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Effect of Seeding of Wood-Ash on Biogas Production Using Pig Waste and Cassava Peels

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Abstract: The effect of seeding of wood-ash using pig waste and cassava peels in laboratory anaerobic digester on the production of biogas was investigated. Pig waste and cassava peels were mixed in varying concentrations and left for anaerobic digestion in sterile distilled water for a period of 45 days. One of the digesters was seeded with wood-ash. The volume of biogas produced ranged from 83-2345 cm^3 with different concentrations of pig waste and cassava peels. The seeded digester yielded the highest volume of biogas. Sole digestion of pig waste and cassava peels yielded 430 and 83 cm^3, respectively. The maceration of cassava peels resulted to an increase of acidity of medium such that biogas production was extremely reduced.

Key words: Biogas, seeding, marceration, wood-ash, digester, pig waste

INTRODUCTION

Biomass technology is a clean and cheap energy source derived from the directs combination of organic materials such as solid agricultural wastes, urban waste and animal wastes (Adegbuyi *et al*., 1996). These organic wastes are surplus in almost all developing countries of the tropics (Oyagade, *et al*., 1999). Several works have revealed that biogas can be generated using organic wastes (Garba and Sambo, 1992; Hansen, 1999).

Total dependence on conventional fuels, is likely to become a serious handicap in the years to come as reserve shortages and specialized technologies hike the costs of fossil and nuclear fuels. But by producing energy from renewable resources such as biogas will actually free the world from remote sources of increasingly expensive fuel supplies.

Biogas is a mixture of colourless flammable gases obtained through the anaerobic digestion of plant based organic waste materials. Decay can be aerobic (with oxygen) or anaerobic (without oxygen). Any organic matter can be broken down either way, but the end products will be quite different.

The composition of biogas is typically methane 50-70%, carbon dioxide 30-40% and the rest is made up of traces of hydrogen, nitrogen and hydrogen sulphide (Abubakar, 1996).

The extraction rate of fuel wood in Nigeria has been estimated at about 3.83 times the rate of regrowth and almost ten times the rate of regeneration (Gornitz, 1983).

Wood fuel, which is the first and oldest method of generation energy, if continually used, will lead to deforestation and soil erosion (Garba and Sambo, 1992).

Generally, the organic matter to be used for biogas production must be highly degradable in order to achieve appreciable yields. Low gas production will result from less degradable wastes (Oyagade *et al*., 1999).

Economically, the extensive utilization of biogas for the energy needs especially in the rural areas of Nigeria would reduce dependence on commercial energy. Similarly, biogas production reduces faecal pathogens, environmental pollution and improves public health condition (Aliyu *et al*., 1996). Methane, which is the major components of the biogas, is also used in the production of methanol for industrial purposes (Van-Buren, 1980).

The chlorination of methane through photo catalysts yields chloroform and carbon tetrachloride, which is used in dry cleaning and fire extinguisher (Van-Buren, 1980).

Anaerobic decay has helped in the provision of rich fertilizer from the digested wastes.

The aim of this study was to supplement pig waste an cassava peels with wood-ash to enhance biogas production.

MATERIALS AND METHODS

Collection of materials for digestion: The materials used for this experiment were pig wastes, cassava peels and wood-ash.

The pig wastes were collected fresh from a pig farm whereas fresh cassava peels were obtained from a gari-processing unit in a nearby locality. Both samples were transferred separately to the laboratory in clean cellophane bags.

Plate 1: Experimental set up for biogas production

Wood-ash was obtained by combusting dry branch fragments of a *Bauhinia monandria* plant. This tree was chosen as a source of wood mainly on the basis of availability.

Setting up the digesters: Six reagents bottles measuring 2.8 L were used as digesters. In setting up a digester an appropriate ratio of waste and distilled water was transferred into a digester with the aid of a funnel. Mechanical grinding of cassava peels was done using a clean mortar and a pestle.

Initially, 400 g of pig waste were mixed with 1200 cm^3 of distilled water and the slurry transferred into digester A. Also, 200 g of pig wastes and 200 g of cassava peels were mixed with 1200 cm^3 of distilled water and the slurry was transferred into digester B.200 g of pig wastes and 200 g of cassava peels seeded with wood-ash were mixed with 1200 cm^3 of distilled water and the slurry transferred into digester C.300 g of pig wastes and 100 g of cassava peels were mixed 1200 cm^3 of distilled water and the slurry transferred into digester D.400 g of macerated cassava peels mixed with 1200 cm^3 of distilled water were transferred into digester E. finally, 400 g of unmacerated cassava peels mixed with 1200 cm^3 0f water were also transferred into digester F.

The digesters were made airtight using rubber corks to avoid gas leakage. A hole, to which a tube fitted, was drilled on the rubber cork. The tube was passed into a measuring cylinder inverted over acidified water in a plastic bowl as shown in Plate 1.

The measuring cylinder was used as a reading scale as well as a gas collector. The acidified water was prepared by adding 0.6 molar of sulphuric acid (H_2SO_4) with 11.2 g of NaCl. This was used to prevent dissolution of the gas released into the water.

The hole on the top of the can was covered with glass funnel and the measuring cylinder filled with acidified water was inverted over the glass funnel. The digesters were corked to generate an anaerobic condition. Biogas productions were recorded at interval of 5 days for duration of 45 days. Rates of biogas production during the period were also recorded.

RESULTS AND DISCUSSION

The composition of digester slurry is shown in Table 1. The amount of biogas production from anaerobic degradation of pig wastes and cassava peels is recorded in Table 2 and Fig. 1. The pH and Titratable acidity (TTA) of digested slurry is recorded in Table 3.

From day 1-5, zero production of gas was recorded in 4 of the digesters, though in digesters B and D fermentation was shown to have resulted to gas production but at minimal level (15 and 14 cm^3, respectively). The peak period of gas production was between day 11-15 where digesters A, B, C and E recorded 380, 705, 500 and 132 cm^3 of the gas, respectively. A nil record for D was due to gas leakage, which occurred between days 6-19. Thus, the total and mean gas production was grossly affected. Similarly, a zero production was observed for digester E. This, however was as a result of the pH, which was low (3.34).

A similar peak period was of 15-25 days was reported by Oyagade *et al*. (1999).

Digester C recorded the highest volume of gas produced (2345 cm^3) which is more than twice of digester B with similar parameters as shown in Table 2 and Fig. 2. It can be deduced hence that the effect of seeding with wood-ash enhanced gas production.

This result agrees with the observation of Itodo *et al*. (1992) who observed that the use of wood waste as a medium material for seeding exhibited good characteristics in accelerating biogas yield.

The least total gas production was observed in digester E with a record of 83 cm^3 whereas digester F, which was identical in contents, recorded a volume of 552 cm^3 as shown in Table 2 and Fig. 3.

The maceration of the cassava peels used in digester E exposed a greater surface area of the substrate thereby releasing a larger amount of its mineral contents into the medium.

This must have been responsible for lowering the pH to 3.34 as opposed to 3.63 in digester F as shown in Table 3.

Maramba (1978) reported that a PH range of 6-8 was necessary for biogas generation. Similarly, Garba and Sambo (1992) reported a PH range of 6-7. They observed that at a pH below 7, a significant inhibition of methanogenic bacteria occurred and the acid conditions of pH of 4 proved toxic to these bacteria, thus, at pH 4 gas production was very low and eventually stopped. Here,

Table 1: Media composition of digester slurry

Digester	Pig wastes (g)	Cassava peels (g)	Volume of water (cm^3)
A	400	-	1200
[a]B	200	200	1200
[b]C	200	200	1200
D	300	100	1200
[c]E	-	400	1200
[d]F	-	400	1200

a = without wood-ash; b = seeded with wood-ash; c = macerated cassava peels; d = unmacerated cassava peels

Table 2: Biogas production from pig wastes and cassava peels

Period	Digester A (cm^3)	Digester B (cm^3)	Digester C (cm^3)	Digester D (cm^3)	Digester E (cm^3)	Digester F (cm^3)
1-5	0	15	0	14	0	0
6-10	15	115	445	-	0	80
11-15	380	705	500	-	0	132
16-20	35	15	600	70	22	68
21-25	0	10	315	106	10	60
26-30	0	10	105	72	15	70
31-35	0	0	270	20	26	54
36-40	0	0	110	0	10	68
41-45	0	0	0	0	0	20
Total	430	870	2345	282	83	552
Mean	9.6	19.3	52.1	6.3	1.8	12.3

Table 3: PH and titratable acidity (tta) of digested pig wastes and cassava peels

Digester	pH	TTA (cm^3)
A	7.91	-
B	4.27	1.80
C	4.40	1.90
D	4.67	2.00
E	3.34.	1.30
F	3.63	1.50

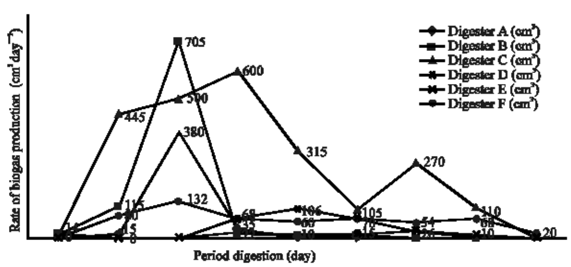

Fig. 1: Comparison of rate of biogas generation using different concentrations of pig wastes and cassava peels

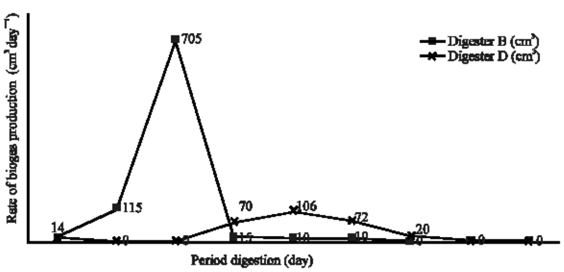

Fig. 2: Comparison of biogas generation between digester B and D

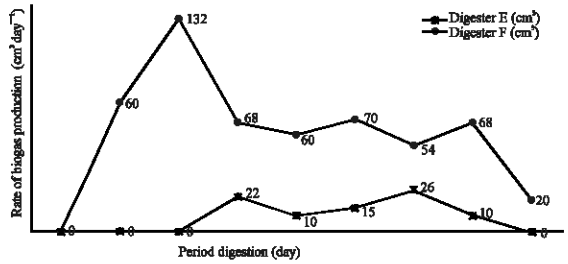

Fig. 3: Comparison of biogas generation between digester E and F

however, it was at pH 3.63 only that gas production continued up to the end of retention time of 45 days. Nonethless, the highest total gas production was shown to have occurred at a pH of 4.40. Also, at pH 7.91 gas production ceased after day 15-20. As shown in Table 3, the low volume of filtrate from digester slurry required to titrate 2 mL of NaOH (0.1M) confirmed the acidity of the media with low PH values. The alkalinity of filtrate from A also was confirmed in the base even at a volume of as high as 13 cm^3. Titratable Acidity (TTA) was observed to be directly proportional to the PH of the digested media.

CONCLUSION

The highest volume of gas produced in digester seeded with wood-ash is an indication that seeding of substrates with wood improves biogas yield. However, the poor performance of digesters must have resulted from the quite acidic PH of the media as opposed to the near neutral requirements of the methanogenic bacteria. It is supposed that methanogenesis occurred here because the methanogens involved was able to adapt to the acidic conditions of the digester media The poor gas yield even under an alkaline PH of 7.91 suggests that the methanogens involves in gas production here thrives better under non-alkaline PH conditions.

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