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BIOGAS PRODUCTION POTENTIAL USING ANIMAL WASTES AS A SOURCE OF ENERGY FOR SELF RELIANCE AND SUSTAINABLE DEVELOPMENT - A CASE STUDY OF KATSINA STATE ABATTOIR, NIGERIA.

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Abstract
Abattoir wastes can be converted to biogas production. This paper presents the potentials of biogas plant In Katsina abattoir because the visceral wastes are polluting the abattoir with its surroundings. The effect of four different rumen dung's slurry concentration (1:1, 1:3.1:4 and 1:5) at 30 days retention time was studied at Ibrahim Shehu Shema center for renewable energy (ISSCRE) of Umaru Musa Yar'adua University Katsina. The result shows that biogas yield in 1:3 and 1:4 were significantly higher than those at 1:1 and 1:5 concentrations for a given retention time. The outcome of the research suggest that biogas production is in order of 1:3>1:4>1:5>1:1, which means that further increase In substrate concentration result in the decrease of the specific growth rote which result in lower gas production. The rumen Dung was examined for PH and specific gravity. The mean rumen PH values were 6.98± 0.03 and 7.14 ± 0.04 for camel and cattle respectively. While mean specific gravity values were 1.016 ± 0.005 and 1.005 0.001 for camel and cattle respectively. The study reveals that for optimum biogas production, the slurry could not be too much concentrated or too much diluted to substrate ratio

Introduction
Biogas is a cheap source of energy because the feed stock is usually waste materials like abattoir waste; it is a methane-rich gas that can be produced from anaerobic digestion of organic materials when biomass is subjected to biological gasification.
The organic waste of the abattoir is polluting the surrounding environment that eventually affects the health condition of both livestock and the people around the area. Biogas is used for cooking, heating and can be used in unit operations like frying, cold storage of agricultural products such as meat, fruit and vegetables. And is also used for sewage treatment to eliminate the harmful micro-organisms. About 85% of the pathogens contained in the waste are killed by the anaerobic digestion process [1]. In order to alleviate problems of increasing energy need and environmental hazard caused by indiscriminate dumping of animal waste in Katsina abattoirs, the need for a biogas plant becomes necessary.
Animal wastes (dung and, other visceral components) which can be rich in biogas are being wasted as a result of lack of utilization [2]. Biogas production is an alternative for the utilization of the energetic value of organic materials without destroying their manorial value. Therefore, the problem is that of production of alternative energy using abattoir waste such that the risk associated with indiscriminate dumping is possibly eliminated. The gas is valued as a source of energy while the slurry is valued for its fertilizing properties (soil nutrients). Energy content of biogas can be transformed into various other forms such as mechanical energy (for running machines) and heat energy (for cooling and lighting) depending on the need and availability of the technology.
The factors that affect the production of biogas include temperature, PH, total solids concentration of the slurry, digester type and design, presence of toxic ingredients in the waste stream and the carbon to nitrogen ratio of the slurry.
Therefore, the objective of the research is to screened abattoir waste for biogas production/concentration potentials at different retention time with a view to solving its disposal problems.

Materials and methods
Description of the study site
Katsina abattoir located at Dutsin-ma road in Katsina local Government Area, lies between 12°15N" and 7°3E" latitude in the Sudan Savannah zone of Nigeria [3]. Katsina has hot and dry climatic conditions for most of the year. The hottest months are March to May with temperature ranging from 23°c to 42°c. The annual rainfall varies from 700mm-l000mm and the rainy season is usually from June to October with temperature rising from 21°c to 36°c, the hammatan is from November to February with temperature 18°c to 32°c. The people of Katsina are mainly farmers, petty traders and civil servants [4]. The populations of livestock in Katsina are ruminants that include camels, cattle, sheep and goats.

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Sample analysis

Rumen is the first and largest compartment in the body of ruminants that stores the ingesta and it can hold different capacities of materials, depending on the size of the animal [5]. Record of the number of animals slaughtered daily determined the total weight of rumen content produced daily, using spring balance.

The open waste dump area of about $50m^2$ is where the rumen contents are dumped with other animal wastes that remain for about a month which makes the dumping area sludgy and full of odour, littering the environment thereby posing health hazard to people and the ruminants living around, the dumping area is large enough to accommodate the biogas plant. The animal waste will be the feed stock for the anaerobic digester (biogas) production because they are organic compounds that contain nitrogen and carbon in the required proportion. The mesophilic temperature range for biogas production is 20-40°c and considering the technology to be used at Katsina which is in the tropics having an annual temperature of 23-32°c shows that biogas plants will operate well within mesophilic temperature conditions.

Materials

The materials used in this work are camels and cattle dung's, both fresh and dried one all serving as the samples/substrates. Empty plastic containers (3000g capacity each) serving as the digesters, while $1000cm^3$ measuring cylinder serving as the gas holder.

Sample collection

The rumen (camels and cattle) dung's was obtained (both fresh and dried one) from Katsina abattoir. All samples were collected and kept in a polythene bag.

Sample processing

The rumen dung's collected (only the dried one) was sun dried and thereafter crushed mechanically using a mortar and pestle to ensure homogeneity at Ibrahim Shehu Shema Center for Renewable Energy (ISSCRE)

Apparatus

The following materials were used for the purpose of this research; candle wax, retort stand, basin, plastic containers, liquid gum, measuring cylinder ($1000cm^3$), a top loading weighing balance (Model BH1000) with capacity of l000kg and resolution of 0.001kg digital PH meter (Hanna Model PH -211), tap water, mortar, pestle, and hose pipe. The volume of gas produced has been taken on 24-hour basis and the average for each week was taken.

Preparation of slurry

For the dried dung's, l000g of the rumen dung's were weighed into an empty plastic container which serve as the digester. It was followed by the addition of $3000cm^3$, $4000cm^3$, and $5000cm^3$ of water and also for the fresh one; 1000g of the rumen dung's were weighed and then followed by the addition of $1000cm^3$ of water. The mixtures were stirred to obtain homogeneity; the slurry was obtained when saturated solution is formed. The hose pipe was inserted via a small hole followed by sealing the hosepipe with a strong effective liquid gum. All the digesters were sealed with a candle wax to obtain and ensure anaerobic environment for the set up.

Mixing ratio/dilution ratio

The dilution ratio of waste to water or the concentration for each of the samples were varied for the dried dung's (camels and cattle) are 1:3, 1:4 and 1:5 and for the fresh one is 1:1 respectively.

Determination of PH

A digital PH meter was used to determine the PH value of the prepared slurry for the samples before digestion, serving as initial PH value and after digestion of each retention time serving as the final PH value.

Experimental set up of biogas

A candle wax was used to seal the digesters containing the slurry to maintain the anaerobic condition. A hosepipe was connected at the top of each digester which was then inserted into a measuring cylinder of 1000cm3 capacity which serves as the gas holder filled with water and placed in an inverted position held firmly by a retort stand in a basin filled with water. The gas produced from the digesters will pass via the hosepipes to the measuring cylinder which as a result displaced the water down ward. The volume of gas produced is measured by the amount of water being displaced from the measuring cylinder and the daily ambient temperature was also noted throughout the retention period.

Results and discussion

Result

An average volume of $15410cm^3$ of biogas was recorded in this research. The weekly biogas produced from the rumen (camels and cattle) dung's both fresh and dried one was shown in table 1. Table 2, shows the cumulative biogas yield for the four digesters at different concentration. The accentuation in this research was on the determination of how concentration of the slurry affects biogas production that took part in the process of anaerobic digestion for a retention period of four weeks. Table 1 shows average biogas production in cm^3 from the both fresh and dried rumen dung's for a retention period of four weeks at average ambient temperature.

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Table 1. Average Gas Produced per week.

		AVERAGE BIOGAS PRODUCED (cm^3)				
S/No	Week	Digester A	Digester B	Digester C	Digester D	Temperature
1.	1	NGP	680	NGP	680	32
2.	2	NGP	840	1040	220	31
3.	3	NGP	3210	2800	1230	31
4.	4	930	2160	750	870	30
ACGP		**930**	**6890**	**4590**	**3000**	

KEY:
A: Fresh dung at Ratio of 1:1
B: Dried dung at Ratio of 1:3
C: Dried dung at Ratio of 1:4
D: Dried dung at Ratio of 1:5
NGP: No Gas produced
ACGP: Average cumulative gas produced

Table 2: Cumulative gas produced by each digester

A	930
B	6890
C	4590
D	3000
GT	**15410cm^3**

GT; Grand Total

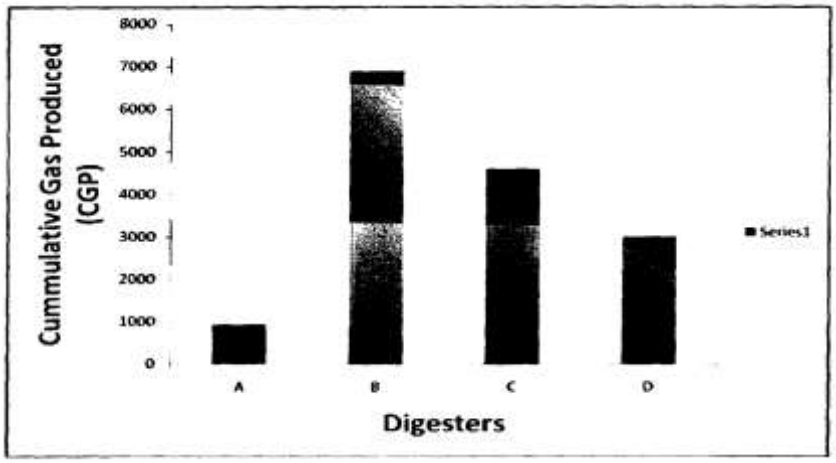

Figure 1: The Cumulative Biogas produced by the four substrates (cm^3)

The figure above represents the cumulative biogas produced by the four substrates in cm^3. It can be seen that the sample B (dried dung at a ratio 1:3) has the highest gas produced.

Discussion

From the experiment performed in the laboratory, a set of results were obtained that contain cumulative biogas yields for different substrate concentration loadings. Thus the results of biogas production from both fresh and dried rumen (camels and cattle) dung's, it was observed that biogas production was slightly slow at the beginning of observation. This is predicted because biogas production rate in batch condition is directly proportional to specific growth rate of methanogen bacteria in the biodigester [6].
The biogas produced in the entire retention time of the experiment yield a total of 15410cm^3. It was observed that at the first week of the experiment, digesters containing the dried dung have produced a significant amount of gas while the digesters containing the fresh dung yield no gas. A 680cm^3 volume of gas was recoded for digesters B and D with a dilution ratio of 1:3 and 1:5 respectively. While zero amount of gas produced was recorded for digesters C (dried dung) and A (fresh dung's) which is due to

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biodegradable material found in the rumen dung's [7]. Also, another gas yield was recorded in the second week of the experiment by digesters B, C and D, while digester A produced no volume of gas as shown in table 1.
However, digester B was found to produce the highest amount of gas in the third week of the experiment, followed by digester C and then D, and also no gas produced in digester A. It was noticed that effect of temperature affect the digester A in its production of gas, because it needs an optimum temperature of 30°c to 40°c for the bacterial growth found in it, any value of temperature below that level can probably lead to slow growth of the methanogen bacteria which leads to gas production [8]. A candle flame was used at the side of the digester A which result its production due to temperature changes by the candle wax.
Furthermore, in the last week of the experiment both the digesters containing the slurry produces an amount of gas as summarized in table 1.
Figure 1. Shows that biogas produced by the digester with a dilution ratio of 1:3 in the total retention time of the experiment has the highest yield of gas production as it can be seen clearly that the biogas production in the experiment is in order of B> C>D>A, which means that the slurry containing the dilution ratio of 1:3 is higher than that of 1:4 followed by 1:5 and then 1:1 of the fresh dung. It was observed that further increase of substrate concentration result in decrease of the specific growth rate [9] and also the specific growth rate decrease almost linearly at high concentration of the substrate.
Moreover, for optimum biogas production the slurry should not be concentrated or too dilute, the water to substrate ratio should be about 1:3 [10] so that the slurry should be at optimum level for the growth of methanogen bacteria which is responsible for biogas production.

Conclusion

The results of this study shows that abattoir waste could serve as a suitable substrate for biogas production. The utilization of this substrate for biogas production could minimize its disposal problems and create another abundant source of energy.

Recommendations

1. In view of the current energy crisis affecting the nations in the world, the dream of attaining food security and poverty eradication as well as environmental management in line with the millennium development goals (MDG) will surely come to reality if at all biogas technology is harnessed.
2. The utilities for operation of biogas technology are wastes, which are cheap, sometimes free, and in abundance. The investment is worthwhile and highly profitable. Nigeria and Africa has an alternative energy source that is ready to be used.
3. There is also the need to accentuate on disabusing the mind of the public on waste because most people are habitual in showing resistance or inertia to waste. Therefore there is need to coax on the idea that organic waste is useless.
4. It serve as a suitable substrate for Biogas production and proper utilization could minimize its disposal problems (such as environment pollution and other social vices) thereby creating another source of sustainable energy.
5. The technique should be modified by using a larger digester thereby utilizing more quantity of animal waste from the abattoir and more gas to be produced for sustainable energy development. Hence the environmental pollution will be drastically reduced.
6. Finally, advance research work should be done to determine the actual dilution ratio for all the substrate used in biogas production.

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