Comparative Study Of The Production Of Biogas From Cow, Pig And Poultry Dung

***Kamen, F. L; Nnamchi, S.N; Ike, I.S; Orga, A.C. and Nkwocha. A.C.**
Department of Chemical Engineering, Federal University of Technology, Owerri, Imo State, Nigeria.
*Corresponding Author; E-mail: felicia.kamen@futo.edu.ng

***Abstract*—A laboratory-scale production of biogas by anaerobic digestion was studied using cow, pig and poultry dung. The research was carried out at the ambient temperature of 30°C by dissolving 150g of dung in 150ml of water in corked flask. The gas from the flask was channeled into a calibrated glass cylinder in inverse position in water and the volume of gas generated recorded on daily basis for 20days. The result showed that cow dung had the highest biogas yield of 107cm^3/150g dry dung, followed by the poultry dung with the yield of 83.1cm^3/150g dry dung and lastly pig dung having the yield of 79cm^3/150g dry dung. Most of the biogas produced was obtained in the second week of the digestion for all the three samples. Conversion of animal dung to biogas provides added value to the wastes as energy resources and reduces environmental problems associated with animal wastes, hence it is a waste-to-wealth technology.**

Keywords—Biogas, Animal dung, Anaerobic digestion, Waste-to-wealth.

1. Introduction

Biogas refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from biogenic materials and it is a type of biofuel. It is produced by the anaerobic digestion or fermentation of biodegradable materials such as animal dung, biomass, manure, sewage, kitchen and municipal wastes. [1] The major constituents of anaerobic fermentation are methane and carbon (iv) oxide. The composition of biogas varies depending on the origin of the anaerobic process. Landfill gas typically has methane concentration around 50% while advanced waste treatment techniques can produce biogas with 55-75% methane or higher using in situ purification methods [2, 3]. There is an increasing campaign for cleaner burning fuel in order to safeguard the environment and protect man from the inhalation of toxic substances. The greenhouse effect and global warming have been on the increase in the recent times. In order to protect man and his environment, biogas and other alternative energy sources that are more eco-friendly are globally encouraged [3]. Fossil fuels like coal, crude oil and natural gas have played a great role in the global energy supply since the era of industrial revolution, however, the increasing worldwide awareness their negative environmental impact, continual price hike and gradual depletion have awaken the drive environmentally friendly and renewable energy sources like biogas. Methane, the major end product of anaerobic digestion can be used directly for energy, converted to methanol, or, when partially oxidized, to synthesized gas, a mixture of hydrogen and carbon monoxide. Synthesized gas then can be converted to clean alternative fuels and chemicals. Biogas plants can also improve sanitation, and the residue is useful as a fertiliser. Biogas is a robust fuel that can be used to supply heat, electricity, process steam and methanol. [4]

Livestock operations produce millions of tonnes of animal wastes yearly, which if left to decompose by themselves will inject large volume of methane into the atmosphere, cause ground water contamination, ammonia leaching, not to mention bad odors. Treating manure by anaerobic digestion gets rid of the environmental threats and produces bio-energy at the same time. Producing biogas from animal dung has two-fold advantage, one is to have farms that grow their own energy by using readily available farm waste to power the farm, the other is to eliminate the environmental threat of methane, a greenhouse gas considered 22 times worse than carbon dioxide. [5] It has been shown that a farm with population of 20-30 cattle will generate about 225kg of dung per day which is capable of producing biogas the will run a diesel generating set for 4-5 hours.[6]

Biogas production has advanced so much in many countries in the world like India, China, Middle East, Germany, Britain and United States to the extent that Artificial neural networks (ANNs) and genetic algorithms (GA) are now being employed to solve complicated problems associated with its production. [7, 8] Instances of co-digestion of sewage sludge and animal wastes with agro-industrial by-products have also been reported. [2, 9] However, in Nigeria they are still in cradle stage. Published materials are also scarce in this all important area of waste-to-wealth technology hence the need to articulate in writing the various research works that going on in the country since biogas production from different sources varies from country to country and is dependent on many factors like the nature of the animals' feed, breed, age of waste, climate and season. [10, 11]

2. Materials and Method

2.1 Sample Collections and Preparation:

The cow dung, pig dung and poultry dung were obtained from the cattle paddock, pigstry and poultry farm respectively of Federal University of Technology, Owerri, Imo State of Nigeria. The samples were collected in polyethylene bags and labeled for easy identification. The samples collected were prepared for use by manual removal of unwanted particles like stones, woods and other non-biodegradable materials.

2.2 Experimentation:

150g each of the cow dung, pig dung and poultry dung were weighed into three 500ml conical flasks. To each of the flasks, 150ml of water were added to form slurry. The flasks were corked with two-hole rubber corks. For each of the flasks, thermometer was fixed in one hole while an L-shaped tube was attached on the other and connected to a calibrated glass tube filled with water in an inverse position. The readings of the height of the water on the calibrated glass were taken on daily basis for 20 days. This was used to calculate the volume of biogas generated. The reaction was conducted at temperature of 30^{o}C.

3. Results and Discussion

3.1 Results

The results of daily production of biogas from cow, pig and poultry dung are shown in Figure1 while the cumulative productions in 20days are shown in Figure 2.

3.2 Discussion

From the results shown in Figure1, the pig dung started production of biogas after 4days while the cow and poultry dung stayed 7days before the onset of biogas production. This can be attributed to the contents of each of the animal dung as lignin and roughages take longer time to digest. Peak daily productions of 18.9cm^3/150g dry dung and 14cm^3/150g dry dung were obtained for the cow and poultry dung respectively on the 12th day while a peak of 16.2cm^3/150 dry dung was obtained for the pig dung on the 13th day. In all the three dung, most of the biogas productions occurred in the second week. In the cumulative production of biogas from the three dung for 20days shown in Figure 2, the cow dung had the highest yield of 107cm^3/150g dry dung, followed by the poultry dung having 83.1cm^3/150 dry dung and pig dung with 78cm^3/150g dry dung. Though the pig dung started biogas production earlier than the others, its overall production was later surpassed by the cow and poultry dung. Biogas production virtually stopped after the 18th day for the three samples.

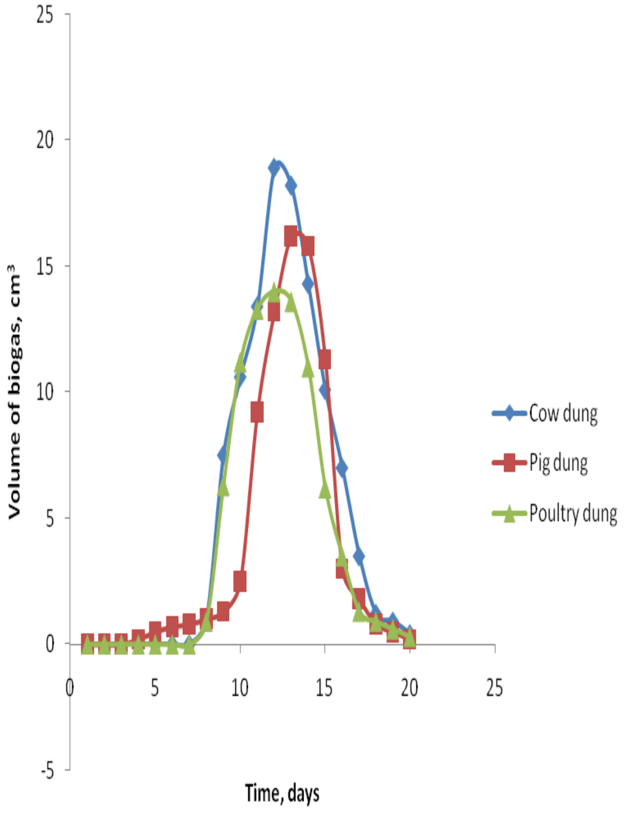

Figure 1: Daily production of biogas from the animal wastes for 20days

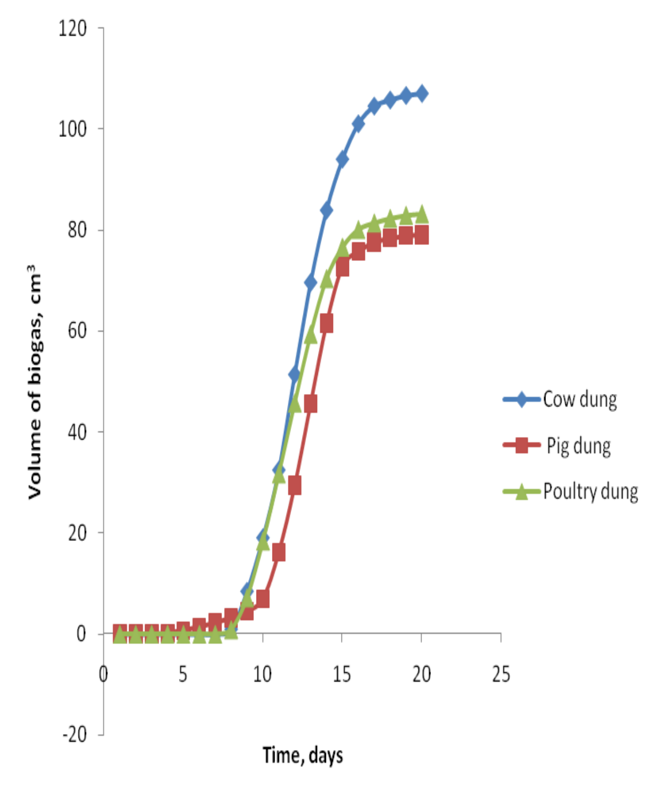

Figure 2: Cumulative production of biogas from the animals' dung for 20days

4. Conclusion

The results of the biogas productions from cow, pig and poultry dung showed that appreciable quantity of biogas can be obtained from the dung of these three domestic animals which if explored in large scale will be of great economic benefit and help to combat environmental pollution.

References

1. Mandal, T and Mandal N.K. (1998) 'Comparative Study of Biogas Production from different Waste Materials.' *Energy Conversion and Management*. Volume 38, Issue 7. Pp 679-683.

2. Comino, E; Riggio,V.A. and Rosso M. (2012) 'Biogas Production by Anaerobic Co-digestion of Cattle Slurry and Cheese Whey' *Bioresources Technology*, Volume 114, Pp 46-53.

3. Kader, F; Baky, A.H; Khan, M.N. and Chowdhury, H.A. (2015) 'Production of Biogas by Anaerobic Digestion of Food Waste and Process Simulation' *American Journal of Mechanical Engineering*, Volume 3, Number3. Pp 79-83.

4. Jingura, R.M. and Matengaifa, R. (2009) 'Optimization of biogas production by anaerobic digestion for sustainable energy development in Zimbabwe'
Renewable and Sustainable Energy Reviews, Volume 13, Issue 5. Pp 1116-1120.

5. Fitzpatrick, T. (2008) 'Biogas Production is all in the Mixing' *Green Farms*. Washinton University, St. Louis.

6. Gaushla & Panjrapoles Project (2003) 'Power generation from Animal Dung/ Alternative Feed Stock'. *Bioenergy*, India. http/www.geda.org.in.

7. Gelegenis, J; Georgakakis, D.; Angelidaki and Mavris, V. (2007) 'Optimization of biogas production by co-digesting whey with diluted

poultry manure' *Renewable Energy*, Volume 32, Issue 13. Pp 2147-2160.

8. Abu, Q. H.; Bani, H. K. and Shatnawi, N. (2009) 'Modeling and optimization of biogas production from a waste digester using artificial neural network and genetic algorithm' http/.www.qspace.qu.edu.qa.

9. Maragkaki, M; Fountoulakis, G; Kyriakor, A; Lasdridi, K. and Manios, T. (2017) 'Pilot-scale Anaerobic Co-digestion of Sewage Sludge with Agro-industrial By-products for Increased Biogas Production' *Journal of Waste Management*, *Science Direct*, Volume 59, Pp 362-370.

10. Makki, E.K. and Eljack, B.E. (2003) 'Seasonal Variation and Production of Biogas from three types of Animal Dung' *Ahfad Journal*, Sudan. http/.www.findarticle.com.

11. Stege, A. (2006) 'Modeling Landfill Biogas Generation for Different Countries' *Methane to Market.* Pp 1-26. http/.www.globalmethane.org.