The effect of plantain peel ash on biogas production from cow dung.

El efecto de la ceniza de cáscara de plátano en la producción de biogás a partir del estiércol de vaca.

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ABSTRACT

A study was carried out to investigate the effect of pretreatment with plantain peel ash on biogas production from cow dung. Two portable floating drum digesters of the same capacity were used for the experiment. One was filled with substrate prepared from cow dung and the second was also filled with substrate prepared from cow dung but pretreated with plantain peel ash. Results showed that 11,998 cm^3 of biogas was produced from the digester that contained substrate of cow dung only while 20,493 cm^3 was produced from the digester that contained substrate pretreated with plantain peel ash. This showed that the increase in the volume of biogas produced as a result of plantain peel ash addition is 8,495 cm^3 which is equivalent to 70.8%.

Keywords: pretreatment, plantain peel ash, biogas, cow dung, digester

RESUMEN

Se llevó a cabo un estudio para investigar el efecto del pretratamiento con ceniza de cáscara de plátano en la producción de biogás a partir de estiércol de vaca. Se utilizaron dos digestores portátiles de tambor flotante de la misma capacidad para el experimento. Una se llenó con sustrato preparado a partir de estiércol de vaca y la segunda también se rellenó con sustrato preparado a partir de estiércol de vaca, pero pretratado con ceniza de cáscara de plátano. Los resultados mostraron que se produjeron 11.998 cm3 de biogás a partir del digestor que contenía sustrato de estiércol de vaca, mientras que 20.493 cm3 se produjeron a partir del digestor que contenía sustrato pretratado con ceniza de cáscara de plátano. Esto demostró que el aumento en el volumen de biogás producido como resultado de la adición de cenizas de cáscara de plátano es de 8,495 cm3, que es equivalente a 70,8%.

Palabras clave: pretratamiento, ceniza de cáscara de plátano, biogás, estiércol de vaca, digestor.

INTRODUCTION

Biogas production by anaerobic digestion is one of the ways of handling and converting agricultural waste to methane for domestic and industrial fuel use. Biogas is composed of methane (55 – 70%), carbon-dioxide (30 – 40%) and traces of other gases such as Nitrogen, Carbon-monoxide, water and hydrogen sulphide (Ubalua, 2008). Opeh and Okezie (2011) reported that biogas is about 20% lighter than air and has an ignition temperature in the range of 650°C to 750°C. It is also odourless, colourless and burns with a brilliant blue flame similar to that of liquefied petroleum gas. The quality of biogas produced can be improved after which it can be used as a very good substitute for liquefied gases obtained from fossil fuels.

It is thus a good and promising source of alternative energy to replace fossil fuel. There is a growing interest in the use of biogas for domestic and industrial purposes in Nigeria today because of its low cost relative to fossil fuel. There is therefore the need to maximize the generation of biogas from available waste to meet the increasing demand.

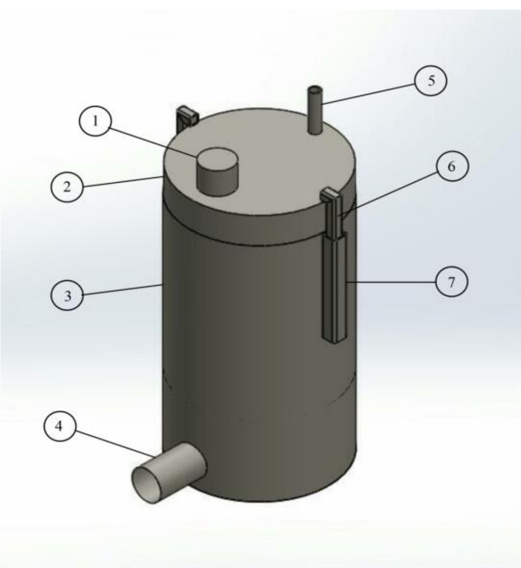
Animal wastes such as poultry waste and cow dung are among the wastes that can be used for biogas production. However, animal waste is made mainly of lignocellulosic fibers that have not been fully digested by the animals (Ismail and Tinia, 2015). This lignocellulosic materials present in the dung restricts the ability to totally harness renewable energy from animal wastes.

Thus the lignocellulosic materials need to be decomposed by pretreatment to improve digestability (Quinones *et al*, 2015). One of the pretreatment methods being adopted is the addition of alkali bases to the slurry before digestion. Abu *et al*, (2015) investigated the effect of NAOH treatment on biogas production from kitchem wastes co-digested with cow dung. They reported that at the addition of 1.5% NAOH, biogas production was almost double the untreated slurry. Adeyanju (2008) reported that biogas yield was significantly increased in the codigestion of pig wastes and cassava peels treated with wood ash.

Plantain peels are wastes generated in the consumption and processing of plantain. The alkali content of plantain peel as is 74% (Babayemi et al, 2010). It thus has the potential to be used as a pretreatment agent in biogas production. This work was therefore carried out to investigate the effect of addition of plantain peel ash on biogas production from cow dung.

MATERIALS AND METHODS

Two floating drum digesters of volume 36.5 litres were designed and constructed at the department of Agricultural and Bioresources Engineering, Federal University of Agriculture, Abeokuta. The isometric view of the digester is shown in Figure 1.



S/N	Parts	Material
1	Substrate Inlet	Stainless Steel
2	Gas Storage Tank	Mild Steel
3	Digester Tank	Mild Steel
4	Substrate Outlet	Stainless Steel
5	Gas Outlet	Mild Steel
6	Guide Bars	Iron
7	Guide Frames	Mild Steel

Fig. 1. Floating drum digester

Cow dung was obtained from the teaching and research farm of Federal University of Agriculture, Abeokuta. Plantain peels were also obtained, sun dried and converted to ash in the laboratory in an electric muffle furnace. In preparing the substrate for the first digester

(digester A), the cow dung was mixed with distilled water in ratio 1:2 since the cow dung is in dry form (Mahanta *et al,* 2005). A mix ratio of 1:2 was also used to prepare the substrate used in the second digester (digester B). However, 0.64 kg of plantain peel ash which is equivalent to 4% of the mass of cow dung used in both digesters was added and thoroughly mixed with the distilled water used (in B). The water was left for two days before the substrate was prepared. The pH of the substrates in both digesters was determined before and after digestion using a pH indicator.

The two digesters were filled with their substrates, covered and made air tight. The initial height of both digesters was 50 cm. The volume of biogas produced was determined by multiplying the cross-sectional area of the floating drum (biogas collector) with its increase in height.

The daily ambient temperature around the two digesters was measured using a mercury-in-glass thermometer throughout the duration of the digestion process.

RESULTS AND DISCUSSION

pH of Substrates: The pH of the substrate before and after digestion is presented in Table 1. The pH in both digesters A and B were 6.0 and 6.5 before digestion and 5.5 and 7.4 after digestion respectively. This shows that the pH of the substrates in both digesters before digestion was adequate for the activeness of the microorganisms for proper digestion of the substrates (Akinnuli and Olugbade, 2014).

Table 1: pH of the substrates in the two digesters

	pH before digestion	pH after digestion
Digester A	6.0	5.5
Digester B	6.5	7.4

Biogas Production: the volume of biogas produced in both digesters at intervals of 5 days is presented in Tables 2 and 3. It was observed that the volume of gas produced in the first interval of 5 days in digester A was 2092 cm^3. The maximum volume of gas produced occurred on the third interval of five days (12 -17 days) and was 3,384 cm^3. The total volume of gas produced after the digestion process was 11,998 cm^3. In digester B, the volume of gas produced in the first interval of 5 days was 3385 which is higher than what was produced in digester A within the same interval, Also the maximum volume of gas was produced in the third interval of five days and was 5,231 cm^3 which was higher than the volume produced in digester A at the same interval. The total volume of gas produce was 20,493 cm^3 which was also higher than the total volume produced in digester A. It could also be seen that the volume produced at each interval of five days in digester B is higher than that of digester A as shown in Fig.2.

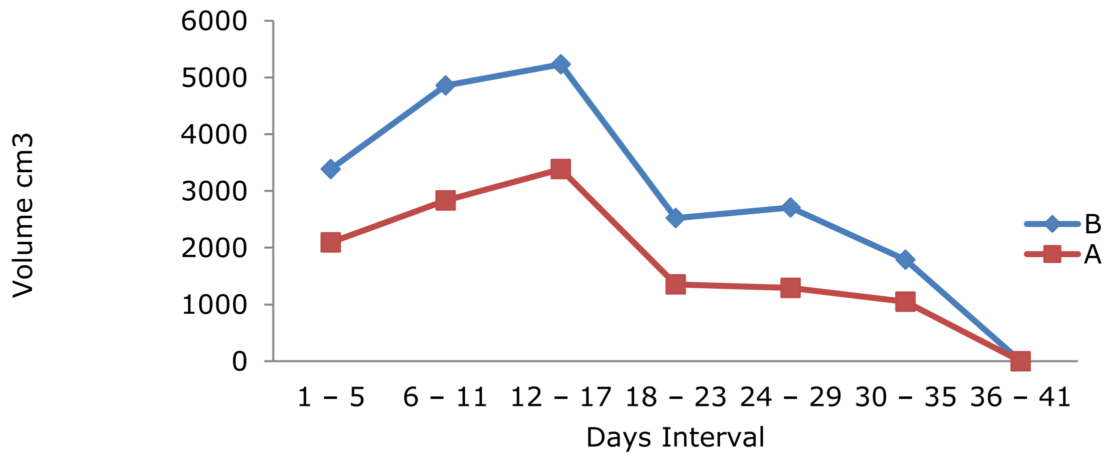


Fig. 2. Trend of gas production at 5 days interval

Table 2. Biogas production in digester A.

Days	Floating drum height (cm)	Change in height of tank (cm)	Volume of gas produced (cm^3)
1 – 5	3.4	3.4	2092
6 – 11	8.0	4.6	2831
12 – 17	13.5	5.5	3384
18 – 23	15.7	2.2	1353
24 – 29	17.6	2.1	1292
30 – 35	8.8	1.7	1046
36 – 41	----	----	-----
		TOTAL =	11998

Table 3: Biogas production in digester B.

Days	Floating drum height (cm)	Change in height of tank (cm)	Volume of gas produced (cm3)
1 – 5	5.5	5.5	3385
6 – 11	13.4	7.9	4862
12 – 17	21.9	8.5	5231
18 – 23	26.0	4.1	2523
24 – 29	30.4	4.4	2707
30 – 35	21.2	2.9	1785
36 – 41	----	----	-----
		TOTAL =	20493

The daily ambient temperature recorded for the digesters ranged from 22 to 33°C. The variation of the ambient temperature throughout the digestion period shows that the digestion took place in the mesophilic range (Fig. 3).

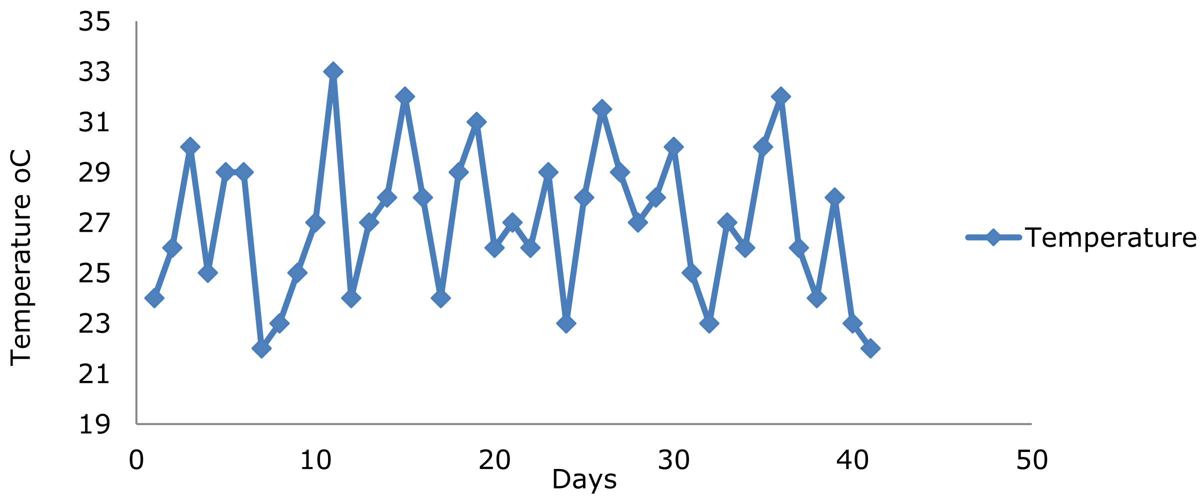


Fig. 3. Variation of temperature with days

It can be concluded from the study that addition of plantain peel ash to substrate of cow dung enhances biogas production. The biogas produced from substrate with plantain peel ash is 20,493 cm^3 while the biogas produce from substrate without plantain peel ash is 11,998 cm^3. This implies that the increase in the volume of biogas produce as a result of plantain peel ash addition is 8,495 cm^3 which is equivalent to 70.8%.

REFERENCES

Abu, Y., Salma A. I., Niloy C. S., Nazmul H. & Mohammad, S. H. 2012. Optimization and Fabrication of a Portable Biogas Reactor. *J. Chem. Eng.*, 7: 6-10

Adeyanju, A.A., 2008. Effect of seeding of wood-ash on biogas production using pig waste and cassava peels. *J. Eng. Appl. Sci.*, 3: 242-245

Akinnuli, B.O. & Olugbade T.O., 2014. Development and performance evaluation of piggery and water hyacinth waste digester for biogas production. *I. J. Eng. Innov. Technol.*, 3: 271-276

Babayemi, J.O., Dauda K.T., Kayode A.A., Nwude D.O., Ajiboye J.A. Essien E.R. & Abiona O. O. 2010. Determination of potash alkali and metal contents of ashes obtained from peels of some varieties of Nigerian grown *Musa Species*. *Bioresources*, 5: 1384 – 1392

Ismail, M.N., & Tinia I.M. 2015. Pretreatment of Lignocellulosic Biomass from Animal Manure as a Means of Enhancing Biogas production. *J. Eng. Life Sci.,* 15: 1-10.

Mahanta, P., Dewan, A., Sah U.K., & Kalita P. 2004. Effect of temperature and total solid concentration on the gas production rate of biogas digester. *J. En. South. Africa*, 15:112-117.

Opeh, R. & Okezie U. 2011. The Significance of Biogas Plants in Nigeria's Energy Strategy. *J. Physical Sci. Innov.*, 3

Quinones, T.S., Mattias P., Budde J. & Heiermann M. 2012. Results of batch anaerobic digestion test- effect of enzymes addition. *Agricult. Eng. Int. CIGR Journal,* 14: 38-48

Ubalua, A.O. 2008. Cassava wastes: Treatment options and value addition alternatives, Africa. *J. Biotechnol.*, 6: 2065-2073.

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