotek, F.V., Krieg, A. and Euler, H. (1999). Biogas digests. *Information and Advisory Service on Appropriate Technology* 1: 1- 46.

Lantz, M., Mattias, S. and Borjesson, L. (2007). The prospects for an expansion of biogas systems in Sweden. *Incentives and Potential, Energy Policy*, (35): 1830-1843.

Maxwell, O. Jnr. (2011). Biogas production from kitchen waste generated on KNUST campus. Kwame Nkrumah University of Science and Technology, Department of Environmental Science. M.Sc. Thesis.

Muhibbu-din, E.I., Adebayo, G.B. and Odedele, O.S. (2020). Production and Characterization of Biogas from Domestic Waste by Anaerobic Digestion. *International Journal of Environment and Bioenergy*, 15(1): 1-9.

Ofoefule, A.U, Uzodinma, E.O. and Anyanwu, C.N. (2010). Studies on the effect of Anaerobic Digestion on the microbial flora of Animal Wastes: Digestion and Modelling of Process Parameters. *Trends in Applied Sciences Research*, 5(1): 39-47.

Sadaka, S.S. and Engler, C.R. (2003). Effect of initial total solids on composting of raw manure with biogas recovery. *Compost Science and Utilization*. 11(4): 361-369.

Sathianathan, M.A. (1975). Biogas achievements and challenges. New Delhi: Association of voluntary agencies for rural development.

Sharada, S., Surendra, B. and Hema, L. (2016). Production of biogas from kitchen waste. *International Journal of Scientific Development and Research*, 1(7): 245 – 255.

Somashekar, R.K., Rinku, V. and Manzoor, A.N. (2014). Potential of biogas production from food waste in a uniquely designed reactor under lab conditions. *International Journal of Geology, Agriculture and Environmental Sciences*, 2(2): 2348-2354.

Ziana, Z. and Rajesh, P. (2015). Production and Analysis of Biogas from Kitchen Waste. *International Research Journal of Engineering and Technology*, 2(4). 234 – 241.